NAEMSP® Review Guide

for *Emergency Medical Services*

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Foreword

The editors hope that you find this review guide helpful when studying for your board certification exam and participating in EMS fellowship education.

Thank you to Drs Cone, Delbridge, Brice, and Myers, as well as the many other contributors to the textbook volumes, as their work is largely reflected here.

Thank you to all of the authors and editors to stepping up to the difficult task of trying to summarize our entire subspecialty.

Accompanying each chapter title is the corresponding page in the textbook for easy reference.

Please remember that if you are studying for the ABEM EMS Subspecialty Certification exam, in order to arrive where you are now, you have already been very good at taking exams throughout your educational journey. If using review guides has not been helpful to you in the past, it may also not be helpful to you now.

Please forward any suggestions, corrections, or other concerns to Ryan.Coughlin@yale.edu so we can make this project better.

VOLUME 1: Clinical Aspects of EMS

1: History of EMS, Page 1

1966 - The National Academy of Sciences National Research Council Report (NAS-NRC)

- EMS in the United States = "woefully inadequate" [Figure 1.1]
- >47,000 deaths in 1965 in motor vehicle accidents
- Many deaths preventable
- Highway Safety Act of 1966 funded to develop EMS standards, improve ambulance services, and create demonstration projects and studies.
- The act prompted DOT (Department of Transportation) to contribute more than $142 million to regional EMS systems between 1968 and 1979. 10M on research alone.

Inadequacies of Prehospital Care in 1966

1. The general public is insensitive to the magnitude of the problem of accidental death and injury.
2. Millions lack instruction in basic first aid.
3. Few are adequately trained in the advanced techniques of cardiopulmonary resuscitation, childbirth, or other life-saving measures, yet every ambulance and rescue squad attendant, policeman, fire fighter, paramedical worker, and worker in high-risk industry should be trained.
4. Local political authorities have neglected their responsibility to provide optimum emergency medical services.
5. Research on trauma has not been supported or identified at the National Institutes of Health on a level consistent with its importance as the fourth leading cause of death and a primary cause of disability.
6. The potentials of the U.S. Public Health Service Program in accident prevention and emergency medical services have not been fully exploited.
7. Data are lacking on how to determine the number of individuals whose lives are lost through injuries compounded by misguided attempts at rescue and first aid, absence of physicians at the scene of the injury, unsuitable ambulances with inadequate equipment and untrained attendants, lack of traffic control, or the lack of voice communication facilities.
8. Helicopter ambulances have not been adapted to civilian peacetime needs.
9. Emergency departments of hospitals are overcrowded, some are archaic, and there are no systematic surveys on which to base requirements for space, equipment, or staffing for present, let alone future, needs.
10. Fundamental research on shock and trauma is inadequately supported; medical and health-related organizations have failed to join forces to apply knowledge already available to advanced treatment of trauma, or educate the public and inform Congress.

Figure 1.1 Key findings of the 1966 NAS-NRC report. Adapted from *Accidental Death and Disability: The Neglected Disease of Modern Society*. Washington, DC: National Academy of Sciences, 1966, National Academy Press.

1973 - **The Emergency Medical Services Systems Act**:

- The law and subsequent regulations emphasized a regional systems approach, a trauma orientation, and a requirement that each funded system address the 15 "essential components." [Figure 1.2] Provided $300M.
- Money ran out in 1980s, but this helped create the infrastructure for EMS funding
- Universal 911 advocated in 1973.
    - **Pros:**
        - Started money flow for EMS nationally.
        - Created DHEW KKK 1822 - Standards for ambulance construction (one of 15 components)
    - **Cons:**
        - Lacked medical direction & oversight as important factors.
        - Not developed for patient or consumer.

- Lacked infrastructure for engineering of system.
- Elements of a successful system could not be assembled into useful framework.
- Some feel it was oversimplified

1. Manpower
2. Training
3. Communications
4. Transportation
5. Facilities
6. Critical care units
7. Public safety agencies
8. Consumer participation
9. Access to care
10. Patient transfer
11. Coordinated patient record-keeping
12. Public information and education
13. Review and evaluation
14. Disaster plan
15. Mutual aid

Figure 1.2 *The Fifteen Essential EMS Components.* Washington, DC: Department of Health, Education, and Welfare, Division of EMS, 1973.

1978 - The DOT & Department of Health, Education and Welfare (DHEW) created Memorandum of Understanding (MOU) on EMS system development responsibilities, which quickly failed.

- The American Society for Testing and Materials created 30 standards, all non-mandated.

1981 - The Omnibus Budget Reconciliation Act

- Reagan signed cost-containment legislation that converted 25 Department of Health and Human Services (DHHS) funding programs into seven consolidated block grants.
- EMS was included in the Preventive Health Block Grant
    - Effectively, individual states were left to determine how much money from the block grants would be distributed locally.
- Generally quite political, with little direct input from the public or the medical community.
- By 1982, all federal EMS system financial support would end, and regional EMS programs would be the responsibility of the regional agencies.
- The federal role was to be “one of technical assistance and coordination.”

1984 - EMS for Children (EMSC) program funded.

1985 - NAEMSP started.

- COBRA/EMTALA (Consolidated Omnibus Budget Reconciliation Act & Emergency Medical Treatment and Labor Act) also passed this year.

1991 - AHA (American Heart Association) introduced chain of survival and ‘early’ approach to cardiac arrest.

1996 - NHTSA (National Highway Traffic Safety Administration) creates **The EMS Agenda for the Future**

- Better roadmap on how to build effective EMS system.

2002 - Medicare reimbursement for air ambulances change in 2002, resulting in an increase in programs, along with problems in regulation of these services due to the 1978 Airline Deregulation Act.

- Advocates for EMS founded in 2002.
- "First-Hour Quintet" from European Resuscitation Council conference
    - Out of hospital cardiac arrest (OHCA)
    - Severe respiratory difficulties
    - Severe trauma
    - Chest pain including ACS (acute coronary syndrome)
    - Stroke

2003 - Institute of Medicine (IOM) released **'Emergency Medical Services at the Crossroads'** which recommended coordinated emergency and trauma care systems across the country. And most importantly said that EMS should be a ABEM recognized subspecialty.

2005 - National EMS Information System (NEMSIS) MOU signed by all 50 states and 2 Territories. 4% of post-9/11 funding went to EMS.

2006 - Initiation of the Federal Interagency Committee on EMS to ID state and local needs, recommend new EMS programs, and coordinate Federal programs interface with EMS systems.

2006 - Institutes of Medicine report on 'The Future of Emergency Care' in the US.

2010 - EMS approved by ACEP as subspecialty.

Section I: Airway

2: EMS Airway Management, 19

- Waveform capnography is critical for EMS airway monitoring

- Controversies: Prehospital endotracheal intubation (ETI):
    - **no proof it improves survival**
    - Adverse effect of ETI is more “time off chest” in CPR
    - Alternative airways in CPR may be better than ETI
    - EDs don’t change alternative airways for ETTs until pt stable.
    - Jury still out on pediatric ETI.

- No definitive advice on “successful PH airway program.”

- Limit ETI attempts to 3.

- Support use of alternative airways e.g. NIPPV (non-invasive positive pressure ventilation)

3: Airway Procedures, 30

- Basic airway interventions can be performed by all prehospital providers.

- Best to base oxygen protocols on clinical findings, not pulse ox reading.

- Always preferable to have NPA/OPA (nasopharyngeal and oropharyngeal airway) and 2 providers for effective BVM (bag-valve mask).

- Prehospital laryngoscopy is difficult. Video-assisted, nasotracheal, digital, lighted stylet, and bougie may all

confer advantages.

- SGAs (supraglottic airways) are assuming a more primary role in airway management, but little prehospital data.
- Many medical directors question role of prehospital cricothyrotomy given rarity and difficulty of procedure.
- Effective TTJV (transtracheal jet ventilation) requires flow of 50 L/min, only available with “wall” oxygen.
    - 16G IV with 50 LPM+20 BPM=TV 950 cc.
- Must continuously verify ETT positioning given risk of dislodgement.
    - **Only capnometers and capnographers are capable of providing continuous tube placement confirmation.**
- ACLS guidelines recommend commercial tube holders, but these have not been verified in prehospital environment and aren’t designed for SGA’s (which also need to be secured).
- Drug-facilitated intubation includes both RSI (rapid sequence intubation) and sedation-only.
    - NAEMSP has published national consensus standards.
    - Most common agents are etomidate and succinylcholine.
    - Agencies that perform RSI should also offer longer-acting paralytic.
    - Specialized pediatric teams may have additional protocols.
- Prehospital NIPPV has been shown to decrease intubation rates, shorten hospital length of stay, and improve survival.

4: Airway Management: Special Situations, 43

- Approaches for the rescuer position for ETI include prone, left lateral decubitus, kneeling, sitting, or straddling the patient in a face-to-face fashion (“Tomahawk” intubation).
- Limited evidence suggests left lateral decubitus may be more successful than other positions
- In terms of lighting: Increase ambient lighting of surrounding environment as much as possible. If adequate lighting is impossible, may consider blind digital intubation, lighted stylet, or SGA (supraglottic airway).
- Small, portable versions of many devices such as VL (video laryngoscopy), ETCO2, suction, and BVM exist for use by specialized wilderness/tactical/etc. teams.
- Feasibility studies have been performed examining the ability to broadcast ETI attempts from the ambulance to a remote observer, utilizing modified VL technology, or even regular smartphone technology.

- **Advanced airway management is impossible in care under fire/direct threat care phase.**
- In the tactical field care/indirect threat care phase, basic airway maneuvers can be attempted, NPA/OPA placed, or placement in the recovery position if unconscious (or sitting upright if conscious and bleeding). Cricothyrotomy can be performed in this phase as well.
- In the evacuation phase, acceptable airway management more closely mirrors normal prehospital environment including multiple ETI options, SGA, cric, etc.
- Airway management technique can affect exposure of tactical provider to an active threat.
- Operational constraints or type of injury may increase consideration of early surgical airway.

Section II: Breathing

5: Respiratory Distress, 53

- Two goals of assessment:
    1. Assess severity of airway and breathing
    2. Make provisional diagnosis/es to guide therapy

- Paramedics have a moderate (not perfect) degree of accuracy in etiology diagnosis
    - Agree with EM physician diagnosis 81% of time

- Disease severity assessment based on general observation,
    - Enhanced by vital signs, oxygen saturation, & CO2 monitoring

- If initial assessment includes possible progression to respiratory failure, need to assess airway for possible NIPPV

- Important to know upfront to what extent a patient wants resuscitation efforts
- Possible life threatening etiologies:
    - Asthma/COPD (chronic obstructive pulmonary disease) exacerbation

    - CHF (congestive heart failure) exacerbation
    - Myocardial infarction (MI) - not necessarily any outward signs, but likely will have subjective dyspnea
    - Pulmonary embolism (PE) - same variable presentation as MIs, +/- hypoxemia
    - Pneumothorax
    - Secondary to metabolic derangements
    - Secondary to neurological impairment

- Panic attacks: A diagnosis of exclusion

- Breath sounds: Cornerstone of diagnostic evaluation, can be fooled

- General treatments for respiratory distress:
    - Beta-agonists: safe to use in CHF (generally.. possible risk of worsen ischemia, but has chronotropic and inotropic support)
    - Consider early NIPPV versus ETI

Specific Disease Processes:

- Asthma: beta-agonists
- COPD: beta-agonists, NIPPV
- CHF: nitroglycerin, aspirin, NIPPV
- Infectious: O2 if needed, beta-agonists if needed, personal protective equipment

6: Oxygenation and Ventilation, 60

- **Oxygenation:** Typically assessed via pulse oximetry, which is unreliable in low tissue perfusion states and falsely reassuring in cases of carbon monoxide poisoning.

- **Ventilation**: EtCO2, as measured by a continuous waveform capnometer, is used as an indirect measure. It also gives information on the frequency and flow rate (i.e., rate & depth) of inhalation and exhalation. It will provide a more immediate representation of changes in respiratory function than SpO2. [Figure 6.2]
    - **Minute ventilation:** TV x RR → normal 6 - 7 L/ min

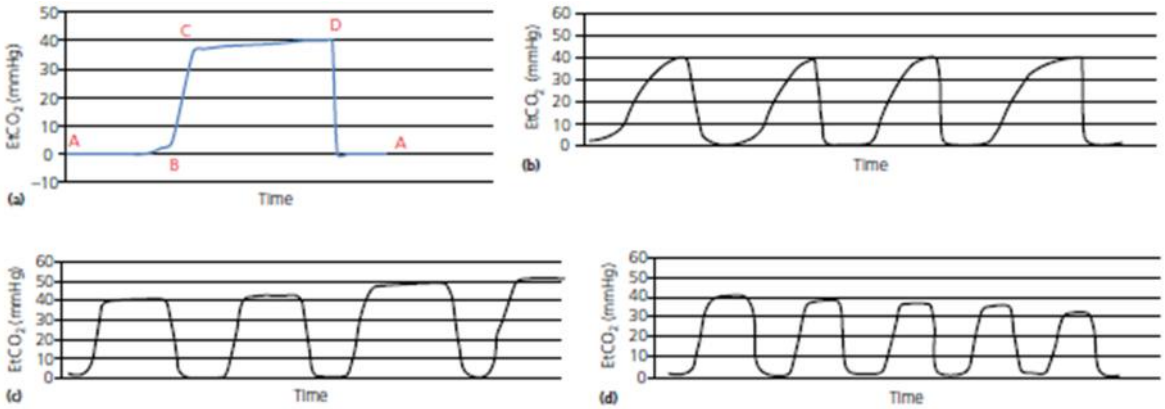

Figure 6.2 Capnography waveforms. (a) Normal waveform. Point A is beginning of expiration. A-B is expiration of dead space air. B-C shows rapid rise in level of CO_2 as air from lungs is exhaled. C-D is the plateau phase representing primarily alveolar air. D represents the value used for determination of $EtCO_2$. D-A represents inspiration. (b) Effect of bronchospasm. Note the slower rise in the CO_2 level leading to the so-called shark fin waveform. (c) Hypoventilation. (d) Hyperventilation.

- Supplemental oxygen should be considered for all patients with respiratory distress, clinical markers of respiratory compromise (e.g., altered mental status), or measured inadequate oxygenation (SpO2 <94%) or ventilation (ETCO2 <35 or >45). [Table 6.2]

Table 6.2 Devices for delivery of supplemental oxygen

Device name	O_2 flow rate (L/min)	FIO_2 (approximate %)
Nasal cannula	1–6	24–44
Simple face mask	5–12	35–55
Partial rebreather mask	8–15	35–60
Non-rebreather mask	8–15	60–95
Venturi mask	4–15	24–50
Tracheostomy mask	10–15	35–60

- Capnography is superior to pulse oximetry as monitor of respiratory function
    - "Shark fin" pattern = obstructive airway disease, often seen in COPD or asthma

- NIPPV useful in patients with pulmonary edema, COPD, asthma, and pulmonary hypertension.
    - **Patients must be awake, protecting their airway, have adequate respiratory drive, and be able to cooperate.**
    - Patients with marked respiratory failure and not appropriate for NIPPV should be treated with BVM.
    - Success of BVM improved with proper positioning & mechanical airway opening techniques (e.g., jaw thrust), and placement of NPA/OPA. Two-person technique is preferable. Care should be taken not to excessively hyperventilate the patient.

- Definitive airway should be placed for patients with marked depression of consciousness, inability to protect airway, or who require full mechanical ventilatory support. This can be ETT or SGA.

- **Ventilator modes:**
    - **Assist Control (AC):** Vent delivers set tidal volume with each breath. Patient can trigger breaths if breathing faster than set rate.
    - **Synchronized Intermittent Mandatory Ventilation (SIMV)**: Identical to AC except patient-triggered breaths are effort-dependent (patient's effort to determine the volume of the breath). If no respiratory effort: SIMV=AC.
    - **Pressure Support (PS)**: Delivers set inspiratory pressure above baseline PEEP with each patient-triggered breath. Patient's respiratory drive determines the rate and the patient's lung compliance and airway resistance determine the tidal volume developed.

- Lung-protective ventilation (tidal volume ~6 mL/kg using **ideal body weight**) should be used when possible. Common in ARDS (Acute Respiratory Distress Syndrome). Rate is typically started at 12/min but should be adjusted based on clinical situation. PEEP is typically started at 5-10 mmHg. Patients with obstructive physiology should be allowed adequate expiratory time, and increased Inspiration to Expiration ratios.

- Changes in peak inspiratory pressure are a common cause of vent alarms.
    - Low PIP (Peak Inspiratory Pressure) is usually a leak in the ventilator circuit.
    - High PIP can be caused by increased airway resistance (blocked tube, secretions) or decreased lung compliance (pulmonary edema, pneumothorax, pleural effusion, hyperinflation).
    - Inspiratory hold test can be used to tell these apart (disallows exhalation, eliminating airway

resistance from measurement). If the plateau pressure rises along with PEEP, decreased lung compliance is likely the cause.

- Must maintain high index of suspicion for pneumothorax, and any sign of tension physiology must be addressed immediately with needle decompression.

Special Considerations:

- Average rotor transport will not result in significant clinical effect on pneumothorax (usually 1,000-3,000 ft).
- Instrument flight conditions sometimes lead to altitudes of 6,000 feet, which will increase pneumothorax size by about 25%. Patients should not be flown fixed-wing (especially without cabin pressurization) without tube thoracostomy.
    - Boyle's law (P1V1 = P2V2)

Section III: Circulation

7: Hypotension and Shock, 69

- **Blood Pressure** = Cardiac Output × Peripheral Vascular Resistance

- **Cardiac Output** = Heart Rate × Stroke Volume

- **Shock Index:** Pulse Rate / Systolic Pressure → Normal = 0.5 - 0.8., Shock > 1

- Clinical assessment of shock: vital signs, pulse ox (which can be inaccurate in the low perfusion state of shock), ETCO2

- Shock treatment: isotonic crystalloid IVF (or IO), hemostatic agents or tourniquets, pressors

- There are lack of definitive studies on out-of-hospital shock treatment → controversies (i.e. pneumatic anti-shock garments)

- Studies showed no difference in survival to hospital discharge with prehospital IVF (San Diego and Houston) in traumatic hemorrhage. These were in systems with short transport times.
    - Goal: Give only enough IV/IO fluids to restore peripheral pulse, or SBP 80-90 (optimum target not defined).

- **Pediatric shock** more commonly present with a low cardiac output and a relatively high systemic vascular resistance (SVR). This has been described as “cold shock,” (Versus low-SVR state or “warm shock” frequently seen in adults). Usually requires more aggressive fluid resuscitation with volumes of 60 cc/kg or more. Add epinephrine as first line pressor for pediatrics.

- Pulse pressure < 30 mmHg or 25% of SBP may be early hypovolemic or obstructive shock.

- Wide pulse pressure may be distributive shock.

- Prehospital hypotension = 30% higher mortality rate.

- Elevated lactate level → patient requires aggressive fluid resuscitation.

Table 7.1 Categories of shock

Type of shock	Disorder	Examples	Comments
Hypovolemic	Decreased intravascular fluid volume	A. External fluid loss 1. Hemorrhage 2. Gastrointestinal losses 3. Renal losses 4. Cutaneous loss B. Internal fluid loss 1. Fractures 2. Intestinal obstruction 3. Hemothorax 4. Hemoperitoneum 5. Third spacing	Hypovolemic shock states, especially hemorrhagic shock, produce flat neck veins, tachycardia, and pallor
Distributive	Increased "pipe" size: peripheral vasodilation	A. Drug or toxin induced B. Spinal cord injury C. Sepsis D. Anaphylaxis E. Hypoxia/anoxia	Distributive shock states usually show flat neck veins, tachycardia, and pallor. Neurogenic shock due to a cervical spinal cord injury tends to show flat neck veins, normal or low pulse rate, and pink skin
Obstruction	Pipe obstruction	A. Pulmonary embolism B. Tension pneumothorax C. Cardiac tamponade D. Severe aortic stenosis E. Venocaval obstruction	Obstructive shock states tend to produce jugular venous distension, tachycardia, and cyanosis
Cardiogenic	"Pump" problems	A. Myocardial infarction B. Arrhythmias C. Cardiomyopathy D. Acute valvular incompetence E. Myocardial contusion F. Myocardial infarction G. Cardiotoxic drugs/poisons	Cardiogenic shock states tend to produce jugular venous distension, tachycardia, and cyanosis

8: Vascular Access, 78

- Flow is based on Poiseuille's Law: it is directly proportional to the radius to the fourth power, and inversely proportional to the length. Large gauge, short catheters are best when possible.

- IO sites:
    - Humeral head – Adducted with palm pronated. Palpate greater tuberosity.
    - Proximal tibia – Two finger breadths below and just medial to tibial tuberosity.
    - Distal tibia – Abduct and externally rotate the hip. Site is flat portion of bone just proximal to the medial malleolus.

- Dialysis fistula is a last resort, but this site is acceptable when the patient is in extremis.

- Pain and anxiety in the pediatric patient is difficult. Can attempt creams or small doses of lidocaine for pain control.

Section IV: Medical Problems

9: The Challenge of the Undifferentiated Patient, 87

- Prioritize life-threatening symptoms in the history, and only perform diagnostic tests relevant to patient's condition (e.g. EKG).
- For the truly undifferentiated patient, problems may occur at transfer to the ED personnel - review the history, diagnosis and testing used prior to the point of transfer.
- Use witnesses or next of kin, and scan the environment for more information, if the patient is unable to provide adequate history or context.
- Vital signs are vital.
- Do no harm.

10: Altered Mental Status, 92

- When history is not possible from patients:
  - Clues from surroundings are useful: bystanders, family, med-alert bracelets, medications, other sick residents or pets.
  - Questions other about the loss of consciousness or seizure-like activity.
  - Search bathrooms, medicine cabinets, nightstands.
  - Consider “huffing” / inhalant abuse.

Box 10.1 Mnemonic for causes of altered mental status

A Alcohol
E Epilepsy, Electrolytes, Encephalopathy
I Insulin (hypoglycemia)
O Oxygen (hypoxia), Overdose
U Uremia
T Trauma, Temperature
I Infection
P Poisons
P Psychiatric
S Shock, Stroke, Space-occupying lesion

- **Physical exam findings**: AVPU classification for level of responsiveness.
  - A = the patient is Alert
  - V = the patient responds only to loud Verbal stimuli
  - P = the patient responds only to Painful stimuli
  - U = the patient is Unconscious

  Evaluate for:
  - Head - trauma, pupil responsivity (toxidrome), odor of drug or toxic ingestion, tongue lacerations or abrasions for seizure activity.
  - Neck - stridor, obstruction as cause of hypoxia.
  - Chest - respiratory rate and pattern, trauma.
  - Abdominal - pulsatile mass as cause of collapse.
  - Neurological - focal or localizing signs, speech patterns, etc.
  - Skin - temperature, dehydration, rash, or track marks.

Medications and Antidotes:

- Dextrose - Only 25% of patients with AMS are hypoglycemic.
  - Can cause skin necrosis after inadvertent extravasation or subcutaneous infiltration, hyperosmolality, hyperkalemia, and potentially a **worsened neurological outcome in patients with focal or global cerebral or myocardial ischemia.**
- Naloxone - overdosing with theoretical risk of seizures but emergence phenomenon is frequent and real risk.
- Recommend against flumazenil → may precipitate seizures in patients with unknown chronic drug or etoh

abuse.

Criteria for non-transport of treated hypoglycemic diabetics:

- History of IDDM (insulin dependant diabetes mellitus) and not taking long acting oral hypoglycemics
- Post treatment BGL 80-100 mg/ dL
- Return of normal mental status and tolerating PO intake in front of EMS
- Responsible adult is present to observe patient
- Absence of complicating factors
- Direct medical oversight may be useful in these cases

11 Cardiac arrest systems of care, 98

- Cardiac arrest is time-critical event, but much of the survival benefit patients receive is due to community-based systems such as rapid recognition, bystander CPR (including dispatcher-assisted), and AED deployment and use.
- Epidemiology: Incidence of SCA is estimated between 166k and 450k/yr.
    - Survival to hospital discharge for OHCA is estimated between 5-10%.
    - VF is initial rhythm in approx 30-60% of cases (ie shockable).
- Elements of Community Cardiac Arrest Care System (Chain of survival):
    - Early recognition and calling for help
    - 9-1-1 dispatching and PAI/DLS
    - bystander CPR
    - PAD
    - first responder BLS care including defibrillation
    - ALS care
    - post-arrest care (including hospital interventions such as percutaneous coronary intervention and targeted temperature management (therapeutic hypothermia).

- Bystander recognition of SCA has been variable due to agonal breathing etc.

- Role of EMD in recognizing SCA from calls that arrive with other chief complaints. Dispatch algorithms have been updated recently to improve dispatcher recognition of agonal breathing as an indicator of OHCA.

- Bystander CPR rates and education efforts should be monitored by EMS MD and providers.

- **Emphasis on compressions before ventilations**

- Public Access Defibrillation: 70-80% of VF can be successfully converted to perfusing rhythm if shocked within 3 min of VF onset, but **survival decreases 7-10% per minute** for each minute delay.
    - AEDs provide faster access to defibrillation. Need to be well placed in community with members knowing they are present and how to put them on.
    - AEDs are very safe, but still some confusion about them.
    - Newer studies (such as ROC) show survival doubles with AED +CPR compared to CPR alone.

- BLS Care of first responders: 1st goal: early defibrillation access - OPALS study found that by increasing BLS response rate of <8 minutes from 77 to 92% improved survival to hospital discharge in SCA patients from 3.9 to 5.2%. 2nd goal: performing/continuing high quality chest compressions/CPR.

- ALS Care: Despite traditional “cornerstone of cardiac arrest care” ALS now recognized as secondary in importance to overall survival when compared to BLS and bystander response.

- Stewart quote: “Without dedicated medical leadership, the EMS system of a community flirts with mediocrity.” EMS physician is important in ensuring a system has adequate: training and equipment, optimal system design, hospital liaison, and QI program.

12 Cardiac arrest: clinical management, 109

- Resuscitation protocols: Initial cardiac arrest care must be provided under standing protocols (not on-line direction). AHA ACLS is what most systems rely on. Protocols should also provide convenient medication dosing mixtures/information. DMO should be prepared to provide appropriate direction for less common scenarios, such as pediatrics, toxins, etc.

Box 12.1 The potentially treatable Hs and Ts of cardiac arrest

Hs:
- Hypovolemia
- Hypoxia
- Hyper-/hypokalemia
- Hydrogen ion (acidosis)
- Hypothermia

Ts:
- Toxins
- Tamponade (cardiac)
- Tension pneumothorax
- Thrombosis (coronary)
- Thrombosis (massive pulmonary)

- Chest compressions: emphasis on early start of continuous, high-quality chest compressions with minimal interruptions. Coronary perfusion pressure >20 mmHg important for ROSC

- Defibrillation: A critical and time-sensitive intervention. Precede defib with chest compression and continue chest compressions following in order to better perfuse myocardium
    - Biphasic defibrillators → electrical current flows in one direction then the opposite → increased rates of ROSC compared to monophasic

- **Airway management:** changing landscape of now reducing time on airway and emphasizing compressions. More attempts halt CPR. Blind insertion supraglottic devices may be of use

- **Ventilation**: minimize ventilations to 8-10 bpm in order to prevent preload reduction due to increased intrathoracic pressure. ITD impedance threshold device is something to consider (though not borne out in studies completely)
    - **Impedance threshold device:** contains one-way valve that permits exhalation during downstroke of chest compression but prevents passive inhalation during upstroke → increased negative intrathoracic pressure, increased cardiac preload, and CPP

- **DNR and Termination of Resuscitation efforts:** Protocols are useful for addressing these situations. Direct medical oversight useful as well. Two primary situations of non-initiation: 1. patient has DNR status; 2. Patient has clear signs of irreversible death

- **Verbeek/ Morrison rule:** indicates termination of resuscitation in patients with an unwitnessed arrest after three periods of CPR, three AED analyses without shock recommendation, and no ROSC

- **Post Arrest Care:** Goals of post arrest care:
    - 1. maintain hemodynamic stability;
    - 2. Preserve the brain;
    - 3. Correct metabolic derangements;
    - 4. consider cooling

- **Therapeutic hypothermia:** AHA Class I recommendation for comatose survivors of out of hospital VT/ VF cardiac arrest, Class IIB for other rhythms - but no evidence that starting cooling in the field is beneficial

13 Chest pain and acute coronary syndrome, 120

- Epidemiology:
  - An MI every 26 seconds
  - 10x mortality of MVAs
  - pts arriving to ED *via EMS* with chest pain -> higher pretest probability of MI than general ED pop

- EMD not as accurate at predicting ACS versus stroke (PPV 6% versus 42%)
  - EMD should instruct patient to take ASA for non-traumatic chest pain, reduces mortality

- EKG interpretation—*computerized interpretation misses up to 20% true STEMIs*. Therefore, education also important

- Meds for ACS:
  - ASA (only med with mortality benefit)
  - O2
  - NTG (decreases MvO2 and increases collateral flow to ischemic areas)
  - morphine (reduced from class I to IIa for NSTEMI; remains I in STEMI)
  - beta blockers (limited/no EMS use --reducing arrhythmic events is equally offset by an increase in development of cardiogenic shock, and survival is similar regardless of early administration)

- Prehospital Fibrinolysis: feasible safe effective, not necessary if PCI readily available
  - PCI reduces mortality

- Systems of care
  - Designated centers for destination
  - prehospital notification (possible earlier activation)
  - air medical transport for PCI
  - expanding role of BLS
  - Shortening door to balloon time by 30 minutes reduces in hospital mortality from STEMI by 1%

14 Cardiac dysrhythmias, 129

- Treat unstable; borderline stable can be evaluated further
    - Hypotension
    - Chest pain
    - ALOC

- Classify EKG findings
    - Rate
    - Regularity
    - Wide vs narrow

- Focus actions to evaluate stable but symptomatic and borderline patients

- Stable wide complex tachyarrhythmias (WCTs)
    - Differentiating SVT vs VT if no P-QRS relationship:
        - A patient with new-onset WCT and a history of previous myocardial infarction or VT very likely will have VT
        - VT will often not slow during vagal maneuvers. Therefore, slowing of a WCT during these efforts suggests SVT. However, the absence of change does not diagnose VT.
        - Most VT does not respond to adenosine, whereas SVT usually slows or terminates. Conversely, lidocaine has little effect on most SVT and will terminate 75–85% of VT.
        - VT is usually regular and rarely seen at a rate of greater than 220/minute. Any chaotic WCT should be considered atrial fibrillation with abnormal conduction. When a chaotic WCT at a rate of greater than 220/minute occurs, atrial fibrillation from Wolff–Parkinson–White syndrome is present. This rhythm is prone to deterioration.

- Adenosine and verapamil can be used to terminate narrow complex tachycardias along with diltiazem
- Amiodarone (5 mg/kg IV over 5 minutes)
- Lidocaine (1.0–1.5 mg/kg IV up to 3 mg/kg)

Controversies

- Rhythm strips vs monitors: Strips are best whenever possible
- Synchronization and sedation during countershock
- Prophylactic lidocaine for PVCs—no benefit
- Pediatric dysrhythmias—Peds can have higher HR - up to 225 in response to physiologic stress. 2 J/kg = unstable dosing
    - Consider volume challenge

- Torsades: tends to be HR dependent and greatest chance of occurring when HR drops below 80-100.
    - Countershock when unstable and TC pacing or isoproterenol (titrate to HR >120)
    - Magnesium sulfate 2G IV push for those who fail counter shock

- Renal failure rhythm disturbances: most commonly hyperK—early $CaCl_2$
    - Lidocaine can cause asystole in the presence of hyperkalemia

15 Cardiac procedures and managing technology, 137

Intraaortic Balloon Pump (IABP)

- Mechanical device used in the stabilization of acutely ill cardiac diseased pt
- Typically seen during transfer between facilities
- IABP role is to stabilize the pt until definitive care can be achieved
    - Decreased cardiac afterload, augment diastolic perfusion pressure, increase coronary perfusion pressure
- Procedure:
    - Inserted into the femoral artery and advanced into the thoracic aorta
    - Balloon placed 1-2 cm distal to the beginning of the subclavian artery and MUST BE above the branches of the renal arteries
    - Tip of the catheter - visible between the 2nd and 3rd ICS
- Indications:
    - Acute MI, cardiogenic shock, ventricular aneurysm, left ventricular failure, valve or papillary muscle rupture
- Contraindications:
    - Absolute: Aortic dissection, abdominal aortic aneurysm, aortic valve incompetence
    - Relative: bleeding disorders and atherosclerosis
- Timing of pump - CRITICAL TO FUNCTION OF THE PUMP
    - Diastole: Balloon is INFLATED - Coronary and carotid arteries are perfused
    - Systole: Balloon is DEFLATED just prior to systole
- Triggers for pump timing:
    - ECG and arterial pressures
- Special circumstances:
    - Cardiac arrest will initiate “trigger arrest” alarm - will lead to thrombosis if left like this
    - CPR - switch to “arterial trigger” mode
    - If this does not work - switch to “internal trigger” within the IABP to avoid thrombus formation (last resort)
    - If ROSC is achieved this mode will need to be discontinued
    - With IABP failure: manual pumping of the balloon should occur with a Luer-Lok syringe

Ventricular Assist Devices (VAD)

- Cannulae in apex of left ventricle with blood flow TO pump and in ascending aorta with blood flow FROM pump

- LVAD (Left VAD) Complications:
    - Device problems
        - Battery or cable connection problems
        - Device failure
        - Patient problems
        - Neurological events like TIAs and CVAs

        - Bleeding (GI, epistaxis, hematomas, etc.)
        - Cardiac dysrhythmias
        - Infection
- Prehospital Encounters for LVADs
    - If possible, EMS should get a list of nearby patients with LVAD
    - ABCs
    - Do NOT cut clothes with shears as you could cut wires
    - EKG
    - Hemodynamic compromise: provide IV fluids
    - Only treat arrhythmias if symptomatic
    - CPR should only be performed in 2nd generation or later LVADs, and only as a last resort
        - This point is controversial
    - Transport to an LVAD facility only. With all batteries, controllers, etc.

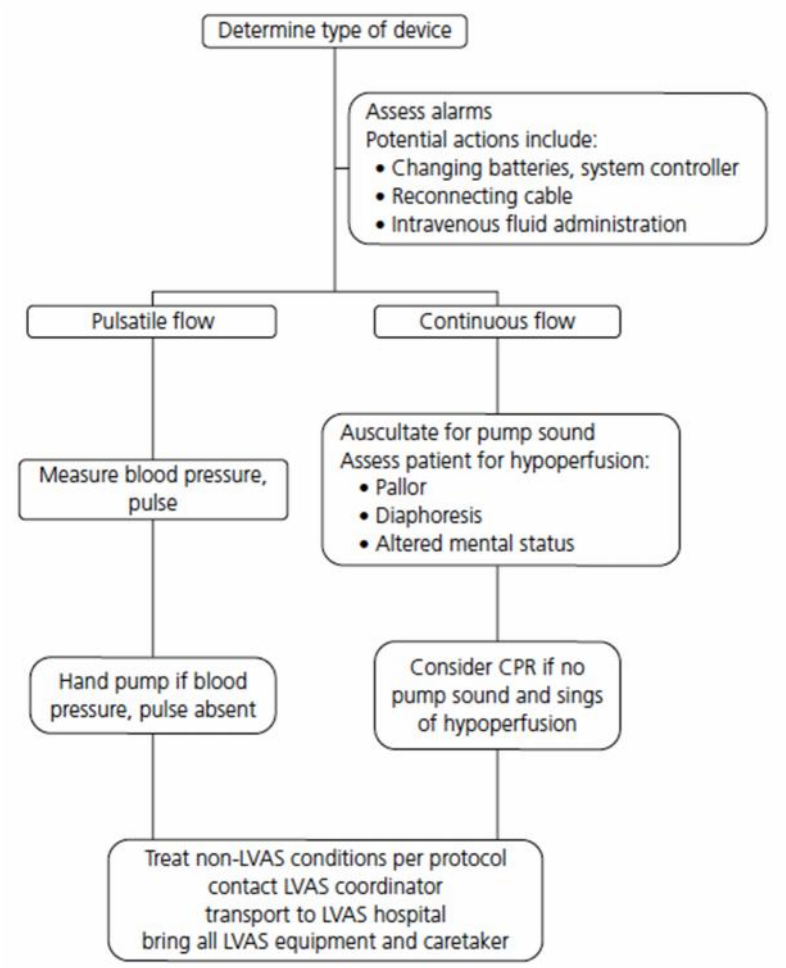

Figure 15.2 Emergency assessment of a patient with a left ventricular assist system (LVAS). CPR, cardiopulmonary resuscitation.

Implanted Cardiac Pacemaker

- Five letter codes, first three letters most commonly used:

    - First letter: Chamber paced
    - Second letter: Chamber sensed
    - Third Letter: Response after sensing
        - AOO Atrial pace; no sense, no inhibitions
        - AAI Atrial paced; atrial sense, inhibited by atrial beat
        - VOO Ventricular pace; no sense, no inhibitions
        - VVI Ventricular paced; ventricular sense, inhibited by ventricular beat
        - DOO Dual chamber pace; no sense, no inhibitions
        - DVI Dual chamber paced; ventricular sense, inhibited by ventricular beat
        - DDD Dual chamber pace; dual chamber sense, inhibited by either chamber

- If pacemaker requires suspension of firing, place magnet over pacemaker
    - This places pacer in an asynchronous fixed rate

Implantable cardioverter-defibrillators

- Three most common scenarios prehospital:
    - 1. Device failure and not firing with ventricular arrhythmia
    - 2. Appropriate firing with ventricular arrhythmia
    - 3. Inappropriate firing with NO ventricular arrhythmia
        - In this scenario, a magnet could be used to stop the firing

Pericardial tamponade

- Pericardiocentesis indicated for PEA in event of cardiac arrest from cardiac tamponade
    - Insert an 18 gauge needle to left of xiphoid
    - Aspiration of blood that does not clot indicates removal from the pericardial space as opposed to intraventricular blood

16 Abdominal pain, 144

- Abdominal pain patients represent approximately 5% of EMS call, and undertriage by EMs providers is common (11 to 22% sensitivity)

- Pain is caused by inflammatory, ischemic, or infectious etiologies, and diagnoses are commonly developed by quadrant location of the symptoms
    - Consider age and gender appropriate diagnoses when making differential

- Pain mechanisms:
    - Visceral-from a hollow or solid organ, causing poorly localized pain
    - Somatic- from the peritoneal lining causing more severe and localized pain

- Adequate history includes AMPLE and OPQRST description of pain
    - AMPLE: Allergies, Meds, Previous medical history, Last meal, and Events leading up to the EMS call
    - OPQRST: Onset, Palliation/Provocation, Quality, Radiation, Severity, and Time

- Physical exam includes vital signs and palpation of the abdomen in all 4 quadrants and eliciting peritoneal discomfort (e.g. tapping on the heel)

- Treatment
    - In all cases, stabilize ABC's, assure hemodynamic stability and relieve pain
    - IV fluid therapy to maintain a SBP of 90 to 100,
    - Small doses of IV opioid analgesics
    - 12-lead EKG and cardiac monitoring
    - O2 therapy as appropriate

17 Submersion injuries/drowning, 151

- Epidemiology
  - 4000-7000 non-fatal cases/year
  - 3000-6000 fatal cases/year
  - Drowning of children generally result from lapses in adult supervision
  - The risk of drowning or near drowning is 3–4 times higher in unfenced pools

- Definitions:
  - **Drowning:** suffocation and death as a result of submersion in liquid
  - **Wet drowning:** aspiration of watery sand and other material leading to pulmonary edema, pneumonitis, and surfactant dysfunction
  - **Dry drowning:** minimal aspiration due to laryngospasm
  - **Near drowning:** immediate survival after submersion event with symptoms ranging for asymptomatic patients to ROSC patients
  - **Secondary drowning:** death from ARDS following drowning

- Management:
  - Important to guide bystanders through CPR with AED (if available)
    - **42% kids who drowned at home had no CPR until EMS arrival**
  - Scene/crowd control assists with good CPR and prevention of secondary drowning events
  - Treat as all other cardiac arrests and consider transport to speciality centers as indicated
  - Consider active rewarming if severe hypothermia
  - Management of near drowning--focuses on ABC's, supplemental oxygen
  - Trauma is often concurrent, but benefits of c-spine immobilization should be weighed against difficulty of rescue efforts and rescuer safety
  - Should not be allowed to AMA

- Prognosis:
  - 10% survivors have severe lasting effects secondary to cerebral hypoxia

18 Choking, 155

- Time sensitive nature and can quickly progress to cardiac arrest

- Bystanders are optimal first responders, and knowing maneuvers (Heimlich) to help dislodge FB is the most useful

- Epidemiology:
    - Food most common object, but other non-edible objects are frequent in children
    - Toddlers 1-4 yo are highest risk, then 4-9 year olds, then adults over 60

- Maneuvers
    - For awake persons, the Heimlich is -86.5% effective at removing an obstruction
    - ACLS is recommending chest thrusts
        - Preferred in unconscious, pregnant, obese, and infants < 1 yo
        - Have higher morbidity than abdominal thrusts
    - EMS may attempt the Heimlich, direct visualization and removal with Magill forceps
    - Intubation may be attempted to push the foreign body into the mainstem bronchus
    - Cricothyroidotomy is a last resort
    - ENT may be required after initial stabilization

19 Syncope, 158

- **Syncope:** loss of consciousness and postural tone caused by diminished cerebral blood flow which must include both cerebral hemispheres simultaneously or reticular activating system in brainstem.

- Causes
  - Reflex mediated is the most common cause and best prognosis.
    - Body has an inappropriate autonomic response to a change in posture
    - Examples: vasovagal, orthostatic
  - Cardiac
    - Transient lack of adequate cardiac output
    - Examples: V Fib/tach, SVT, sick sinus, afib with RVR, AS, PE, long QT
  - Neurogenic
    - Rare
    - TIA, SAH, migraine, psychogenic
  - Idiopathic (35%)

- Assessment:
  - True syncope resolves on own, not with dextrose or after seizure
  - History is pivotal, but may need to get supporting details from bystanders
  - Complete physical exam is important although may be normal
  - Check glucose and EKG

- Differential diagnosis: seizure, pseudosyncope, narcolepsy, cataplexy

20 Seizures, 163

- **Seizure:** Excitation of susceptible groups of cerebral neurons or failure of inhibition by GABA system leads to prolongation of seizures
    - Seizures originate from cerebral cortex or thalamus
    - Important to determine if symptomatic seizure or unprovoked

- **Status epilepticus:** 5 min of seizing or multiple episodes without recovering to full consciousness between seizures

- Causes:
    - Electrolyte abnormalities
    - Medication and medication withdrawal
    - Toxins
    - Infections (CNS and systemic)
    - Hypoxia
    - Trauma,
    - Sleep deprivation
    - Pregnancy

- Febrile seizure:
    - 3 mo-5yrs due to maturing brain
    - No other cause found for seizure
    - **Simple Febrile Seizures:** last less than 10 min, are generalized tonic-clonic, and occur only once in 24 hours

- Treatment:
    - Protect patient
    - Oxygen
    - Check fingerstick
    - Benzodiazepines
        - Lorazepam (Ativan): 0.1-0.15 mg/kg IV over 1-2 minutes, max of 8 mg
        - Midazolam (Versed): 0.2 mg/kg IM or IV, max of 10 mg
        - Diazepam (Valium): 0.2 mg /kg IV at 5 mg/minute, max of 10 mg in pediatrics and 20 mg in adults
            - Can be given rectally at 0.5 mg/kg in pediatrics
    - Spinal immobilization probably unnecessary unless significant trauma

Box 20.2 Classification of clinical seizure types

- **I** Partial-onset seizures
  - **A** Simple partial seizure
    - **1** Motor symptoms
    - **2** Sensory symptoms
    - **3** Special sensory symptoms
    - **4** Other
  - **B** Complex partial seizure (clouded consciousness)
    - **1** Partial-onset seizure evolving into a complex partial seizure
    - **2** Impairment of consciousness at onset
  - **C** Partial-onset seizure evolving into a generalized seizure
- **II** Generalized-onset seizures
  - **A** Absence seizures
  - **B** Myoclonic seizures
  - **C** Clonic seizures
  - **D** Tonic seizures
  - **E** Tonic-clonic seizures
  - **F** Atonic seizures
  - **G** Others
- **III** Unclassifiable seizure types

21 Stroke, 171

- Epidemiology:
  - Stroke is now the fourth leading cause of death in the United States,
  - Leading cause of adult disability
  - Fall was stated as the primary problem in 21% dispatches in one review
    - Dispatchers correctly identify stroke 31-52% of time
  - Strokes are ischemic (80%) or hemorrhagic

- Definitions:
  - **Ischemic penumbra:** area surrounding central ischemia which has decreased blood supply, but can be salvaged depending on severity and duration of ischemia
  - **TIA:** neurological deficit lasting from a few minutes (NINDS) to 24 hours
    - Patients with TIA have a 10-20% risk of stroke in next 90 days, half in next 24-48h

- Management:
  - Obtain last known well time
  - Treat reversible conditions such as hypoglycemia
  - Identify stroke mimics
    - Complex migraine
    - Conversion disorders
    - Encephalopathy
    - Hypoglycemia
    - Labyrinthitis
    - Meniere disease
    - Todd Paralysis
    - Ramsay-Hunt syndrome
  - Blood pressure control may be feasible in the pre-hospital setting
  - TPA
- Prehospital Stroke Scales:
  - Goal is to use pre-hospital notification to decrease door to CT, time to tPA 3 (+) hours
  - Cincinnati and LAPSS are validated prehospital stroke scales that increase sensitivity
  - Melbourne Ambulance Stroke Screen (MASS) is hybrid of both

Box 21.2 Inclusion and exclusion criteria for intravenous tPA [24]

Inclusion criteria

Ischemic stroke onset within 4.5 h of drug administration
Measurable deficit on NIH Stroke Scale examination
Head CT does not show hemorrhage or non-stroke cause of deficit
Patient's age is >18 years

Exclusion criteria

Minor or rapidly improving symptoms
Seizure at onset of stroke
Major surgery within 14 days
Prior stroke or serious head trauma with past 3 months
Known history of intracranial hemorrhage
Sustained blood pressure >185/110 mmHg
Aggressive treatment necessary to lower blood pressure
Symptoms suggestive of subarachnoid hemorrhage
Gastrointestinal or genitourinary hemorrhage in last 21 days
Arterial puncture at a non-compressible site within 7 days
Heparin administration within 48 h with elevated aPTT
Prothrombin time >15 s
Platelet count <100,000 uL
Serum glucose <50 mg/dL or >400 mg/dL

Relative contraindications

Large stroke with NIH Stroke Scale score >22
CT shows evidence of large MCA territory infarction (sulcal effacement or blurring of gray-white junction in greater than one-third of MCA territory)

Relative contraindications for the 3-to 4.5-hour treatment window

History of prior stroke and diabetes mellitus
NIH Stroke Scale >25
Oral anticoagulant use regardless of INR
Age >80 years

Source: Miller 2012.[24] Reproduced with permission of Springer. INR, international normalized ratio; MCA, middle cerebral artery; NIH, National Institutes of Health; aPTT, activated partial thromboplastin time; t-PA, tissue plasminogen activator.

Table 21.2 Los Angeles Prehospital Stroke Scale

Criteria	Results		
Over age 45	Yes	Unknown	
No history of seizures	Yes	Unknown	
Symptoms less than 24 hours	Yes	Unknown	
Patient's baseline function is *not* bedridden or confined to a wheelchair	Yes	Unknown	
Blood glucose between 60 and 400	Yes	No	
Examination for asymmetry			
Facial droop	Normal	Right	Left
Grip strength	Normal	Weak/none	
Arm strength (by downward drift)	Normal	Drifts down	Falls rapidly
Examination finding unilateral?	Yes	No	

If exam findings are positive and answers are "yes" then LAPSS screening criteria are met and stroke is suspected. Source: Kidwell C. *Stroke* 2000; 31: 71–6. Reproduced with permission of Wolters Kluwer Health.

Table 21.1 The Cincinnati Prehospital Stroke Scale

Evaluate the following	Result
Facial droop (ask the patient to smile showing teeth)	Normal: No asymmetry Abnormal: One side of the face droops
Arm drift (with eyes closed, have the patient hold arms in front of body, palms up, for 10 seconds)	Normal: Able to hold arms out at 90°; both arms stay up or fall together Abnormal: One arm drifts downward
Abnormal speech (ask the patient to say a simple sentence, for example, "It is sunny today")	Normal: No slurring Abnormal: Slurs words or uses words that make no sense

Source: Kothari RU. *Ann Emerg Med* 1999;33:373–7. Reproduced with permission of Elsevier.

22 Allergic reactions, 179

- Definition of anaphylaxis:

Box 22.2 Definition of anaphylaxis

Acute cutaneous and/or mucosal involvement after antigen exposure *plus:*

- Respiratory compromise
  - Bronchospasm
  - Stridor
  - Hypoxia
- Cardiovascular compromise
  - Hypotension
  - Collapse
- Persistent gastrointestinal symptoms
  - Vomiting
  - Crampy abdominal pain

- Types of Allergic Reactions:

Box 22.1 Types of hypersensitivity reactions and anaphylaxis production

Type I Immediate(IgE or IgG) – most common
Type II Cytotoxic complement cascade (IgG or IgM)-Yes
Type III Immune complex (IgG or IgM)-Yes
Type IV Delayed T-cell-No anaphylaxis

- Management:
  - Determine mechanism of sting or origin of allergy
  - ABC's, IV,oxygen, monitor
  - Albuterol nebulizer as needed
    - Epi nebulized by placing 0.5 mL of 1:1000 solution in 2.5 mL NS
  - Epi auto injector if available
    - Caution in Epi >age 50
    - Epi IM > SQ –if hemodynamically stable 0.3ml of 1:1000
  - Epi IV
    - Epi IV 1 ml of 1:10,000 if hemodynamically unstable (mix w 10mL NS and slow push over 5-10 min)
  - Wound Care
  - Antihistamines
  - If the patient takes beta blocker, give glucagon 1 mg increments to overcome beta blockade

Diabetic emergencies, 184

- Epidemiology:
  - 8.3% of total US population with DM
  - Not all recognized (90-95% Type II)
  - EMS is usually called for hypoglycemic emergencies

- Hypoglycemia:
  - Glucose < 70
  - Treatments:
    - Oral glucose
    - IV dextrose
      - Giving 50 ml of D50 raises blood glucose 166 mg/dL, but varies widely
      - D10 has the same median time to euglycemia, requires 15g less glucose so there are fewer hyperglycemic events, and is less sclerosing
    - IM/IN/SC glucagon

- Safe refusals after correction of hypoglycemia by paramedics include:
  - Returning to baseline mental status
  - Tolerating PO intake
  - Having a responsible adult present with the patient
  - Not having any condition that predisposes to a repeat episode
  - Written instructions to follow-up with their physician
  - No long acting agents (either insulin or oral)

- Hyperglycemia:
  - Glucose > 200 mg/dL
  - Includes DKA and hyperglycemic hyperosmolar state (HHS)
    - HHS mortality 10-50%

- Pediatric hyperglycemia/dka:
  - Predisposed to life-threatening cerebral edema with rapid volume repletion
  - Initial resuscitation should only be intended to reverse appearance of shock or hypotension
  - Insulin at the hospital plays an important role

24 Renal failure and dialysis, 190

- Pathophysiology:
  - Kidney receive about 20% of cardiac output

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- Acute Kidney Injury (AKI):
  - Defined as rapid loss of the kidneys' excretory function with accumulation of urea and creatinine or decreased urine output
    - Increase in serum creatinine by ≥0.3mg/dL within 48 hours
    - Increase in serum creatinine ≥1.5 times baseline of previous 7 day
    - Urine output <0.5mL/kg/h for 6 hours

- Causes of AKI:
  - Pre-renal-problems affecting kidney before the renal arteries
  - Post-renal-problems after collection system
  - Intrinsic-problems affecting micro and macroscopic structures of kidney

- Chronic Kidney Disease (CKD):
  - Presence of kidney damage or renal dysfunction with GFR < 60 for > 3 months
  - Mainly caused by intrinsic disease most likely secondary to diabetes or hypertension
  - African Americans have a 3.4 times higher incidence of ESRD than Caucasians

- Complications of renal failure include:
  - Fluid overload
  - Electrolyte abnormalities
  - Uremic or infectious pericarditis which may progress to tamponade
  - Cardiovascular disease & Stroke
    - Left ventricular hypertrophy is a common EKG finding that may obscure ischemic changes in CKD patients
  - Anemia with hemoglobin < 10
  - Infection of indwelling catheter

- Post Dialysis complications include:
  - Hypotension
  - Air embolism
  - Bleeding
  - Infection
  - Disequilibrium syndrome

- Destination selection
  - Consider choosing hospitals with dialysis capabilities for ESRD patients

- Disaster and Mass Casualty Preparedness
    - Include dialysis units in your preparedness

25 Infectious and communicable diseases, 198

- Paramedics are typically the first health care personnel to encounter communicable diseases

- General approach:
  - Risk assessment by call taker
  - On scene personnel
    - Do you have nausea, vomiting, diarrhea, cough, runny nose, etc.?
    - Do you have fever or chills?
    - Have you recently returned from or been in contact with someone who has been in an area with a currently active outbreak?
    - Choose appropriate PPE and transport to appropriate facility

- Definitions:
  - **Infectious disease:** invasion of host by disease producing organism
  - **Communicable disease:** disease that can be transmitted from one person to another
  - Example: Malaria is infectious, but NOT communicable

- Modes of transmission:
  - Contact:
    - **Direct:** Contact occurs between an infected individual and the host
      - Examples: biting, kissing, sexual contact (herpes)
    - **Indirect:** Passive transfer through contaminated intermediate object
      - Example: Unwashed bedclothes (staph infection)
  - Droplet:
    - Large droplets generated from respiratory tract from coughing or sneezing, or invasive airway procedures (intubation, suctioning)
    - Examples: meningitis, SARS, RSV, flu, rhinovirus
  - Airborne
    - Infectious agents are contained in very small droplets which can remain suspended for prolonged periods of time
    - Dispersed by air currents
    - Can be inhaled by susceptible host located some distance from source
    - Examples: varicella, tuberculosis, measles
  - Vector
    - Illness is caused by parasites, viruses, or bacteria that are transmitted by arthropods to humans
    - Examples: West Nile Virus, Malaria

  - Common Vehicle
    - Spread of infectious agents by a single contaminated source to multiple hosts
    - Can result in large outbreaks

        - Examples: Salmonella or E. coli outbreaks from food or water

- Influenza
    - Types: A, B, C
        - A is more severe and causes pandemics
        - B is more mild and affects pediatrics more
        - C rarely affects humans and has NOT caused pandemics
    - Symptoms: Fever, sore throat, cough, myalgia, headache, chills
    - Transmission: airborne
    - Incubation: 1 day prior to symptoms to 5 days after symptoms begin
    - Prevention: vaccine is primary way to prevent disease, hand-washing, shielding coughs and sneezes, antivirals as prophylaxis
    - Treatment: Antivirals can be used as treatment for the immunocompromised

- Avian influenza
    - Carried by wild birds, but may kill domesticated birds
    - Type of Influenza A
    - H1N1 and H5N1 are deadly strains found in humans

- Tuberculosis
    - *Mycobacterium tuberculosis*
    - Symptoms: cough, hemoptysis, weight loss, decreased appetite, chills, night sweats, fever and fatigue
    - Transmission: droplet
    - Incubation: 2-10 weeks
        - Those exposed should get a test on first evaluation and a second test 8-12 weeks later
    - Prevention: N95 mask
    - Treatment for active TB: Four drug regimen: Rifampin, isoniazid, pyrazinamide, ethambutol (RIPE)
        - Eliminate in 2-4 weeks with medical therapy
    - Treatment for latent TB: Isoniazid for 6-9 months
    - **Notify public health**

- SARS, MERS, and Related Coronaviruses
    - *Coronaviruses*
    - Symptoms: fever, headache, malaise, myalgia, diarrhea, vomiting, cough
    - Transmission: droplet

- Bioterrorism Agents:

Box 25.1 Centers for Disease Control and Prevention categorization of bioterrorism agents (source: www.bt.cdc.gov/agent/agentlist-category.asp)

Category A

High-priority agents include organisms that pose a risk to national security because they:

- can be easily disseminated or transmitted from person to person
- result in high mortality rates and have the potential for major public health impact
- might cause public panic and social disruption; and
- require special action for public health preparedness.

Anthrax (*Bacillus anthracis*)
Botulism (*Clostridium botulinum* toxin)
Plague (*Yersinia pestis*)
Smallpox (variola major)
Tularemia (*Francisella tularensis*)
Viral hemorrhagic fevers (filoviruses, e.g. Ebola, Marburg, and arenaviruses, e.g. Lassa, Machupo)

Category B

Second highest priority agents include those that:

- are moderately easy to disseminate
- result in moderate morbidity rates and low mortality rates; and
- require specific enhancements of CDC's diagnostic capacity and enhanced disease surveillance.

Brucellosis (*Brucella* species)
Epsilon toxin of *Clostridium perfringens*
Food safety threats (e.g. *Salmonella* species, *Escherichia coli* O157:H7, *Shigella*)
Glanders (*Burkholderia mallei*)
Melioidosis (*Burkholderia pseudomallei*)
Psittacosis (*Chlamydia psittaci*)
Q fever (*Coxiella burnetii*)
Ricin toxin from *Ricinus communis* (castor beans)
Staphylococcal enterotoxin B
Typhus fever (*Rickettsia prowazekii*)
Viral encephalitis (alphaviruses, e.g. Venezuelan equine encephalitis, eastern equine encephalitis, western equine encephalitis)
Water safety threats (e.g. *Vibrio cholerae*, *Cryptosporidium parvum*)

Category C

Third highest priority agents include emerging pathogens that could be engineered for mass dissemination in the future because of:

- availability
- ease of production and dissemination
- potential for high morbidity and mortality rates and major health impact
- emerging infectious diseases such as Nipah virus and hantavirus.

- Anthrax:
  - *Bacillus anthracis*
  - Presentations: cutaneous, gastrointestinal, inhalational
    - Cutaneous: small, painless, pruritic papule, then eschar
      - Low mortality with antibiotics
    - GI: nonspecific symptoms, may progress to widespread GI hemorrhage
      - Mortality of 25-60%
    - Inhalational: flu-like sx initially, 2-3 days later fulminant disease
      - Mortality of 97% without antibiotics, 75% with antibiotics
  - Transmission: Injected, ingested or inhaled from environment
  - Prevention: Vaccine is available
  - If exposed to inhalational, post-exposure prophylaxis is recommended
    - Doxycycline and ciprofloxacin are antibiotics of choice

- Botulism:
    - *Clostridium botulinum*
        - Neurotoxin prevents release of acetylcholine
    - Symptoms: neurotoxin causes flaccid paralysis
    - Four types of exposure: foodborne, wound, intestinal, inhalational
    - Treatment: Trivalent and Heptavalent Botulinum Antitoxin and supportive care
    - No reported cases of person to person transmission
    - Bag any suspected clothing or items with botulism suspected

- Plague:
    - *Yersinia pestis*
    - Symptoms: fever, chills, sore throat, malaise, headache, suppurative lymph nodes.
    - Transmission: Contact and vector-borne
    - Precautions: Airborne precautions
    - Treatment: Doxycycline and ciprofloxacin
    - Fatality of 50-90% without antibiotics, treated is 15%

- Smallpox
    - *Variola major* and *Variola minor*
    - *V. major* is the more severe type with a 30% mortality rate
    - Symptoms: fever, headache, nausea, vomiting, muscle pain, malaise
    - Transmission: Airborne
    - Prevention: Vaccine
        - Modified smallpox can occur in previously vaccinated persons
        - Suspected patient: N95 masks
    - Contaminated clothing, bed, items: Autoclaved or washed with bleach

- Tularemia
    - *Francisella tularensis*
    - Forms: ulceroglandular, glandular, oculoglandular, septic, oropharyngeal, pneumonia
        - Ulceroglandular is the most common form
    - Symptoms: flu-like sx, fever, cough, sore throat, chills, headache, body aches
    - Transmission: through skin, mucous membranes, lungs and GI tract
    - Vehicles and equipment must be decontaminated afterwards

- Viral hemorrhagic fevers
    - Examples: Ebola, Marburg, Hantavirus
    - Symptoms: fever, headache, muscle aches, fatigue
    - Initial transmission is via vector and varies with each virus
    - Person to person is typically by direct contact with blood fluids
    - Monitoring of exposed persons: 3-21 days with twice daily temperatures

- Treatment: supportive care

Section V: Trauma Problems

26 Trauma Systems of Care, 211

- Epidemiology:
  - Injury related ED visits (36%)
  - Mostly 18-24 y/o male group with unintentional MVCs

- Central EMS trauma concepts:
  - Consistent assessment algorithm that can be applied to any trauma patient
  - Time is of the essence so have appropriate destination policies
  - Limit additional mortality
  - Universal precautions and scene safety

- Special Considerations:
  - Scene assessment
    - Photography, event data recorders in MVCs, telemedicine evals
  - Airway management
    - Ideally related to distance to trauma center, adequacy of BVM oxygenation, and ability of paramedics to perform prehospital RSI
  - Perfusion
    - Hypotensive or hypoperfusing patients should receive IV/IO access and fluids
    - Permissive hypotension: 80-90 mmHg systolic is the goal of therapy
  - Pregnancy
    - Mostly commonly due to MVCs which predispose to abruptio placentae
    - Fetal viability at 24-26 weeks gestation may determine destination (neonatal)
    - Perimortem c-section: maternal cardiac arrest < 5 minutes and fetal distress
  - Pediatrics
    - Fluid resuscitation usually underestimated, 20 ml/kg boluses

- Field Triage Decision Scheme
  - Revised 2006 approved by ACS, CDC, NHTSA
  - Isolated traumatic mechanism criteria has very low sensitivity and PPV->overtriage

- Trauma Scoring Systems
  - Better for research than field patient care
  - Revised Trauma Score (0-4)=RR, SBP, GCS

- Public Health Campaigns
  - Drunk driving
  - Helmets

- Seatbelt use
- Firearm storage

27 Blunt trauma considerations, 216

- Critically ill
    - On scene time ideally <10 mins
    - Control life-threatening hemorrhage and support of airway are only interventions on scene
    - Secondary survey can be deferred in the trauma center

- Air transport controversial -may not confer any benefit likely due to poor field triage of patients

- Patient outcomes significantly better at trauma centers with a 25% reduction in fatality risk

- Special Populations
    - Pregnancy
        - Trauma is leading cause of maternal mortality
        - “What’s best for mom, is best for baby”
        - Predictors for fetal loss include: higher ISS, lower GCS, abdominal abbreviated injury scale (AIS) >3, vaginal bleeding, and shock with significant base excess
        - Patients over 20 weeks gestation should be placed in left lateral decubitus
        - Destinations capable of OB/NICU care should be considered if patient is potentially viable
    - Geriatrics
        - More likely to have intra abdominal injury with concurrent head, leg, or chest trauma regardless of MVC speed
        - CDC field triage guidelines use age >55 for increased risk of death due to trauma

- Revised Trauma Score (RTS) is one of the more common scoring systems, in addition to ISS, and incorporates GCS, respiratory rate, and systolic blood pressure

28 Motor vehicle crashes, 222

- 5th leading cause of death

- Extremes of age are more likely to be seriously injured

- Three point seat belts decrease fatalities by 45% and in combination with airbags by 50%

- 4 possible collisions during a motor vehicle accident:
    - Collision of car with object
    - Collision of passenger with interior
    - Collision of internal organs to bony structures
    - Loose items/people in car hitting other passengers

- Frontal crashes
    - 42% of crashes
    - Most commonly affect: lower extremities, pelvis, thorax, head, abdomen
    - Since airbags: head, face, aortic, and cardiac injuries less common
    - Rib fractures still common especially in elderly

- Side Crashes
    - 25% of crashes
    - More dangerous than frontal crashes
    - Involve a “bullet vehicle” that hits the “stuck vehicle”
    - Most commonly affect: head, thorax, pelvis, abdomen
    - More likely to be injured if you are the “near-side” passenger

- Rear Crashes
    - 22% of crashes
    - Least worrisome of planar crashes
    - Large crumple zone
    - Occupants also protected by seats

- Rollover Crashes
    - 9 % of crashes
    - Arrested rollovers are associated with greater risk of injury
    - Ejection is much more likely and associated with severe injury
    - Most commonly injured include: thorax, abdomen, head, spine, extremities

29 Penetrating trauma, 228

- Trauma: leading cause of death for North Americans 1–34 yo;

    - surpassed only by cancer and cardiovascular disease >35yo.

- Deaths have trimodal distribution:
    - 50% occur within few minutes,
    - 30% die in first few hours (EMS can make a difference)
    - 20% occur days-weeks later (multi-organ failure)

- Kinetic Energy= ½ mass x velocity^2

- Conservation of Energy: energy cannot be created or destroyed, only transferred from one form to another

- Ballistics = trajectory + how projectile acts when it hits its target
    - Low energy: knives, hand-launched missiles
    - Medium energy: handguns, smaller bullets, lower velocities (200–400 m/s)
    - High energy: military or hunting rifles, larger bullets, higher velocities (600–1000 m/s)

- High velocity projectile injury (>750 m/s) = three injury patterns: direct, pressure wave, cavitation
    - Pressure wave: moves faster than the bullet (faster/blunter projectile=greater effect)
    - Cavitation: high energy missiles ->shockwave and cavity in body tissues (can be 40x diam of bullet)

- Bullets may tumble or wobble (yaw), often decreasing the velocity and accuracy
    - If it tumbles or yaws after hitting tissue, the bullet's surface area with respect to tissue is increased, thereby increasing the amount and rate of energy transfer, and thus the extent of injury

- Conditions requiring rapid stabilization:
    - Open PTX (sucking chest wound->one way occlusive dressing)
    - Tension PTX (needle decompression)
    - Hemorrhage ->tourniquet
    - Hypotension in trauma -> **ONLY give fluids if SBP<70 or absent radial pulse**
    - Airway obstruction if no contraindication jaw thrust, OPA/NPA, intubation, cric

- Up to one-third of all traumatic deaths occur before arrival at hospital

- Prehospital traumatic cardiopulmonary arrest is associated with very poor survival (0–5%)

- Isolated penetrating trauma (stab wound) to the thorax is the most salvageable
    - ED thoracotomy within 15 min -may have up to a 25% survival rate

- Penetrating abdominal trauma: high mortality
    - relative lack of skeletal protection and highly vascular structures, solid organ injury
        - hemorrhagic shock, hollow organ injury->peritonitis

- Penetrating neck trauma: zone 1=high mortality, use occlusive dressing to avoid air embolism.
    - IV on opposite extremity to neck injury
    - Common carotid injuries in 10% of penetrating neck trauma
    - Assess for neurologic deficit

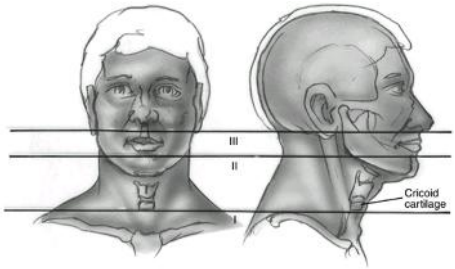


FIG. 73-8. Horizontal entry zones of the neck for penetrating injuries to the neck. (Modified from Jurkovich GJ. The neck. In: Early care of the injured patient. Moore EE, ed. Toronto: BC Becker, 1990:126.)

- Penetrating extremity trauma: vascular injuries, bony injuries, amputations

- "Scoop and Run" vs. "Stay and Play": Reduced mortality when scene times shorter

- Golden Hour for Trauma: Best survival for patients requiring surgery when the surgery begins within one hour

- Platinum 10 minutes: goal is to begin transport of the patient within 10 minutes of arrival on scene (barring e.g. extrication)

- ACS Prehospital trauma triage criteria using physiologic, anatomic injury, mechanism, age, and comorbid conditions

- Trauma systems are designated to provide a coordinated response across a continuum of injury prevention strategies, emergency access (911), prehospital EMS, trauma triage, dedicated trauma centers, specialized trauma teams, rehab

- Medicolegal:
    - documentation/PCR legal records
    - forensic evidence preservation -> may need to notify police of all GSW
    - mandated reporters if children in imminent risk

30 Traumatic brain injury, 237

- TBI accounts for 1/3 of traumatic deaths in US
    - falls (35%), motor vehicle collisions (17%), direct blows to the head (16%)
    - Men > Women, children = ⅓ of cases
    - Kids/Elderly more likely to present to ED and also to die from injury

- Insult = direct impact, acceleration/deceleration injury, or penetrating wound ->bleeding, contusion, and ultimately cell death

    - secondary insult (even single episode hypotension or hypoxemia → 150% increase mortality)

- CPP = MAP - ICP → very difficult to measure pre-hospital

- Secondary assessment: pupils, GCS; EtOH can complicate
    - Mild TBI (GCS 14-15), moderate (GCS 9-13), severe (GCS 8 or less)
    - Field differentiation of TBI impossible, important to **reassess** GCS, eval herniation
        - decrease of more than two points indicates increased ICP and increased in hospital mortality
    - If clinical sx herniation → mild hyperventilation to ETCO2 30-35 mmHg
    - Hyperventilation → cerebral vasoconstriction → reduction blood flow → lower ICP → secondary brain injury

- Indications for ED evaluation of sports related TBI: altered mental status, continued vomiting, retrograde amnesia, LOC

31 Electrical injuries, 243

- Electrical injuries have trimodal age distribution: toddlers-household sockets and cords, adolescents-risky behavior around electrical power lines, adults who work with electricity for living
- Most frequently, electrical injury is minor
- Electricity=flow of electrons from higher to lower concentration
- Direct Current (DC)=electrons flow constantly in one direction across voltage potential (battery)
- Alternating Current (AC)=direction of electron flow changes rapidly in cyclic fashion, in US standard household current flows at 60Hz and 110V
- Six factors determine outcome of human contact with electrical current
    - Voltage
    - type of current
    - amount of current
    - Resistance
    - pathway of current
    - duration of contact
    -
- Low Voltage= less than 1,000 volts
- AC exposure to same voltage is 3x more dangerous than same voltage of DC current
- “Let-go current” (6-9 mA)= level above which muscular tetany prevents release of the current source, flexor tetany of fingers/forearms overpower extensors
- Vfib occurs at 50-100 mA
- Ohm’s law, I=V/R or current = voltage/resistance
- Path of electricity flow determines tissues at risk (thorax vs cerebral)
- Tissue low resistance=nerve, blood vessels, high=skin, bone, fat
- Electrical energy->thermal energy conversion: massive internal/external burns
- SCENE SAFETY
    - Personnel should stay 10-30 feet away from source until utility company confirms off
    - Protective equipment: rubber gloves and boots
- MCC death electrical injury=cardiac arrhythmia, resp. arrest (AC->VF, DC->asystole)
    - MCC EKG abnl=sinus tach, NSST-T Wave changes (transient)
- Treatment also includes trauma and burn evaluation

- Aggressive resuscitation (victims usually young, no CV disease)

Lightning: unidirectional cloud-to-ground current resulting from static charges that develop when cold high-pressure front moves over a warm, moist low-pressure area

- Actual energy delivered is less than typical high-voltage injury due to short duration
- 70% lightning strikes not fatal, 30% strikes involve more than 1 patient (hit shelter)
- 5 Basic Mechanisms of Injury
  - 1. Direct Strike: hits person out in open, usually fatal
  - 2. Splash Injury: lightning strikes object or person and 'splashes' to nearby victim
  - 3. Contact Injury: victim in physical contact with person directly struck
  - 4. Step voltage/ground current injury: lightning hits ground, spreads radial to human body as it offers less resistance than ground, travels one leg->other
  - 5. Blunt trauma: victim thrown by concussive forces of shockwave->opisthotonic muscle contractions->fractures/trauma
- MCC death=immediate cardiorespiratory arrest
- "Resuscitate the Dead": significant potential for resus with early/sustained EMS tx
  - *Initial care to apparently dead victims first, change in typical MCI triage*
- Severe burns uncommon due to brevity of exposure
- Less important for burn care/aggressive IVF compared to high-voltage electrical inj.
- Victims struck during rain->"flashover effect"=decreasing current transit through body and also risk of severe internal injury
- Lichtenberg/feathering burns=pathognomonic for lightning injury, not true burn (extravasation of RBCs into superficial skin layers along current lines of flashover)
- Keraunoparalysis "lightning paraplegia"=immediate effect of lightning injury, paralysis of limbs with pallor, cool temp, absent pulses (result of severe arterial vasospasm from catecholamine release, resolves in few hours)
- Other injuries: neuro effects (LOC, confusion), TM injury, ARF

32 Blast injury, 248

Table 32.1 Categories of explosive injuries

Category	Mechanism	Injury type
Primary	A form of barotrauma, unique to explosions, which causes damage to air-filled organs	• Blast lung • Tympanic membrane rupture and middle ear damage • Abdominal hemorrhage and perforation • Globe (eye) rupture • Concussion
Secondary	Trauma caused by the acceleration of shrapnel and other debris by the blast	• Penetrating ballistic (fragmentation) • Blunt injuries (rapid deceleration) • Eye penetration
Tertiary	Casualty becomes a missile and is propelled through the air, with typical patterns of blunt trauma	• Fracture and traumatic amputation • Blunt chest and abdominal trauma • Impalement • Closed and open brain injury
Quaternary	All other explosion-related injuries, illnesses, or diseases which are not due to primary, secondary, or tertiary mechanisms	• Burns (flash, partial, and full thickness) • Crush injuries • Exacerbation of underlying conditions (asthma, angina, etc.) • Inhalation injury
Quinary	The intentional addition of agents that may result in injury	• Radiation • Chemical • Biological (including suicide bombers with hepatitis or HIV)

- Explosive injury is caused by the blast wave generated by the transformation of a high explosive from solid to gas almost instantaneously.
- **Unexploded ordnance (UXO):** grenades/ ammunition
- **IED:** improvised explosive device -> most common, most purposeful combat injuries
- **Spall** tissue disruption occurs via blast wave and small particles of tissue and liquids are thrown into the air space; occurs in gas/tissue interfaces e.g. sinus, lung, middle ear, bowel--this is **primary injury.**
- **Primary injury:** barotrauma causing damage to air filled organs
- **Secondary injury** occurs from projectiles dislodged by the blast striking the body, most common form of blast trauma
- **Tertiary injury** comes from the patient being dislodged by the blast and contacting another object.
- **Quaternary blast:** all other explosion related injuries, illnesses or diseases not included in primary, secondary or tertiary (e.g. burns, crush injuries, inhalation injury)
- **Quinary blast:** injury occurs due to additional components to the bomb, such as a Suicide Bomber who has hepatitis or a "dirty bomb" with radiological contaminants.
- **Category 1 injuries:** penetrating injuries or non intact skin exposures, treat for HBV and tetanus
- Airway concerns mainly with burn patients-early ALS airway including potential extraglottic devices with intubation capabilities. Don't use tape to secure ETT in burn patient due to potential slough of skin.
- Penetrating chest trauma may cause tension ptx, use a 14 g angiocath and a flutter valve, at least 3.5 cm

long if possible. Use a chest seal dressing for open chest injuries.

- Patients with primary blast lung are at risk for arterial gas embolism.
- In a mass casualty incident with blast and burn injuries, CPR should be withheld unless the injuries are the result of an electrical incident
- **Tactical Combat Casualty Care (TCCC):** 3 goals
    - 1. Treat the casualty
    - 2. Prevent additional casualties
    - 3. Complete the mission
    -
- **Medical threat assessment (MTA):** consider potential medical threats that may confront the responding during EMS operations and develops the plan to mitigate and respond to the threats

33 Thermal and chemical burns, 253

- Demographics:
  - Deaths from fires and burns are third leading cause of fatal home injury
  - Chemical burns account for 3% of burns and 7% burn admissions annually
  - Approximately 3,400 deaths annually
  - Risk factors: extremes of age, poverty, African or Native American descent, and rural area dwellers

- Skin is largest organ and serves as a barrier to the environment

- Skin is made up of epidermis, dermis, and subcutaneous tissue

- Assessing burns
  - Severity
    - Consider age of pt (<2 or >50), location of burn, pre existing conditions, presence of trauma
  - Depth
    - Superficial, superficial partial-thickness, deep partial-thickness, full-thickness burns

Table 33.1 Classification of burns based on depth

Classification	Cause	Appearance	Sensation	Healing time	Scarring
Superficial burn	Ultraviolet light, very short flash (flame exposure)	Dry and red; blanches with pressure	Painful	3–6 days	None
Superficial partial-thickness burn	Scald (spill or splash), short flash	Blisters; moist, red and weeping; blanches with pressure	Painful to air and temperature	7–20 days	Unusual; potential pigmentary changes
Deep partial-thickness burn	Scald (spill), flame, oil, grease	Blisters (easily unroofed); wet or waxy dry; variable color (patchy to cheesy white to red); does not blanch with pressure	Perceptive of pressure only	More than 21 days	Severe (hypertrophic) risk of contracture
Full-thickness burn	Scald (immersion), flame, steam, oil, grease, chemical, high-voltage electricity	Waxy white to leathery gray to charred and black; dry and inelastic; does not blanch with pressure	Deep pressure only	Never (if the burn affects more than 2% of the total surface area of the body)	Very severe risk of contracture

Source: Data from US Army Institute of Surgical Research.

  - Size
    - Rule of 9's for Adults (exclude 1st degree): 9% for each arm, 18% for each leg, 9% for head,18% for front torso, 18% for back torso.
    - Rule of 9's for Children (exclude 1st degree): 9% for each arm, *14% for each leg, 18% for head,* 18% for front torso, 18% for back torso.

      - For fluid resuscitation, aggressive hydration is important

Box 33.1 Basic fluid guidelines for burn injuries

- Fluid guidelines should be used in all adults and children with burns >20% total body surface area (TBSA)
- Common formulas used to initiate resuscitation estimate a crystalloid need for 2–4 mL/kg body weight/% TBSA during the first 24 hours
- Fluid resuscitation, regardless of solution type or estimated need, should be titrated to maintain a urine output of approximately 0.5–1.0 mL/kg/hour in adults and 1.0–1.5 mL/kg/hour in children
- Maintenance fluids should be administered to children in addition to their calculated fluid requirements caused by injury
- Increased volume requirements can be anticipated in patients with full-thickness injuries, inhalation injury, and a delay in resuscitation

Source: Data from US Army Institute of Surgical Research.

Critically ill burn patients are best cared for at a dedicated burn center, particularly patients with any of the following:

- >10% TBSA partial thickness burns
- Any size full-thickness burn
- Burns to hands, genitals, face, eyes, ears, or joints
- Circumferential burns
- Inhalation injury
- Serious chemical injury
- Serious electrical injuries, including lightning

Outpatient management: <10%TBSA in adult, <5% TBSA in young or old, <2% full thickness burn

In terms of specific burn syndromes:

- Inhalational Injuries
  - Increased pulmonary compliance and fluid requirements
  - Doubles mortality
  - Edema formation in posterior pharynx is associated with deep burns to upper chest, lower face, and neck
  - Stridor and tachypnea are late signs
  - Early grading by fiberoptic bronchoscopy is often inaccurate

- Chemical Burns
  - A caustic or corrosive agent is a chemical capable of causing tissue and mucous membrane injury upon contact
    - pH <3 or >11
  - Majority of burns are result of accidental exposure at work
  - Most common complications: cellulitis, pneumonia, and respiratory failure
  - Common agents: hydrochloric acid, potassium hydroxide, sulfuric and phosphoric acid
- Prehospital Considerations
  - Trauma occurs in 5-15% of burn patients and takes precedence over burn care. Transport to trauma center if appropriate
  - If intubated, use umbilical ribbon to secure, do not tape to patient as skin (and tape) will fall off

- Resuscitate with Parkland formula (ringer's lactate at 4 mL/kg/%burn for adults and 3 mL/kg/%burn for kids over 24 hours) vs modified Brooke (ringer's lactate at 2 mL/kg/%burn for adults and 3 mL/kg/%burn of kids over 24 hours)
- Key Tenets:
  - Through, systematic evaluation
  - Knowledge of local resources
  - Appropriate use of spinal motion restriction, splinting, pain medication, IV fluids, etc
  - Recognition of chemical exposure

- Special Considerations:
  - Compartment syndrome
    - May need escharotomy and/or fasciotomy
    - Escharotomies are performed on the medial and lateral portions of the affected extremities and on the midaxillary lines of the trunk connected by an inverted V along the costal margins
  - Pain Management
    - Failure to appropriately manage pain associated with increased chronic pain and PTSD
  - Hydrofluoric Acid Burns
    - HF over 20% concentration exposure results in risk for severe burns and toxicity
    - Tx: Calcium
  - Prolonged transport interval
    - Antibiotics e.g. Levaquin PO is given in the military if abdomen is unaffected
    - Control hypothermia
    - advanced methods of pain management, including ketamine, transmucosal analgesia, peripheral nerve blocks.

34 Crush injury, 261

- Crush syndrome leading to acute renal failure is 2nd most common cause of morbidity in disasters situations after direct trauma

- Crush Injury defined as anatomical injury associated with direct trauma due to compressive force

- Extended entrapment may cause: crush syndrome, traumatic rhabdomyolysis, or compartment syndrome

- Crush syndrome - systemic manifestation of skeletal muscle injury from extended compression

- Compartment syndrome - increase in pressure within a fascial compartment that compromises venous outflow, and then arteriolar inflow, with capillary leakage and edema that leads to progressive muscle damage and rhabdomyolysis

- Pathophysiology of Crush Injury
    - Ischemia/reperfusion injury and the intense local and systemic inflammatory response
    - Reactive oxygen species and activated neutrophils are main players of ischemia/reperfusion injury
    - Risk factors are: mass of injured muscle and ischemia time
        - Takes 4 hours for skeletal muscle at room temperature, but can be shorter if direct trauma is the cause of ischemia rather than vascular perfusion
    - The injury results in leakage of myoglobin, urate, potassium and phosphate from the sarcolemma membrane and an influx of water, calcium, and sodium into muscles
    - Systemic manifestations: hypovolemia/hypotension due to fluid shifting into muscles, hyperkalemia and metabolic acidosis, acute renal failure from urate and myoglobin

- Management of Crush Injuries
    - Depends on the circumstances of the injury, but should begin as all trauma with primary survey and treatment of immediate life threats
    - Pain medication including opiates and ketamine if in scope of practice should be given
    - If a mass casualty or disaster scenario with prolonged time to definitive care, it seems reasonable to consider giving antibiotics for open soft tissue injuries or fractures
    - For compartment syndrome, it is likely better to elevate the extremity and fluid resuscitate rather than perform field fasciotomy

- Management of Crush Injuries with Crush Syndrome
    - Should be clinically suspected based on time of entrapment and mass of skeletal muscle involved
    - Treatment focus: hypotension and cardiovascular collapse upon extrication and late renal failure
    - Traumatic rhabdomyolysis has been reported to occur in less than 1 hour
    - Acute renal failure following rhabdomyolysis has been reported in up to 33% cases and has been reported to account for up to 50% of the fatalities
    - The mainstay of treatment should be fluid resuscitation via intermittent fluid bolus, but consider surrounding environment as there will likely be technical operations that are ongoing
        - IV/IO access should be obtained on largely uninjured extremity

        - Consider central venous access as well as hypodermoclysis if EMS physician or advanced EMS provider is available and this is in the scope of practice
        - When vascular access is impossible you could consider applying a tourniquet close to the time of extrication. This may prevent sudden fluid and electrolyte shifts, but literature is lacking for this purpose
    - Therapeutic options of hyperkalemia treatment will be based on scope of practice and the availability of resources
        - Consider empiric treatment of metabolic acidosis with sodium bicarbonate intermittent bolus vs drip (1 amp in a bag of 0.45% NS or 3 amps in D5W)
        - If EKG changes, calcium would be warranted; however, calcium will be taken up by the injured skeletal muscles and can aggravate the calcium dependent apoptosis of muscle cells
        - Consider albuterol as a treatment for hyperkalemia, but keep in mind the safety of oxygen vs compressed air with ongoing technical rescue operations and with oxygen as a possible limited resource in a disaster setting
        - Consider mannitol as a nephroprotective option as it can reduce compartment pressures and reduces interstitial volume. It acts as an osmotic agent as well as a free radical scavenger.
    - Transport should be to a designated trauma center even in the absence of multisystem trauma

35 Hemorrhage control, 265

- Arterial hemorrhage will require pressure greater than SBP for 20 min to control.

- In contrast, venous and capillary bleeding may be amenable to hemostatic dressings.

- Traditional measures to diagnose hemorrhagic shock have limitations, e.g. AMS may also be due to hypoxia or hypoglycemia, but other metrics have shown promise such as pulse pressure (SBP - DBP) and shock index (HR/SBP). Serum lactate and dynamic pulse oximetry still in development.

- Control hemorrhage with direct pressure, pressure dressing, splinting, and tourniquet application. Elevation and pressure points alone generally do not work.

- Rapid wound closure would be helpful but has limited utility in the field although new devices are being developed. Internal occlusion (REBOA) may have a role in the future

- Advanced hemostatic agents (for dressings) all have drawbacks.
    - Zeolite (quikclot) - rapid absorption of water which concentrates platelets etc at wound site. Cheap but produces a hyperthermic reaction. Newer similar agents less hyperthermic.
    - Celox - Chitosan product that has mucoadhesive properties that directly seal the leak. Cheap but unproven.
    - Combat gauze - kaolin impregnated gauze that theoretically activates clotting factors.

- Permissive hypotension (target MAP in the 60's)

- Prevent hypothermia - hypothermia inhibits clotting, etc. Terrible triad of trauma - acidosis, hypothermia, coagulopathy.

- Special considerations
    - Transfusion - limited prehospitally to special teams and air medical providers. Most are using uncrossed blood.
    - Recombinant factors - used primarily for hemophiliacs at this time although may have application in trauma in future
    - TXA - showed benefit when given in first 3 hrs. May have an role in EMS in future.

36 Orthopedic injuries, 272

- Begins with trauma assessment and treatment for potential life threats
- Including mechanism of injury as part of the secondary exam
- Hemorrhage control with direct pressure of open fractures, covering exposed bones with saline moistened gauze, and pain management (opiates and immobilization) should be performed
- Decision for field reductions should be based on neurovascular compromise, extrication time, transport time, and provider training
- A neurovascular exam including nerve function and vascular patency should be conducted on all extremity injuries prior to and after any manipulation or splinting
- **Clavicle**
    - Sling and swathe placement.
    - Check for neurovascular status of subclavian vessels, brachial plexus, and for pneumothorax.
    - AC and SC joints should be checked
- **Scapula**
    - Sling and swathe placement.
    - Up to 75% will have additional injuries due to significant mechanism.
    - Careful exam for rib fractures, pneumothorax, and upper arm injuries is warranted.
- **Shoulder**
    - Sling and swathe placement.
    - Consider short board if concern for humeral head fracture.
    - Shoulder is the most common major joint dislocation. Usually anterior.
    - Axillary nerve (deltoid, lateral shoulder sensation) injury.
    - Rarely has vascular injury, but if so it will be the axillary artery.
    - 15-35% have associated second fractures.
    - No indication for prehospital reduction in most cases.
- **Humerus**
    - Short board splint with sling and swathe
    - Injuries divided into proximal, midshaft, and distal.
    - Axillary nerve and artery injuries in up to 50% displaced humeral fractures.
    - Humeral shaft fractures can be associated with radial nerve (wrist and finger extension, first dorsal web space sensation) or brachial artery/vein injuries.
- **Elbow**
    - Short board splint
    - Elbow is composed of humerus, ulna, radius.

    - Brachial vessels run in close proximity.
    - Supracondylar fractures among most common fractures in pediatrics.
    - 90% of dislocations are posterolateral from FOOSH.
    - Most commonly associated with brachial artery and ulnar nerve (index finger abduction, pinky finger) injuries.

- **Forearm**
    - Short board with sling.
    - Neurovascular compromise less common than injuries to elbow/humerus.

- **Wrist**
    - Short board or pillow in position of function in sling.
    - Most common fractures: distal radius and ulna followed by carpal bones (scaphoid and triquetrum).

- **Hand/fingers**
    - Malleable finger splint, buddy tape, tongue depressors.
    - Assess function of median nerve (thumb and index opposition, index finger sensation), ulnar, and radial nerves.
    - Assess capillary refill and flexor and extensor function in each finger.
    - High pressure injection injury always requires transport to the ED.

- **Pelvis**
    - Associated with high mortality (10-15%)
    - Mechanism should be considered: high speed MVC, ped vs auto, significant falls
    - Anterior-posterior compressive forces associated with most hemodynamic instability
    - Should be suspected if: significant torso trauma, perineal or flank hematoma, blood at penile meatus or vaginal opening, obvious bony instability
    - Consider use of pelvic binder

- **Hip**
    - Backboard or longboard splints and pillows.
    - 80% hip fractures occur in people aged 75 and over and 75% of those are female.
    - 90% due to elderly falls.
    - Pain, shortening, and external rotation of limb can be seen.
    - Dislocations are generally caused by high energy mechanism and should receive prompt transport as neurovascular complications common if not reduced within 6 hours.

- **Femur**
    - Traction splint.
    - Large volume hemorrhage can occur with potential distal limb ischemia/hypovolemia, but compartment syndrome is rare.
    - Limb appears shortened.

- **Knee**
    - Short board A splint, but do not splint fully extended.
    - Knee dislocations rare, but can cause popliteal artery injury.
        - 50% of knee dislocations spontaneously reduce prior to ED presentation.
    - Medial tibial plateau fracture to peroneal nerve (ankle eversion/dorsiflexion, dorsal foot surface and 1st dorsal web space sensation) and/or popliteal artery and compartment syndrome.

- **Lower leg**
    - Longboard splint.
    - Tibia is most commonly fractured of all long bones and 80% time there is an additional fibula fracture.
    - Compartment syndrome occurs in 8% of tibial shaft fracture.

- **Ankle/foot**
    - Pillow splint.
    - Consider ottawa rules for triage purposes only, but this has not been validated in prehospital setting.

- **Spine Injuries**
    - Incidence of cervical spine injuries in trauma is 4%. Higher if trauma above the clavicles (5-10%).
    - Overall incidence of spinal cord injury <2% in blunt trauma.
    - Neurogenic shock secondary to autonomic dysfunction and presents with hypotension and bradycardia.
    - Altered patients have a higher potential for occult spinal injuries
    - Central Cord (most common): bilateral upper extremity weakness most severe in distal upper extremities. Most common in elderly.
    - Immobilization: Controversial

- Splinting
    - Mainstay of prehospital care.
    - Reduces pain, chance of further injury, reduction of hemorrhage, and maintenance of alignment
    - Prefabricated splints, pillows, cardboard, sheets, sticks can be used as needed for splinting
    - Traction splints considered standard of care for femoral shaft fractures.
    - Complications of traction: peroneal nerve palsies, compartment syndrome, urethral injury, pressure ulcer, distal ischemia

- Reductions
    - System specific, but generally deferred if transport time is minimal
    - Indications for gentle reduction: severe angulation and distal neurovascular compromise

- Amputations

- Bleeding control with direct pressure or tourniquet
- Stump can be cleaned of debris with sterile saline and then covered with moistened gauze
- Do not manually debride in prehospital setting.
- Efforts should be made to locate the amputated part which should be wrapped in sterile gauze and placed in a bag. That bag should be placed on ice, but should not be frozen.

37 Ocular trauma, 280

- Eye injuries are significant in 50% of facial trauma cases.
- Most common in male patients and those under 30.
- Trauma is the second most common cause of monocular blindness, trailing only cataracts
- Beware distraction of eye injuries; facial injuries can include airway compromise
- Chemical exposure of the eye requires immediate, copious irrigation with tap water or NS.
- Do a visual acuity, even counting fingers or presence or movement of light is helpful
    - Pocket snellen chart with pinhole occluder if patient usually wears glasses.
- Check eyelids and associated anatomy for injury
    - EOM especially superior gaze for orbital blowout
    - Cornea for hyphema
    - Periorbital sensation for infraorbital nerve injury.
- If open globe injury suspected, protect eye with hard shield, elevate head of bed 30 to 45 degrees, provide pain control and anti-emetic meds.
    - Check for penetrating/retained foreign bodies and use a cup over the eye if present--do not remove.

38 Bites, stings, and envenomations, 284

- Recall the types of allergic reactions:

Box 22.1 Types of hypersensitivity reactions and anaphylaxis production

Type I Immediate(IgE or IgG) – most common
Type II Cytotoxic complement cascade (IgG or IgM)-Yes
Type III Immune complex (IgG or IgM)-Yes
Type IV Delayed T-cell-No anaphylaxis

- Anaphylaxis can rapidly progress to life threatening event
  - Causative agents broad: medications (ACE's), foods, additives, latex, contrast dye, hymenoptera (bees), arthropod bites, marine envenomations, insect bites, mold

Box 22.2 Definition of anaphylaxis

Acute cutaneous and/or mucosal involvement after antigen exposure
plus:
- Respiratory compromise
  - Bronchospasm
  - Stridor
  - Hypoxia
- Cardiovascular compromise
  - Hypotension
  - Collapse
- Persistent gastrointestinal symptoms
  - Vomiting
  - Crampy abdominal pain

- Assessment and Treatment Approach:
  - Importance of scene safety (rescue/rx not possible if providers afflicted)
  - Determine mechanism of sting or origin of allergy
  - Query for specific sx: SOB, dysphagia, voice changes
  - Exam: voice, airway edema, facial edema, lungs/wheeze, rash, hypotension
  - Prehospital treatment: IV, O2, monitor, neb prn, Epi auto injector if available, wound care/removal of stinger, antihistamines, Epi IV
    - Note: caution in Epi >age 50
    - Epi IM > SQ –if hemodynamically stable 0.3ml of 1:1000
    - Epi IV 1 ml of 1:10,000 if hemodynamically unstable

- Hymenoptera: greater chance of systemic reaction than other insects, particularly if multiple stings

- Consider allergic reaction as etiology of SOB calls

- Gila monster bites infrequent, but may still be attached to patient
  - pry jaws apart
  - place flame under belly

    - submerge in cold water

Animal Bites

- Account for 1% of ED visits but are seldom encountered in EMS.
    - Scene safety concerns are paramount, co-dispatch law enforcement and/or animal control and do not transport

- The EMS Medical Director should be aware of dangerous animal species in the area.

- All bites other than marine envenomations should be copiously irrigated after hemostasis is achieved.

- Splint extremities if they are involved.

- Most mammalian bites are caused by dogs and cats and involve the upper extremities with high rates of infection and corresponding need for antibiotics.

- Reptile bites are mainly from Crotalid snakes (hemotoxic symptoms) and Elapid snakes (water environments, neurotoxic symptoms).
    - Compression immobilization and positioning at or below the level of the heart are the only recommended prehospital therapies as antivenins are difficult to administer.

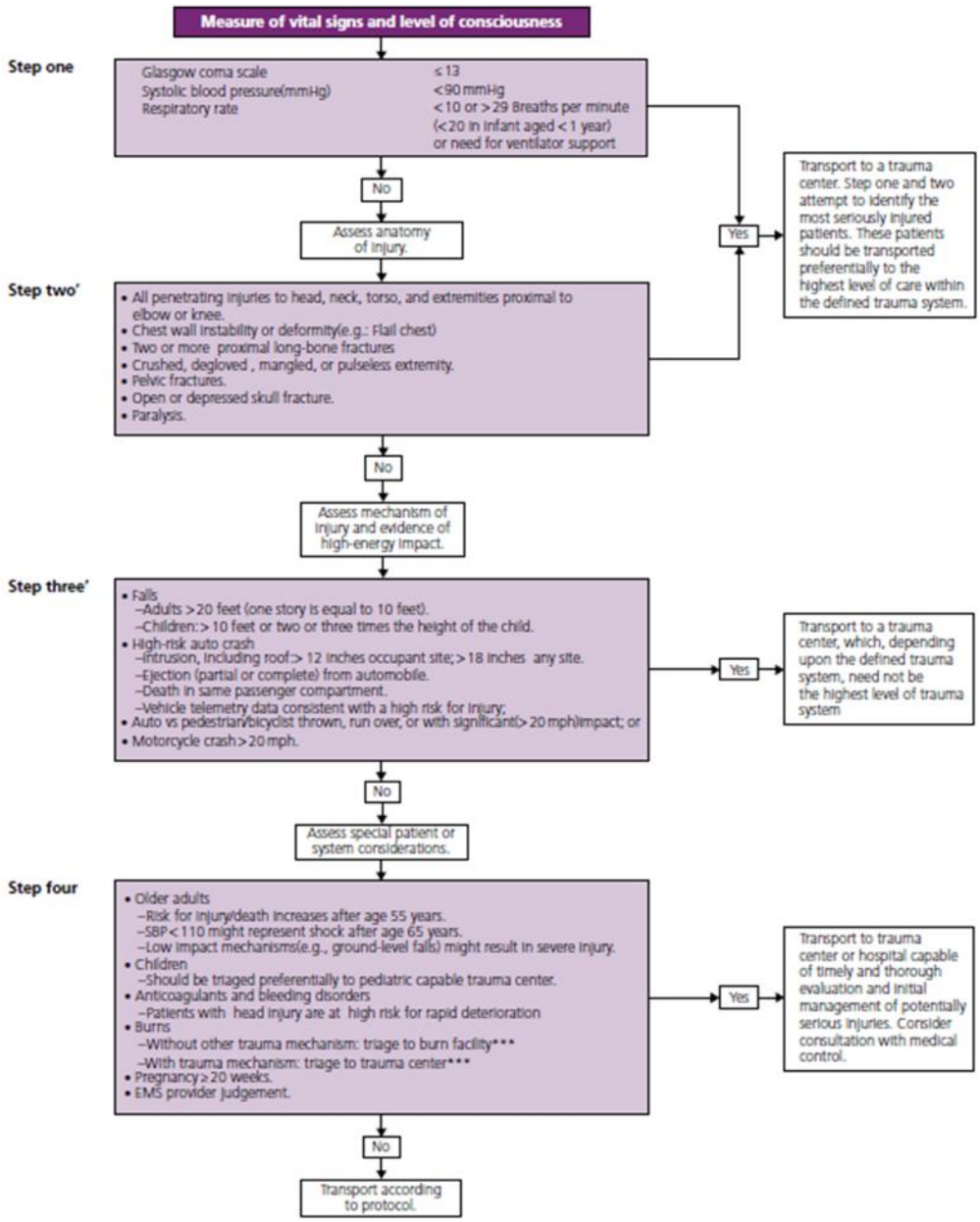
- For marine envenomations remove any remaining tentacles or nematocysts with gloved hands/instruments after stabilizing with a vinegar solution and use local heat application to degrade toxins and provide pain relief.

- Black widow spider bites should be treated with analgesics and benzodiazepines as needed for pain and muscle spasm.

- Rabies PEP recommended universally for bites from skunks, foxes, raccoons and bats (directly witnessed or suspected).
    - Dogs, cats or ferrets who cause bites should be observed for 10 days in quarantine before deciding on RPEP if the animal is asymptomatic. Use the poison center as a resource when dealing with non-indigenous animals/insects.

39 Field trauma triage, 289

- Unintentional injury is leading cause of death in patients ages 1-44 years old
- 30 million injuries annually lead to ED visits, and 18% of those were transported by EMS
- 25% reduction in mortality for severely injured adults who received care at Level 1 vs non-trauma center
- Trauma system (ACS-COT) began publishing hospital and destination guidelines in 1976
- Target for undertriage within trauma systems range from 0-5% of patients requiring Level 2 or higher care
- Field Triage Decision Scheme Recommendations (taken from MMWR from CDC):
    - Step 1: Physiologic Criteria
        - Measure vitals and GCS (GCS <13, SBP<90, RR<10 or >29)
        - Abnormal vitals are specific, not sensitive for identifying ISS>15. PPV approx. 40%
        - Adults meeting this criteria had reduced odds of mortality if treated at level 1 center
    - Step 2: Anatomic Criteria
        - Combining physiologic and anatomic criteria has sensitivity of 0.8 and PPV 26%
        - Includes: penetrating injuries to head, neck, torso, and proximal to knees and elbows, chest wall instability or deformity, two or more proximal long bone fractures, crushed/degloved/mangled/pulseless extremity, amputation proximal to wrist or ankle, pelvic fractures, open or depressed skull fractures, paralysis
    - Step 3: Mechanism of Injury Criteria
        - Uses mechanism of injury to determine if there may be severe, but occult injury.
        - Helps reduce undertriage
        - Includes: falls >20 ft for adults and >10 feet or 2-3 times height of child, high risk auto crashes (intrusion >12 inches on occupant side or >18 inches on any side, ejection, death in same vehicle, vehicle telemetry data consistent with high risk injury), auto vs ped/bike >20 mph or run over or thrown, motorcycle crash >20 mph
    - Step 4: Special Considerations
        - Designed for patients with underlying conditions that place them at higher risk for injury
        - Helps reduce undertriage
        - Includes: Age >55, SBP <110 if over 65, children should preferentially go to peds trauma centers, anticoagulants and bleeding disorders, burns (either to burn centers or trauma centers if concomitant trauma), pregnancy > 20 weeks, EMS provider judgement
        - Severely injured pediatric patients fare better at pediatric-capable trauma centers.



Abbreviations: EMS-emergency medical services.

* The upper age limit of respiratory rate in infants is >>29 breaths per minute to maintain a higher level of overtriage for infants.

† Trauma centers are designated level I –IV. A level I center has the greatest amount of resources and personnel for care of the Injured patient and provides regional leadership in education, research and prevention programs. A level II facility offer similar resources to a level I facility, possibly differing only in continuous availability of certain subspecialties or sufficient prevention, education, and research activities for level I designations; level II facilities are not required to be resident or fellow education centers. A level III center is capable of assessment, resuscitation, and emergency surgery, with severely injured patients being transferred to a level I or II facility. A level IV trauma center is capable of providing 24-hour physician coverage, resuscitation, and stabilization to injured patients before transfer to a facility that provides a higher level of trauma care.

§ Any injury noted in step two or mechanism identified in step three triggers a "yes" response.

¶ Age < 15 years

** Intrusion refers to interior compartment intrusion, as opposed to deformation which refers to exterior damage.

†† Includes pedestrians or bicyclist thrown or run over by a motor vehicle or those with estimated impact > 20 mph with a motor vehicle.

§§ Local or regional protocols should be used to determine the most appropriate level of trauma center within the defined trauma system; need not be the highest level trauma center.

¶¶ Age> 55 years

*** Patients with both burns and concomitant trauma for whom the burn injury poses the greatest risk for morbidity and mortality should be transferred to a burn center. If the nonburn trauma presents a greater immediate risk, the patient may be stabilized in a trauma center and then transferred to a burn center.

††† Patients who do not meet any of the triage criteria in steps One through four should be transported to the most appropriate medical facility as outlined in local EMS protocols.

40 Trauma-stabilizing procedures, 297

- Hands-on and didactic training with skill verification should occur prior to implementation of any procedure

- Needle Thoracostomy
    - Purpose: Relieve tension pneumothorax
    - Considerations: any patient who suffers from rapid cardiopulmonary decompensation, blunt chest trauma with precipitous decline in clinical course, obvious subcutaneous emphysema, tracheal deviation if present, decreased breath sounds if appreciated
    - Technique: Sterile prep and insertion at the 2nd intercostal space in the midclavicular line with an alternate site being the 4th or 5th intercostals space at the midaxillary line. Ideal placement is over the top of the rib.
    - Complications: Complication rate is low, but it is possible to puncture the subclavian vessels if too high using the 2nd intercostal space or the abdominal viscera if too low on the 4/5th intercostal space. Laceration of the internal mammary artery and infection should also be considered
      .
- Tube Thoracostomy
    - Limited in the field generally to air medical services and military situations
    - Indication: Rapidly evacuate large amount of blood from pleural space or to decompress a large pneumothorax if a long transport time is expected
    - Advantages: Lower likelihood of tube kinking, clotting, or dislodging compared to needle thoracostomy
    - Technique: Sterile prep, 4/5th intercostal space at the midaxillary line using lidocaine, 10 blade scalpel, kelly clamps, chest tube, and suture to secure the tube with chest tube drainage apparatus vs heimlich value
    - Complications: Empyema (given unsterile prehospital environment), injury to heart, abdominal organs, great vessels, lung parenchyma

- Pericardiocentesis
    - Procedure of choice for cardiac tamponade, but not fully investigated in prehospital setting
    - Cardiac tamponade present in up to 90% of penetrating injuries to heart
    - Indication: Presence of life threatening changes with signs of traumatic tamponade, Beck's triad (muffled heart sounds, JVD, and hypotension), Kussmaul signs (pulsus paradoxus, drop of >10 mmHg during inspiration and paradoxical increase in JVD), resuscitation of PEA when other causes have been ruled out and patient remains pulseless
    - Technique (no guidance): Sterile prep to subxiphoid region. Use 18G spinal needle and enter directly below/adjacent to xiphoid process at 45 degree angle and aiming towards the left shoulder until blood return is achieved. Initially 50cc blood should be removed prior to reassessment and then 25 cc increments should be removed until hemodynamic improvement. You can leave catheter in place using Seldinger technique if you have the equipment.
    - Technique (with EKG or US): Same technique as above, but use an alligator clip jumper cable from EKG lead V1 (if 12 lead) or II (if 3 lead) to proximal metal portion of spinal needle. Look for ST

elevation on monitor. If ultrasound, identify point of maximal effusion to guide site selection, but you should try to use the most superficial site possible. Angle and depth should be guided by US.

- Complications: Use of this technique may prolong time to thoracotomy. Additionally, you may injure the pericardium or lacerate a coronary vessel.

- Spinal Immobilization
  - Designed to protect the spinal cord for further injury, but this is a difficult procedure to study given the medical-legal climate
  - Recent studies show lack of evidence of effectiveness of c collars and long spine boards in maintaining spinal alignment as well as documented adverse events with routine immobilization
  - This remains a controversial topic: there is a joint NAEMSP-ACOT position paper
    - Penetrating trauma: studies indicate that spinal cord injuries from bullet wounds are complete at the time of injury or stable and thus do not require immobilization. C-collars also prevent full visualization of any neck wounds. Position paper states patients with penetrating trauma and no signs of spinal injury should not be immobilized on a long spine board.
    - Blunt trauma: patients with altered mental status, neurologic deficit, intoxication, or suspected extremity fracture were more likely to have spinal injuries. Another paper suggests that extremes of age, language barriers, and midline or paraspinal pain, in addition to the above mentioned criteria, should be considered for full immobilization. The position paper includes the concept that spinal immobilization does not require use of the long spine board.
  - C-collar
    - Immobilization starts with manual stabilization of the head and placement of an appropriately sized rigid cervical collar
    - The patient should not be able to flex or extend the neck, but should be able to open the mouth.
    - Complications: respiratory compromise, vascular occlusion, and patient comfort if not properly fitting
  - Backboard
    - Indications: Position paper states this may be appropriate in blunt trauma with altered mental status, spinal pain or tenderness, a neurologic complaint, anatomical deformity of the spine, a high-energy mechanism, intoxication, inability to communicate with the patient, or a distracting injury
    - Long spine board: application is with log roll. Patient is secured from chest down.
    - Scoop stretcher: Stretcher is opened and hinged portion is placed above the patient's head and bottom is left open. Stretcher then closed under patient (watch for pinching). Patient is secured from chest down.
    - Vacuum Mattress: Place mattress on ground with valve facing up near the patient's feet. Patient is placed onto mattress while maintaining spinal stabilization. Mattress is pumped up several times, and then molded to patient with special attention around the head, and straps are placed. Air is vacuumed from the mattress.

        - Extrication device: After application of c-collar and placement of device behind the patient, straps are secured in this order: Middle torso, bottom torso, legs, top torso, head. Patient is then extricated and placed on longboard.
        - Complications: Discomfort, increased utilization of radiology, decubitus ulcers, risk of respiratory compromise. Pregnant patients >20 weeks may experience compression of great vessels, and the board should be wedged toward a left lateral slant during immobilization.
        - Padding: consider padding to reduce discomfort and tissue damage. Time of spinal immobilization should be limited, especially in high risk patients.
        - Children: Use undamaged car seats if the child is already immobilized in one and does not require further assessment or care. Consider short boards with padding, KED, or other modality.
    - Selective Spinal Immobilization
        - Reasonable to employ protocols that limit spinal motion immobilization to patients who may benefit.
        - Most protocols use NEXUS or Canadian C-Spine rules
        - Both rules have been studied in prehospital setting and found to function effectively

Section VI: Obstetrics and Gynecological Problems

41 Physiology of pregnancy: EMS implications, 307

- Physiologic changes: Increased blood volume, HR, RR, CO. BP can be decreased or normal

- Higher risk of difficult airway: increased edema, increased risk of regurg/aspiration, increased bleeding due to capillary engorgement, decreased FRC, increased O2 consumption.
    - - Anticipate more liberal use of airway adjuncts (NPA, OPA, etc.).
    - - Anticipate rapid desaturation. Keep as upright as possible and use supplemental O2 liberally.

- Increased blood volume may lead to prolonged compensation for major blood loss, but followed by rapid decompensation.
    - - Treat aggressively with IV fluid resuscitation.
    - - Permissive hypotension probably shouldn't be applied to pregnant patients.
    - - Place in left lateral decubitus position

- EKG changes are common, including left axis deviation, inferior and precordial nonspecific ST/T changes. Common arrhythmias are SVT, AFib, and rarely VT.
    - - Avoid pharmacologic therapy if possible.
    - - Adenosine is probably safe.
    - - Use lidocaine as first-line agent for VT, followed by procainamide. Avoid amiodarone.
    - - Electrical cardioversion is considered safe for unstable patients.

- Standard prehospital treatments for asthma exacerbations are considered safe in pregnancy

- Carbon Monoxide: EMS providers should consider transport to a specialty center that can provide hyperbaric oxygen for the following indications:
    - - CO level >20%
    - - Depressed mental status
    - - Seizures
    - - Metabolic acidosis
    - - Fetal distress
    - - Cardiotoxicity
    - - Any neurologic findings in the mother

- Newborns of mothers with gestational diabetes mellitus are at high risk of severe hypoglycemia in the minutes after delivery. EMS providers should anticipate this and have a neonatal dextrose protocol.

42 Emergencies of pregnancy, 312

- Pertinent historical information

    - Estimated weeks of gestation
    - Number of pregnancies
    - Number and type of deliveries
    - Complications of previous pregnancies (GDM, preeclampsia, preterm labor)
    - Contraction intervals, membrane rupture, and bleeding

- Any woman of reproductive age with abdominal pain or vaginal bleeding has ruptured ectopic pregnancy until proven otherwise.
    - Note: The passage of tissue does not distinguish miscarriage from ruptured ectopic.
    - If in shock, obtain large-bore IV access and resuscitate appropriately with IV fluids.

- Placental abruption should be considered in women who present with vaginal bleeding +/- abdominal pain, a history of trauma, or appear to be in preterm labor.
    - Determine presence of risk factors: cocaine/drug use, hypertension, preeclampsia, etc.
    - Large-bore IV access and transport to OB-capable facility (trauma center if traumatic injury).
    - Abruption may be concealed (no obvious vaginal bleeding).
    - Treat shock aggressively with IV fluid resuscitation even if minimal bleeding.

- Classic presentation of placenta previa is painless bleeding in late second or early third trimester, though bleeding can be painful.
    - If suspected, obtain large-bore IV access and transport to OB-capable facility.
    - Treat shock with IV fluids as appropriate.

- Preeclampsia is typically recognized with a new BP reading of 140/90 mmHg or higher.
    - Prophylactic use of magnesium in patients with preeclampsia may reduce risk of eclampsia and maternal death.
    - Prehospital treatment should focus on supportive care and transport to OB-capable facility.
    - Eclampsia should be treated with IV magnesium in a loading dose of 4-6 g over 15-20 minutes followed by continuous infusion of 2 g/hr.

43 Normal childbirth, 318

- Pertinent historical information (see previous chapter)

- Exam: If signs of active labor (regular contractions, urge to defecate or push, rupture of membranes, etc.), visual exam of the perineum is necessary.

- Management:
    - Supplemental O2 and large-bore IV access should be started.
    - Direct medical oversight should always be notified of any impending delivery.
    - Basic care of outborn neonate includes suctioning of mouth and pharynx if inadequate respirations, gentle stimulation of feet or back, drying, and warming. If warming and stimulating do not lead to adequate respirations, resuscitation via PALS or NRP algorithms should be begun.
    - Do not delay transport for delivery of the placenta.

- Protocols should reflect the fact that “minor” trauma can cause placental abruption.

- Basic trauma care includes airway & hemorrhage control, supplemental oxygen, immobilization, and rapid transport to appropriate facility (ideally one with both trauma & OB capabilities).

- Pregnant patient over 20 weeks gestation with cardiac arrest should be immediately transported, as success of perimortem C-section in the ED correlates directly with duration of arrest.

44 Childbirth emergencies, 322

- Request for additional resources should be made as soon as crews encounter a multiple gestation birth, an abnormal presentation, or any other childbirth emergency.

- **Umbilical cord prolapse:** priority is manual elevation of the presenting part, positioning mother in knee-to-chest or steep Trendelenburg to ease pressure on the cord, and rapid transport to appropriate facility.

- **Nuchal cord:** attempt should be made to lift the cord over the infant's head. If the cord is too tightly wrapped, the nares and mouth should be suctioned while the cord is double-clamped in preparation to cut the cord. Delivery should proceed as quickly as possible after the cord is cut.

- **Breech delivery:** once recognized, rapid transport should be expedited to OB facility.
    - Presenting part should be supported but not elevated (unless cord prolapse).
    - Avoid traction.
    - If head entrapment occurs, the provider may place fingers gently on the maxilla to flex the neck and facilitate delivery of the head.

- **Shoulder dystocia:** should be suspected with the "turtle sign" (movement of fetal head backwards into introitus), or when delivery does not complete with gentle downward movement of fetal head.
    - Primary focus of prehospital effort should be positioning and gentle suprapubic pressure to attempt to reduce anterior shoulder impaction.
    - This can be accompanied by the McRoberts maneuver (hyperflexion of maternal hips)
    - Corkscrew maneuver can be attempted with direct medical oversight (apply two fingers to front part of top shoulder and rotate neonate toward the back)
    - If these fail, attempt Gaskin maneuver (rolling patient to all fours)
    - EMS physicians may attempt other maneuvers (Woods, Rubin, Zavanelli), but instructing crews to perform any of these via online consult is extremely difficult.

- **Postpartum hemorrhage:**
    - Treatment starts with with fundal massage for uterine atony.
    - Large-bore IV access should be obtained and treatment for shock as appropriate.
    - Maneuvers to facilitate delivery of the placenta (traction on the cord) should not be undertaken by prehospital providers.
    - Second most common cause of postpartum hemorrhage is laceration of the genital tract. Bleeding from perineal lacerations should be controlled using standard techniques.
    - Online direction for manual reduction of inverted uterus may be attempted in special circumstances (prolonged transport times, remote scenes, etc.)

45 Perimortem cesarean section, 325

- Should be performed within 4 minutes of maternal arrest, with delivery by 5 minutes;
    - *in cases beyond 20-24 weeks gestation (fundus at or above umbilicus).

- PMCS is beneficial to maternal resuscitation, not solely to rescue the fetus.

- Few cases of field PMCS reported. Almost certainly outside nursing or paramedic scope of practice, even with on-line medical control. Rapid transport with ongoing resuscitation of the mother is probably the best, especially if transport time is presumed to be short.

- Time should not be spent looking for fetal viability. Consider PMCS for any pregnancy beyond 20 weeks, or for any obviously gravid uterus deemed to large enough to cause aortocaval compression.

- PMCS should still be considered beyond “4 minute” rule as neurologically intact infant survival is documented well beyond this cutoff.

- Training courses exist (ALSO, MOET, ALARM) which include PMCS. EMS physicians should be trained adequately to perform this procedure in the field if appropriate.

- Procedure:
    - Generous midline incision from pubis to umbilicus, following linea nigra.
    - Displace bladder caudally. Stab incision of bladder if distended and obstructing access.
    - Short vertical incision of lower uterine segment, just cephalad to bladder.
    - Extend incision cephalad using scissors, incising through placenta if necessary.
    - If vertex, insert hands into uterine cavity and elevate head and shoulders out of incision.
    - Resuscitate neonate as indicated.
    - Consider packing or suturing uterus if appropriate. Can also apply direct aortic pressure.

- No physician in the US has been held liable for performing PMCS, even when against wishes of family.

- No reported cases of infants surviving beyond early neonatal period with significant neuro disability.

Section VII: Toxicological Problems

46 Principles of toxicology, 333

- Providers should maintain broad differential. Patients should be thoroughly assessed and stabilized; many toxicologic emergencies do not have specific antidotes or treatment and supportive care is paramount.

- Gather as much information about the exposure as possible.

- Directed examination can reveal significant findings suggesting specific toxin/toxidrome.

- Numerous agents can cause QRS prolongation. Reasonable to treat any poisoned patient with prolonged QRS interval, especially if unstable, with 1-2 mEq/kg of sodium bicarb, while monitoring QRS intervals.

- Numerous agents can cause QT prolongation. Reasonable to treat any poisoned patient with prolonged QTc (especially if >500 ms) with IV magnesium +/- calcium.

- Supportive treatment is most important, including ensuring airway patency and ventilation (with ETI if necessary), IV access and IV fluids, continuous cardiac monitoring including pulse ox, and fingerstick glucose measurement. Seizures should be treated with benzodiazepines.

Table 46.3 Examples of potential toxins associated with miosis or mydriasis

Miosis	Mydriasis
Antipsychotic agents	Anticholinergics
Carbamates	Sympathomimetics
Clonidine	Selective serotonin reuptake inhibitors
Opiates	Withdrawal syndromes
Organophosphates	
Sedative-hypnotics	

Table 46.1 Odors that suggest a toxicological exposure

Odor	Possible source
Bitter almonds	Cyanide
Fruity	Isopropanol, acetone
Garlic	Organophosphates
Gasoline	Petroleum distillates
Mothballs	Naphthalene, camphor
Pears	Chloral hydrate
Minty	Methylsalicylate
Rotten eggs	Hydrogen sulfide
Freshly mowed hay	Phosgene

- Toxicologic protocols should remain general -- impossible to prepare for each agent individually. Focus on supportive care, and always include poison control center contact information.

- Hydrofluoric acid is unique agent that does not behave like typical acids. It is found in wheel cleaner and glass etching agents. It permeates tissues and binds calcium and magnesium, leaching them out of cells. This causes severe pain, and electrolyte derangements -- hyperkalemia, hypocalcemia, hypomagnesemia. Treatment is aggressive IV fluid electrolyte repletion and cardiac monitoring.

Table 46.4 Toxidromes

Toxidrome	Signs and symptoms	Potential agent example
Opioid	Sedation, miosis, decreased bowel sounds, decreased respirations	Codeine, fentanyl, heroin, hydrocodone, methadone, morphine, oxycodone
Anticholinergic	Mydriasis, dry skin, dry mucous membranes, decreased bowel sounds, sedation, altered mental status, hallucinations, urinary retention	Atropine, antihistamines, cyclic antidepressants, cyclobenzaprine, phenothiazines, scopolamine
Sedative hypnotic	Sedation, decreased respirations, normal pupils, normal vital signs	Benzodiazepines, barbiturates, zolpidem
Sympathomimetic	Agitation, mydriasis, tachycardia, hypertension, hyperthermia, diaphoresis	Amphetamines, cocaine, ephedrine, phencyclidine, pseudoephedrine
Cholinergic	Miosis, lacrimation, diaphoresis, bronchospasm, bronchorrhea, vomiting, diarrhea, bradycardia	Organophosphates, carbamates, nerve agents
Serotonin toxicity	Altered mental status, tachycardia, hypertension, hyperreflexia, clonus, hyperthermia	Overdose of serotonergic agents alone or in combination (i.e. selective serotonin reuptake inhibitors, dextromethorphan, meperidine)

Table 46.5 Antidotes

Agent or clinical finding	Antidote
Acetaminophen	N-acetylcysteine
Benzodiazepines	Flumazenil*
Beta-blockers	Glucagon
Cardiac glycosides	Digoxin immune Fab
Crotalid evenomation	Crotalidae polyvalent immune Fab
Cyanide	Sodium thiosulfate* Sodium nitrite Hydroxycobalamin*
Ethylene glycol	Fomepizole
Iron	Deferoxamine
Isoniazid	Pyridoxine
Methanol	Fomepizole
Methemoglobinemia	Methylene blue
Opioids	Naloxone*
Organophosphates	Atropine* Pralidoxime*
Sulfonylureas	Glucose* Octreotide

*Antidotes that may be available to EMS personnel.

- Decontamination:
  - Surface decontamination should occur before transport. Wear appropriate PPE for contaminating agent. Gas or vapor exposure requires removal from the site only (ocular decontamination may still be needed). Remove and seal contaminated clothing in plastic bags to prevent off-gassing. Brush all solids from skin and clothing, irrigate exposed areas 10-15 minutes with water or saline, scrub with a soft brush. Irrigate any wounds for additional 5-10 minutes.
  - Ocular irrigation should be done for at least 15-30 minutes. Tap water is acceptable alternative to saline, though LR is preferable. Irrigate away from medial canthus. As endpoint of ocular decon is normalization of pH and this is not typically able to be checked in the field, irrigation should be continued during transport.
  - Gastric lavage, forced emesis, or activated charcoal are all probably inappropriate for prehospital care. Focus on supportive care and rapid transport to appropriate facility.

- Endpoint of naloxone treatment is restoration of respiratory function, ability to protect airway, and improved level of consciousness. Over-treatment with naloxone can precipitate severe withdrawal.
  - Onset of action for IN naloxone is longer than IV (8-12 vs 6-8 minutes), and optimal IN dosing is unclear.

- Hydrofluoric acid is unique agent that does not behave like typical acids. It is found in wheel cleaner and glass etching agents. It permeates tissues and binds calcium and magnesium, leaching them out of cells. This causes severe pain, and electrolyte derangements -- hyperkalemia, hypocalcemia, hypomagnesemia. Treatment is aggressive IV fluid electrolyte repletion and cardiac monitoring.

47 Treatment and evaluation of specific toxins, 341

- Agents that can cause rapid loss of consciousness: CO, hypoxic environment, nerve agents, H2S.

- Victims exposed to gas or vapor only, without skin or eye irritation and no visible toxins on person, may be evacuated immediately. Eye irritation alone indicates need for irrigation during transport.

- Priorities include recognizing potential chemical source, adopting appropriate PPE, removing victims from exposure, and decontamination if necessary followed by supportive care.

- Organophosphates: pesticides and nerve agents; cause DUMBBELLS physiology
    - PPE: Level A required for nerve agents; all are highly volatile (except VX).
    - For carbamate pesticides, unless the patient is drenched in pesticide, standard universal precautions are sufficient.
    - Vomitus may be capable of causing secondary contamination.
    - Decontamination involves removing all clothes and jewelry, and irrigation with water +/- soap.
    - Pesticides may require significant scrubbing.
    - Miosis is not a common sign with organophosphate toxicity with non-vapor exposure (such as ingestion of carbamate pesticide).
    - Treatment begins with airway management and ventilatory support, including suction.
    - Avoid succinylcholine if intubating.
    - Begin with atropine (2 mg adult, 0.05 mg/kg peds), repeated every 1-5 minutes titrated to effect (reduced secretions/bronchoconstriction and improved bradycardia).
    - If symptoms do not immediately resolve with single dose atropine, pralidoxime should be given (1-2g adult, 25-50 mg/kg peds) over 15-30 minutes.
    - Benzodiazepines for seizures, knowing these may worsen respiratory depression.
    - MARK 1 auto injector contains 2 mg atropine + 600 mg pralidoxime in two injections.
    - ATNAA/DuoDote administers 2.1mg atropine + 600 mg pralidoxime simultaneously

- Gases: chlorine, phosgene, anhydrous ammonia, hydrofluoric acid, hydrocarbons
    - Chlorine, ammonia, HF all have high water solubility, which leads to pungent odors and rapid onset of symptoms in the eyes and upper airway mucosa.
    - Phosgene has lower water solubility, so not as strong of a warning odor (newly mown hay), and is more likely to penetrate to lower airways and cause alveolar damage with noncardiogenic pulmonary edema.
    - Remove clothing and irrigate eyes. Supportive care includes supplemental O2, suctioning, beta-agonist/anticholinergic nebs, IV fluids for shock. Consider IV steroid if gas exposure triggers underlying asthma/COPD symptoms. Respiratory distress or stridor indicates need for intubation. Phosgene exposures require prolonged observation period for delayed symptoms.
    - No specific antidotes. Consider nebulized sodium bicarb in chlorine exposure. Consider IV calcium gluconate for prophylaxis with significant inhalation exposure to HF.
    - Hydrocarbons are themselves minimally toxic but can displace oxygen. Exposed patients should be

removed from environment (maintaining safety of rescuers in hypoxic environment), and administered 100% O2.

  - Hydrocarbon abuse (huffing) may lead to sudden cardiac death when an epinephrine surge triggers fatal ventricular arrhythmia. Epi should be avoided in this population.
  - Huffing methanol-containing products can lead to methanol toxicity (blindness, metabolic acidosis). Huffing metallic spray paints can lead to toluene toxicity (acidosis and severe hypokalemia, even to the point of paralysis). Huffing solvents containing methylene chloride can lead to carbon monoxide toxicity.

- Carbon monoxide: Binds Hgb much more avidly than O2.
  - Symptoms are myriad, with acute exposures initially causing non-specific symptoms such as headache, nausea, dizziness progressing to altered mental status, syncope, seizures, coma. Hypotension, ischemia, infarct, arrhythmia are possible. Rhabdo, renal failure, pulmonary edema can also occur.
  - Chronic low-level exposures can cause headaches, lightheadedness, ataxia, cognitive/mood changes.
  - Firefighting units typically carry CO detection equipment. Gold standard is CO-oximeter measurement of venous carboxyhemoglobin levels. Prehospital non-invasive CO-oximetry unit is available, though its role remains undefined.
  - Initiate treatment based on clinical symptoms and history, in conjunction with measured environmental CO levels. Remove patient from environment and give high-flow 100% O2.
  - Utility of hyperbaric treatment for CO poisoning remains controversial. ACEP has published clinical policy paper stating HBO cannot be mandated, based on available evidence. Reasonable to consider HBO for CO-poisoned patients with loss of consciousness, focal neurologic signs, or for pregnant patients with fetal distress. Some also recommend it for cardiovascular signs. Adult patients with cardiac arrest from CO poisoning have nearly universally fatal outcomes; only pediatric arrest or witnessed arrest should be considered for HBO. If decided upon, HBO should be begun as soon as possible, ideally within 6 hours of exposure, no later than 24 hours later.
  - CO levels should guide therapy but should not be sole determinant and toxicity is based both on level and duration of exposure. Maternal levels do not correlate with fetal exposure. Some have proposed absolute CO-Hgb levels of >25% (>15% in pregnant patients) for HBO treatment.

- Cyanide: Usually generated during burning of natural & synthetic substances.
  - Uncouples oxidative phosphorylation, leading to dyspnea, headache, nausea, anxiety, and altered mental status progressing to syncope, apnea, and death.

  - Should be considered with history suggesting exposure combined with lactic acidosis + hemodynamic or respiratory compromise that does not respond to O2. Bitter almond odor and cherry-red skin or venous blood are not reliable signs.
  - No decontamination required other than removing from exposed environment.
  - Antidotes include sodium nitrite, sodium thiosulfate, and hydroxocobalamin.
  - Sodium nitrite (300 mg adult over 2-3 minutes) produces methemoglobin which displaces CO from

mitochondria. Can lead to hypotension and toxic methemoglobinemia. It decreases patient's O2 carrying capacity, which may be problematic in victims of significant smoke inhalation.
    - Sodium thiosulfate (12.5 g adult, 0.42 g/kg peds) converts cyanide to thiocyanate, which is excreted by kidneys. It is probably the ideal prehospital agent for cyanide toxicity, especially to be given empirically with low suspicion of significant CN poisoning.
    - Hydroxocobalamin (5g adult, 70 mg/kg peds over 15 minutes) scavenges cyanide itself, forming cyanocobalamin which is excreted by kidneys. It does have some side effects including urine/serum discoloration, pustular skin reactions, hypertension). Incompatible in same IV line as sodium thiosulfate.
    - Ingestion of potassium cyanide salts as a suicide attempt can lead to the victim off-gassing CN gas with potential for secondary exposure of providers. It will typically cause nausea, vomiting, and hemorrhagic gastritis in victims.

- Hydrogen sulfide: Similar to CN, has stronger odor but victims can become "odor fatigued."
    - Most tragic situations occur when initial victim enters toxic environment and is overwhelmed and loses consciousness, followed by multiple rescuers who do the same.
    - Most common agent utilized in "chemical suicides."
    - Treatment is supportive: removal from environment + 100% O2.

- Vesicants: sulfur mustard, lewisite, nitrogen mustards (now used as chemo agents)
    - PPE: Level A required for hot zone operations.
    - Decontamination: Most are internalized within 15 minutes on tissue but can persist on objects so all clothing/jewelry/etc must be removed.
    - Symptoms include desquamation, painful blisters, corneal damage. Vapor inhalation leads to necrosis of upper airways, pulmonary edema.
    - Sulfur mustard: Penetrates most materials and has no warning properties. Delayed onset of symptoms. Also causes bone marrow suppression.
    - Lewisite: Contains arsenic. Similar to sulfur mustard but much faster symptom onset.

- White phosphorus: Common ingredient in meth labs. When ingested or inhaled, causes vomiting & diarrhea. Breath, emesis, and other excreta has characteristic garlic odor.
    - Surface decontamination should occur before transport.
    - Wear appropriate PPE for contaminating agent.
    - Gas or vapor exposure requires removal from the site only (ocular decontamination may still be needed).
    - Remove and seal contaminated clothing in plastic bags to prevent off-gassing.
    - Brush all solids from skin and clothing, irrigate exposed areas 10-15 minutes with water or saline, scrub with a soft brush.
    - Irrigate any wounds for additional 5-10 minutes.

Section VIII: Environmental Problems

48 Cold exposure illness and injury, 351

- **Hypothermia**: Core temp < 95 F (35C).
    - Clinically cold stress exceeding body's ability to produce sufficient heat to maintain body temperature.

- EMS providers more likely to encounter "urban hypothermia," a chronic condition resulting from cold exposure with a combination of factors including medical conditions, medications, change in temperature perception, substance abuse, inadequate nutrition, inadequate social circumstances.

- Heat loss
    - Radiation aka Infrared emission (40% of all heat loss)
    - Evaporation due to sweating
    - Conduction (direct transfer of heat from object to object)
    - Convection (heat loss is a function of the square of wind velocity up to 40 mph; i.e. wind chill).

- Assessment & treatment should be based on patient's clinical presentation:
    - Mild: Shivering, loss of fine then gross motor function, progressive loss of cognitive function. At this stage, patient can still rewarm themselves if cold stress is removed.
    - Moderate: Loss of shivering, progression of confusion to unconsciousness, vulnerability of heart to A-Fib. Patient cannot rewarm self even if cold stress removed.
    - Severe: Rigidity, loss of vital signs, vulnerability of heart to V-Fib with rough handling (eventually to spontaneous V-Fib), coma

- Beyond removing patient from cold stress, prehospital treatment modalities include forced warm air full-body blanket, electric heater with rigid torso cover, and charcoal vest forced hot air heaters. Avoid warm/hot water immersion.

- Acute environmental (primary) hypothermia patients may not need evacuation if changes can be made to patient's clothing or route such that recurrent cold stress is minimized. Patients with severe hypothermia should be evacuated in a manner that minimizes bumping and jolting.

- "No one is dead until warm and dead" is not always practical. Rescuer safety comes first. Conditions incompatible with life include core temp <50F (10C), cold water submersion >1 hr, obvious fatal injuries, and frozen patients (ice in the airway or chest wall too rigid to perform CPR).

- Optimal resuscitation techniques for hypothermic arrest have not been determined. Some experts recommend rewarming in place, while others recommend transporting with ongoing CPR if definitive rewarming care is available within 3 hours.

- **Trenchfoot** occurs with subacute exposure to cold but nonfreezing temperatures, especially when complicated by water exposure, excessively tight footwear, and immobility. Foot becomes macerated with vasomotor instability and anesthesia (may not be noticed by patients, especially alcoholics and the chronically homeless). Prolonged vasoconstriction leads to tissue injury.
    - Pretreatment: Pre Hyperemic. Blanched, local edema, anesthesia.
    - Treatment: Hyperemic, swollen, painful. Blisters and gangrene can occur in severe cases.
    - Post Hyperemic: Ongoing vasomotor instability, cold sensitivity, limb coolness; exertional blistering, edema, paresthesias. Can last for years.
    - Best prevented by frequent changes with clean, dry socks.
    - Avoiding immobility and prolonged exposure to cold/wet conditions, and keeping feet dry for 8 out of every 24 hours are also important.
    - Treatment consists of removing wet clothes, keeping feet dry and elevated.

- For **frostbite**, prehospital grading system of “degrees” is commonly used:
    - First-degree: numbness, erythema, white/yellow plaques, edema without tissue loss.
    - Second-degree: Blisters surrounded by erythema and edema.
    - Third-degree: More extensive blood-containing blisters.
    - Fourth-degree: Includes subcuticular tissues. Difficult to distinguish from third-degree prehospital.

- Two key principles of frostbite treatment: Avoid thawing and refreezing the frozen part. Avoid burns.
    - Rewarm core temp to >93F (>34C), the completely immerse frozen part in hot water bath (99-108F or 37-42C). Rapid rewarming is probably superior. Pain control is required.
    - In wilderness, only thaw extremity if:
        - 1) The patient will not need to use the part for evacuation until healing is complete.
        - 2) The patient themselves can be kept warm until healing is complete.
        - 3) Thawing can be completed in a controlled, uninterrupted manner with well-regulated rewarming bath.
        - • Three phases of cold water immersion:
    - Cold shock response: Hyperventilation & gasp response, can lead to unconsciousness from hyperventilation or panic and water aspiration. High risk of drowning if no floatation device used.
    - After recovery from cold shock, patient has about 10 minutes of useful activity. After this, drowning will occur without floatation device. Useful actions to promote recovery should be performed, but excess activity will accelerate hyperthermia.
    - Unconsciousness from hyperthermia may not be lethal until 2 hours, if floatation device keeps patient’s head out of the water.
    - 1-10-1 Rule: 1 minute to control ventilation & prevent panic. 10 minutes of useful activity. 1 hour until unconsciousness due to hypothermia.

- Sudden death can occur up to 24 hours after cold water rescue. Rescuers should keep patients horizontal, minimize physical activity, and carefully monitor for cardiopulmonary collapse.

49 Heat-related illness, 358

- Heat-related homeostatic mechanisms
    - Cutaneous vasodilation, sweating, decreased voluntary movement, anorexia, decreased heat production, and increased respiration.
    - Minute ventilation, HR, and cardiac output increase and perfusion to the viscera decreases.

- Hot, humid environments confer the greatest risk.

- High risk populations include the elderly (reduced reserve, decreased ability to thermoregulate, less mobile, more likely to be volume depleted, more likely to be on meds that impair thermoregulation), the obese, and those physically active in hot/humid environments (athletes, military, outdoor workers).

- **Heat edema** of the extremities is the mildest form.
    - Move to cooler environment, elevate, compression stockings.

- **Heat syncope** is the result of venous pooling and peripheral vasodilation.
    - Move to cooler environment, administer IV fluids.

- **Heat tetany** can arise from respiratory alkalosis from hyperventilation due to heat stress.
    - Move to cooler environment. Breathing into paper bag not recommended.

- **Heat cramps** are caused by heavy sweating plus repletion with hypotonic fluids causing hyponatremia.
    - Treat by rehydration with oral electrolyte solution or IV fluids. Salt tablets not recommended.

- **Heat exhaustion** includes those experiencing systemic symptoms such as dizziness, fatigue, headache, nausea, visual changes, weakness, anxiety, confusion, fever, hypotension, skin flushing, tachycardia. Core temperature is < 40C. Patients present with near-normal mental status.
    - Treatment is removal of patient from heat stress, cooling, and rehydration (preferably orally).

- **Heat stroke**: Hyperthermic + CNS dysfunction. Other concerning signs are anhidrosis, cardiac dysrhythmias, pulmonary edema, tachycardia, tachypnea, shock. Core temp often 40-44 C. Classic heat stroke occurs in elderly/debilitated patients that cannot respond to external heat stress over the course of several days. Exertional heat stroke occurs in healthy adults who are active in hot/humid environments.
    - Treatment is the same as heat exhaustion, except that IV fluids are preferred. Treat seizures with benzodiazepines.

- Decreased mortality and improved outcomes with rapid cooling to 38.3 C. Cooling techniques in prehospital environment consist chiefly of mist spray + fan, ice packs to groin and axilla.

50 High-altitude illnesses, 363

- Physiologic changes occur as high altitude is reached (1500m).
    - At 3500m, each breath contains about 60% as much oxygen as sea level (due to decreased barometric pressure, the concentration of oxygen remains 21%).
    - At 5000m, each breath contains about half as much oxygen as sea level.

- Physiologic changes include EPO secretion, increased RR and TV (causing a metabolic acidosis which the kidneys respond to by secreting bicarb, allowing further increases in minute ventilation), dehydration, peripheral edema, and periodic breathing. Sympathetic increases in HR & BP are temporary.

- **Acute Mountain Sickness** is most common altitude illness, can occur as low as 2500-2700m.
    - AMS may be related to mild increases in ICP and mild cerebral edema.
    - Symptoms resemble those of a hangover. No neurologic deficits or altered mental status occurs.
    - Mild AMS can be treated by halting ascent for acclimatization (3-4 days). Acetazolamide 250 mg PO BID may accelerate acclimatization. NSAID or ondansetron can be used for symptom control.
    - Moderate-severe AMS is treated by descent of at least 500-1000m. Lightweight portable hyperbaric chambers or supplemental O2 are also effective.

- **High Altitude Cerebral Edema** can progress from AMS in as little as 12 hours (usually 1-3 days).
    - Ataxic gait, severe lassitude, altered level of consciousness; also headache, vomiting.
    - Descent must begin immediately.
    - Treat with dexamethasone 8mg by any route followed by 4 mg every 4-6 hours.
    - Provide supplemental oxygen with goal SpO2 of >90%.
    - Furosemide, hypertonic saline, and mannitol are all reasonable adjunct treatments.

- **High Altitude Pulmonary Edema** is the most common cause of death from altitude illness.
    - Symptoms begin with decreased activity tolerance and progress to fatigue, weakness, exertional dyspnea, dry cough, cyanosis.
    - Treatment must begin with rapid descent of 500-1000m, along with supplemental high-flow O2.
    - After successful acclimatization at lower altitude (2-3 days), the climber may re-ascend, if recovery is complete.
    - EPAP/CPAP, furosemide, PDE-5 inhibitors, CCB may be considered as adjunctive treatments.

- Essential items for the medical director include education of providers, public service education as appropriate for your area, and interagency/interfacility cooperation to optimize response.

51 Effects of flight, 368

- Effects of decreased temperature and decreased barometric pressure must be taken into account when transporting patients by air.

- Pneumothorax may not require chest tube prior to air transport, especially by helicopter.
- Endotracheal tube cuff pressures must be monitored on ascent and descent. Consider filling the balloon with saline rather than air prior to air transport.
- Hypoxemia is a major concern. Use pulse oximetry and supplemental oxygen liberally.
- Vibration and noise contribute to crew fatigue and equipment malfunction, especially in helicopters.
- Crews must take into account G forces of take-off and landing, especially in fixed-wing aircraft.
- Motion sickness can affect patients and crew. Zofran ODT is probably the ideal treatment for crew.
- “Flicker vertigo” can occur due to helicopter rotor motion; may be attenuated by using helmets with visors to limit view of rotor motion.
- NVG with counterweight weighs about 3.7kg, which can lead to significant neck pain for crews.
- Flight-specific PPE (helmet, flame-retardant uniforms, etc.) can lead to dehydration and heat injuries.

52 Diving injury, 372

- Every 33 feet of depth (34 feet in freshwater) increases pressure by 1 atmosphere (760 mmHg)

- **Boyle's law** is responsible for barotraumatic injuries:
    - - Volume & pressure of gas are inversely related: $P_1V_1 = P_2V_2$
    - - Air inspired at depth will greatly increase in volume upon ascent

- **Dalton's law** is responsible for oxygen toxicity and nitrogen narcosis:
    - - The total pressure exerted by a mixture of gases = sum of partial pressures of gases in the mix
    - - $P(total) = P(O_2) + P(N_2) + P(CO_2)$
    - - Partial pressures of gases increase proportionally with depth

- **Henry's law** is responsible for decompression sickness:
    - - Concentration of gas dissolved in a liquid is directly proportional to partial pressure of gas above the liquid
    - - $P = kC$

- Barotrauma is the most common medical problem associated with diving; can affect any air-filled organ. The primary dive concern of barotrauma is the resultant panic causing rapid ascent or drowning.

- Injury of descent is barotraumatic and can affect several organ systems:
    - **Middle ear:** "ear squeeze," inability to clear ears can result in TM rupture and cold caloric response. Avoid diving with a cold, use decongestants.
    - **Inner ear:** Forceful Valsalva against closed eustachian tube can result in trauma to vestibular and cochlear structures. Symptoms are vertigo, "roaring" tinnitus, and hearing loss. Treatment includes rest, HOB elevation, symptom control, and ENT referral.
    - **External ear:** tight-fitting hood causes relative negative pressure gradient in external canal, pulling TM outward with discomfort.
    - **Sinus:** Most commonly frontal sinus. Facial pain, facial numbness, epistaxis, maxillary pain. Use decongestants or topical nasal vasoconstrictors. Steroid burst may hasten recovery.
    - **Mask squeeze:** Failure to equalize pressures can result in facial petechiae/ecchymosis, conjunctival hemorrhage
    - **Suit barotrauma:** Folds in wet or dry suit become compressed and cause ecchymosis.
    - **Dental:** Air trapped below decayed teeth or other hardware becomes painful during dive.

- Injury at depth includes nitrogen narcosis, oxygen toxicity, and immersion pulmonary edema.
    - **Nitrogen narcosis:** Typically occurs at depths greater than 100-120 feet. Increased nitrogen tissue concentrations result in euphoria, impaired decision-making and judgment, loss of fine motor skills. It improves rapidly with ascent. Recreational divers should not dive deeper than 120 feet with compressed air. Commercial divers use mixes with other inert gases to decrease risk of nitrogen narcosis.

- **Oxygen toxicity:** Exposure to increased partial pressures of O2 results in tissue damage, most notably to brain, lung, and eye. Treatment is immediate ascent.
    - CNS toxicity: Symptoms experienced on continuum, abbreviated VENTIDC (visual changes, ear ringing, nausea, tingling/twitching in the face, irritability/anxiety/agitation, dyspnea/dizziness/discoordination, convulsions).
    - Pulmonary "whole body" toxicity: Pulmonary irritation from prolonged exposure to O2.
- **Immersion pulmonary edema:** rapid onset of dyspnea at depth with cough/hemoptysis upon ascent. Not the same as decompression sickness. Treatment is oxygen and diuretics.

- Injury of ascent is also due to barotrauma. Most severe forms involve pulmonary barotrauma.
    - **Reverse sinus/ear barotrauma:** Can result in blood in ear or nose, TM rupture, pneumocephalus.
    - **Alternobaric vertigo:** Middle ear pressures become unequal, resulting in vertigo. Redescent of a few feet should resolve symptoms, followed by careful reascent.
    - **GI barotrauma (aerogastralgia):** Expansion of bowel gas causes GI discomfort. Eructation or flatulence usually resolve symptoms.
    - **Pulmonary barotrauma:** Most commonly caused by uncontrolled rapid ascent without exhaling. Can result in alveolar hemorrhage, pneumothorax/mediastinum, subcutaneous emphysema.
    - **Arterial gas embolism:** Most feared complication of pulmonary barotrauma. Second-most common cause of mortality among divers behind drowning. Symptoms occur during ascent or within 10 minutes of reaching the surface, and depend on amount and distribution of air embolism. Most severe presentation is immediate PEA arrest on surfacing, usually unsalvageable. Virtually any neurologic sign is possible, with most common being confusion, stupor, loss of consciousness. Other symptoms can include chest pain, hemoptysis, dyspnea, blindness, nausea/vomiting.
    - **Decompression sickness:** Inflammatory and obstructive effects of inert gas bubbles in the vascular system and tissues. Risk is increased by length and depth of dive; can occur despite adherence to dive tables. Increased risk with age, obesity, dehydration, activity before diving, flying after diving. Typically classified according to organ system involved:
        - MSK ("the bends"): Most common. Boring, deep pain in major joints
        - Cutaneous: Rash, pruritus, formication, cutis marmorata (marbling of the skin)
        - Pulmonary ("the chokes"): Dry cough, dyspnea, cyanosis
            - Results from massive pulmonary gas embolism. Rare but serious.
        - Neurological: Random/diffuse CNS involvement, usually thoracic/lumbar spinal cord
        - Vestibular ("the staggers"): Vertigo, nystagmus, nausea/vomiting
        - Vasomotor: "Decompression shock" unresponsive to IV fluids
        - Dysbaric osteonecrosis: Long-term avascular/aseptic necrosis of bone
        - Dysbaric retinopathy: Uncommon direct effect to retinas

- **Shallow water blackout:** During breath-hold dive, exercise-induced hypoxemia may cause LOC before CO2 accumulation prompts urge to breath. Most common among sport freedivers and similar.

- Patients suspected to have arterial gas embolism or decompression sickness should be transported as rapidly as possible to a hyperbaric-capable facility. Other treatments are supportive (NRB O2, IVF).

- Divers Alert Network is a 24/7 hotline for dive-related injury & referral and evacuation assistance.

Section IX: Special Populations

53 The special needs of children, 381

- NAEMSP model pediatric protocols developed so systems would not have to start from scratch.

- Pediatric Assessment Triangle involves assessment of Appearance, work of Breathing, and Circulation to develop general impression of illness severity in first 30-60 seconds of encounter.
    - Appearance: TICLS (Tone, Interactiveness, Consolability, Look/gaze, Speech/cry)

- Providers should be given a reference with normal ranges for vital signs through age ranges.

- Clinical signs should trump vital sign values (i.e., a child with signs of poor perfusion should be treated as such regardless of the blood pressure measurement).

- Length-based tape devices are useful for calculating drug dosages and equipment sizing based on lean body weight.

- NAEMSP policy statements include a list of pedi equipment for ALS and BLS ambulances

- Must take into account developmental stage of patient; providers should have a general idea of behaviors/capabilities of “average” child at different ages.

- Most important aspect of evaluating child with special health needs is obtaining developmental level and baseline activity/behavior from parent or caregiver.
    - Determine what is different from normal.
    - Ask the caregiver the best way to approach the child, and include caregiver as extensively as is appropriate.
    - Ask if they have a special emergency information form, or a “go bag” with special equipment for transportation.
    - These children often obtain care at specialized children’s hospitals, which may require transport outside of usual protocols.

- Children under age 18 cannot provide informed consent unless they are an emancipated minor.
    - Emancipated minor laws differ from state to state. In most states this includes minors who are married, have a child, are pregnant, are active military, or are not living at home and self-supporting. Emancipated minors can consent to and refuse EMS treatment.

- Mature minors are those who have been declared adults by the court. This varies state by state but is usually older than 14 years. A mature minor can refuse treatment and transport as long as they are not on a psych hold and are deemed to have decision-making capacity.

- The emergency exception rule/implied consent rule requires four specific conditions:
    - The child's legal guardian is unavailable or unable to provide consent
    - The child is suffering from emergency condition placing health or life in danger
    - Treatment or transport cannot be delayed until consent can be obtained
    - EMS administers only treatment for the emergency condition

- In implied consent cases, thorough documentation is paramount. This should include attempts to contact guardian, nature of emergency, and treatment provided. Online medical control should be contacted.

- For guardians to refuse for their child, they must have decision-making capacity.
    - EMS providers should contact on-line medical control in these cases.
    - If it is determined that emergency treatment and transport are required, or the parent does have not capacity, then law enforcement may be required to take temporary protective custody of the child.
    - State laws differ in the application, but when applied this allows EMS to transport and treat child with non-life-threatening conditions.

54 Pediatric medical priorities, 386

- Respiratory: Cardiopulmonary arrest in pediatric patients is primarily respiratory in origin:
    - Mainstay of respiratory management is to ensure open airway and provide supplemental O2.
    - Children in respiratory distress require supplemental high-flow O2 by mask at 12-15 L/min. “Blow-by O2” may be useful in agitated/anxious children. BVM or CPAP if needed.
    - The airway should be managed in the least invasive way possible. Transport upright whenever possible.
    - Wheezing should be treated with albuterol regardless of suspected etiology. Also consider ipratropium, steroids, IV Mg, nebulized or IM epinephrine.
    - If respiratory distress with stridor, give nebulized epinephrine, can be repeated for ongoing distress. Children receiving nebulized epi should be transported.
    - Proficiency in pediatric BVM is mandatory for all prehospital providers. The breadth of available evidence suggests poorer outcomes with attempted prehospital pediatric ETI.
    - Children with known cardiac lesions should only be given supplemental O2 needed to maintain their baseline O2 saturation, which is often lower than normal.

- ALTE/(BRUE): Most will be completely recovered by EMS arrival but should still be transported.
    - blood glucose measurement
    - scene size-up for any evidence of NAT.

- Seizures:
    - Blood glucose in all actively seizing patients, treat <45 mg/dL in neonates, <60 in infants and older.
    - Prehospital providers should focus on appropriate management and transport of pediatric seizures, not trying to diagnose the cause of the seizure. Many pediatric conditions can mimic seizures.

- Shock: Tachycardia is the key vital sign indicating compensated shock. Hypotension indicating decompensated shock is a late finding, and cardiopulmonary failure may occur within minutes.
    - Tachycardia without fever, anxiety, or hypoxemia requires immediate intervention.
    - Other signs of shock include skin signs of poor perfusion and altered mental status.
    - Treatment begins with IV fluid bolus 20 mL/kg over 5-20 minutes, which may be best given using the push-pull syringe technique, can and should be repeated as needed. If cardiogenic shock suspected, give smaller boluses of 5-10 mL/kg. If suspected DKA, give 10-20 mL/kg bolus over an hour. Stop IV fluid resuscitation if pulmonary edema occurs.
    - IV access can be difficult. For an ill child, avoid prolonged scene time searching for access, consider limiting number of IV attempts prior to IO.

- • Pediatric cardiac arrest is usually result of respiratory failure or shock.
    - Sudden cardiac arrest should be treated as in adults, with high quality CPR and early defibrillation.
    - Most infant OHCA are unwitnessed. Favorable neurologic outcomes more common in adolescents
    - Initial rhythm is most commonly asystole, except in adolescents (VT/VF) or traumatic arrest (PEA).
    - Dose attenuator for AED recommended for children up to 25kg (approx. 8 years old). In infants < 1

year old, dose attenuator for AED may be used, but manual defibrillation is preferred. A regular AED should be used if nothing else is available.

- Therapeutic hypothermia has not been shown to be beneficial in pediatric arrest.

- No model offline protocol for pediatric arrest field TOR exists. No reliable predictors of outcome have been identified to guide TOR protocol development.

55 Pediatric trauma priorities, 393

- Traumatic injury is most common chief complaint among pediatric EMS calls, and the #1 cause of death and disability in children and adolescents.
- Due to smaller body size, multisystem trauma is more common in children. Internal injury cannot be ruled out by absence of external signs of trauma. Larger surface-area-to-mass ratio leaves children more vulnerable to hypothermia following trauma. Cover infant's heads and warm ambulance during transport.
- Disproportionately large head means head trauma is more common and most serious cause of serious trauma.
- Must keep in mind pediatric airway anatomy considerations, which persist until about 8-9 years old.
- Injury risk of cervical spine given large head and relatively weak neck.
- Ability to increase cardiac output is almost entirely dependent on ability to increase heart rate. In young children, relatively small volumes of blood loss can result in hemorrhagic shock.
- Musculoskeletal system is more elastic and less likely to yield fractures. When they do occur, they are often in the epiphyseal-metaphyseal region.
- Significant internal chest & abdominal trauma can occur from blunt chest trauma without rib fracture.
- Waddell's triad: multisystem injury pattern seen in pediatric pedestrian struck mechanism.
    - Lower extremity (femur) fracture + blunt chest/abdominal trauma + blunt head trauma
- Handlebar injuries from bicycle falls can cause occult intra-abdominal trauma (duodenal hematoma).
- Lap belt sign can indicate significant intra-abdominal injury (hollow viscus), and T/L-spine compression fractures. These injuries may have delayed presentation.
- Pediatric patients are often under-treated in terms of pain. Best evidence supports weight-based dosing of morphine (0.1 mg/kg IV) or fentanyl (0.1 ug/kg IV).
- Pediatric trauma resuscitation pitfalls include:
    - Failure to recognize early compensated shock (unexplained tachycardia or altered mental status)
    - Failure to suspect abdominal injury in polytrauma, even if no obvious external injury
    - Swallowed air with gastric distension can mimic visceral injury, impair ventilation (consider NG/OG tube)
- CDC Field Triage criteria updated to add modification to Step 1 criteria such that any patient requiring ventilatory support, regardless of respiratory rate, should be immediately transported to trauma center.

56 Technology-dependent children, 397

- Some of the most common medical devices are gastrostomy/jejunostomy tubes, central venous catheters, medication nebulizers, VP shunts, and tracheostomies.

- Standard BLS care is adequate to care for most technology-dependent children during transport, but consider use of pediatric-specific transport teams when appropriate.

- Children's caretakers and parents are a vital resource, but still may provide incomplete information. Best practice is for EMS agencies to engage with local hospitals to facilitate preparation and information exchange for these patients. AAP and ACEP endorse use of standardized emergency information form.

- DOPE mnemonic: Dislodgement, Obstruction, Pneumothorax (airway) vs Peritonitis/Perforation/Pseudocyst (for G/J tubes or VP shunts), Equipment Malfunction
    - Rely on home equipment when possible. Bring all necessary equipment along when transporting.

- Tracheostomy:
    - Most common problems are dislodgement or obstruction. If connected to ventilator, pneumothorax or ventilator equipment failure are also possible.
    - Equipment includes suction & catheters, replacement trach & cannula (parents will often have these), and trach tape or other securing equipment.
    - If in distress, first attempt to BVM via trach or via mouth with trach stoma covered. Use drops of saline to attempt to break up secretions within the trach.
    - If trach needs to be removed, first slightly hyperextend head & neck, release trach ties, and deflate balloon. If replacing the same trach, cleanse it and ensure balloon is still functional. Using the obturator or soaking trach in cold water can ease re-insertion.
    - If replacement trach unavailable, use trimmed ETT. Use lubricant, obturator, and apply traction above & below stoma. If unable to pass, try a smaller trach or ET tube.

- Home O2: Transfer to ambulance O2 supply for transport, but make note of flow/FiO2/etc.

- Ventilators: Transfer to ambulance power for transport, but be sure to bring batteries. Leave on home settings if at all possible. If significant distress, hypoxemia, or high-pressure alarms, consider switching to BVM for transport.

- G-tubes: Families often have replacement G-tubes, or same tube can be reused after cleansing and rinsing.
    - If mature stoma is open and without injury and G-tube balloon is still functional, attempt to insert. If the G-tube is in place but obstructed, attempt to flush with 5-10 mL of carbonated beverage.
    - Foley catheter can be used if replacement G-tube is unavailable. If high resistance, make attempt with red rubber catheter. If red rubber catheter is passed, then re-attempt with Foley or G-tube. If still unable, use red rubber catheter or smaller Foley. Inflate balloon and check placement with aspiration of gastric contents and auscultation of air insufflation.

- VNS: Can often be palpated near the patient's clavicle. A magnet can be placed over the device to treat/prevent breakthrough seizure, but otherwise seizure care should proceed as usual.

- Cochlear implants: In general, should be left in place during prehospital care. Increased risk for meningitis, mastoiditis, and intracranial abscess.

- VP shunts: May present with infection, malfunction (obstruction or broken tubing). Both are associated with headache, fever, nausea/vomiting, altered mental status, and focal neuro signs.

- Central venous catheters: If currently in use, can be used by prehospital providers for emergency treatment if expeditious IV or IO access if not possible. Prone to bacteremia and sepsis.

57 Approach to the geriatric patient, 401

- Normal Physiologic Changes of aging:
    - diminished physiological capacity: decreased functional reserve in most organ systems, prolonged recovery periods
- Common changes in normal aging include:
    - thin skin (prone to skin tears, pressure ulcers)
    - difficulty with temp regulation
    - bone loss: increase risk of fractures, reduced spine flexibility
    - reduced cardiac reserve
    - decreased renal function & drug clearance
    - decline in hormone levels
    - decreased vision (cataracts) and hearing loss

- Patient Assessment:
    - no change in initial steps (ABCs)
    - social history particularly important.
    - Communication:
        - Do not assume patient is unable to communicate: always speak to the patient first and establish their level of understanding and participation. Strong, clear voice but avoid shouting.
        - Ensure that patient has communication aids (hearing/vision)
        - Determine the baseline cognitive & physical functioning of the patient.
        - Identify advanced directives and goals of care, health care proxy or activated power of attorney.

- Geriatric medical conditions:
    - **Cognitive impairment** is very common. The Six-Item Screener is a validated instrument which can be used prehospital with good sensitivity & specificity for cognitive impairment;
    - SIX ITEM SCREENER: One point for each correct answer. 3+ errors indicate possible dementia
        - Ask the patient to repeat three words: apple, penny, table. (If failed, stop now).
            - What year is this?
            - What month is this?
            - What is the day of the week?
            - What were the three objects I asked you to remember?

    - **Depression** is very common & risk factor for increased use of services, death & disability. The Patient Health Questionnaire – 2 (PHQ-2) is effective in identifying potentially depressed patients and can be used prehospital:
        - 1. During the past 2 weeks have you often been bothered by little interest or pleasure in doing things? (Not at all - 0, Several days - 1, More than half the days - 2, Nearly every day - 3)

        - 2. During the past 2 weeks have you often been bothered by feeling down, depressed, or hopeless? (Same scoring as above)
        - Score >2 is concerning for major depressive disorder.

- **Falls** are a leading & preventable cause of morbidity, mortality, and loss of quality of life.

- **Medications and Drug Toxicity:** High risk of "polypharmacy" in this population. Obtain as complete a list as possible. Bring pill bottles. Look for pill-taking strategies (pill boxes, calendars, etc.)

- **Altered Mental Status:** Delirium is common, especially among those with multiple underlying comorbidities, and can be precipitated by infection, medication effect/toxicity/overdose, trauma, etc. Extremely important to determine baseline mental status and neurologic function.

- **Cardiac Arrest:** Half of prehospital OHCA patients are elderly. Overall poor survival from OHCA (< 10%). Consider Morrison's field TOR criteria (unwitnessed, no AED shock [non shockable rhythm], no ROSC in the field).

- **Trauma:** older adults are less likely to receive trauma center care than younger adults with similar injury severity. Original Field Trauma Triage Guidelines were not age-specific. The most recent version includes a "Special Consideration" that patients >55 should be *considered* for transport to a trauma center (not required).

- **Social Emergencies:** Gaps in social support, caregiver crisis, or evolving family conflicts can be major underlying precipitants for acute decompensation.

- **Medication & Alcohol Abuse:** Older adults misusing alcohol or drugs are often socially isolated; therefore EMS providers may be the first to identify the problem upon interacting with the patient in their home.

- **Elder abuse and maltreatment:** Elder mistreatment includes financial, psychological, physical & sexual abuse. Risk factors include social isolation, dementia, shared living with abuser.
    - Characteristics of abuser: mental illness, alcohol abuse, dependency on the older adult. EMS providers may be mandated reporters of suspected elder abuse, depending on the state.
    - Regardless, an established protocol for reporting suspected abuse should be written.

- **Caregiver distress:** EMS providers should make note of the state of the family/caregivers. Caregiver distress and burnout is a common reason or complicating factor in requesting emergency care.

- **Special considerations** include specialized equipment (padded backboards, temperature control mechanisms, etc.), integration of EMS and ED EMR systems, and increased vigilance when considering refusal of transport of an elderly patient.

- **Nursing homes & assisted living facilities:** EMS agencies should coordinate with local long-term care

facilities to improve access to patient records and necessary documentation when called to transport patients to the hospital.

- **Public Health:** The role of community paramedicine programs in public health care of the elderly is an area of interest, but logistical/administrative problems of funding and care integration persist.

58 Bariatric patient challenges, 407

- BMI = Weight in Kg/ Height in M; Overweight = BMI 25 – 29.9; Obese = BMI > 30

- Airway:
  - Two-person bagging whenever possible.
  - Positioning is critical for management of airway and breathing. Consider ramp positioning for intubation
  - Surgical airway challenging, landmarks often obscured.

- Breathing:
  - High intraabdominal pressure decreases effect of diaphragmatic effort and decreases venous return
  - Decreased lung volumes: decrease FRC and expiratory reserve, decreased lung and chest wall compliance
  - Desaturate more quickly (smaller oxygen reserve but increased metabolic activity and oxygen demand).
  - Should sit pt in Fowler's or ramped/semi-Fowler's to displace soft tissue whenever feasible
  - Increase PEEP with NIPPV (start around 10 cmH20)
  - TV: still use lung protective 6-8 ml/kg, but based on *ideal* body weight (height)

- Circulation
  - Increased circulatory volume, hyperkinetic system limits physiologic response to acute insult
  - CPR: often less effective, mechanical devices may not fit. No current literature demonstrating negative effect of BMI on outcome from OHCA.
  - Venous access may be difficult, landmarks obscured, longer IV or IO needles may be needed
  - Drug dosing a challenge > lipophilic medications should be dosed according to TBW, while hydrophilic medications should be dosed according to IBW.
  - Medications in general more likely to have erratic absorption, longer onset, and prolonged duration.

Dosing calculation	Example medications
No weight consideration	Adenosine, amiodarone, metoprolol, ondansetron, dobutamine, epinephrine
Ideal Body Weight	Dopamine, ketamine, lidocaine, morphine, norepinephrine, procainamide, rocuronium, vecuronium

Total Body Weight	Diltiazem, Etomidate, fentanyl, lorazepam, midazolam, propofol, succinylcholine
TBW for bolus; IDW for continuous infusion	Lorazepam, Midazolam

- Bariatric Surgery: reserved from BMI > 40 or > 35 with comorbidities
    - Short term complications: infection, delayed wound healing, PE, DVT, anastomotic or staple leak, postoperative hemorrhage
    - Long-term complications: SBO, gastric or small bowel ulcers, nausea/vomiting, band erosion or slippage, stricture, gastro-enteric fistula, internal hernia, dumping syndrome

- Patient Packaging & Movement:
    - Most EMS stretchers are 23 inches wide/ support 550-700 lbs.
    - Bariatric stretchers are 29 inches wide, weight of 850-1600.
    - May need attachable wings. Stretcher should be kept at lowest position to minimize risk of tipping.
    - Immobilization devices (c-collars etc) may not fit properly, be familiar with towels and alternatives
    - No fewer than four, and *ideally six*, personnel are used to move a loaded bariatric stretcher.
    - Hydraulic systems are usually used to put stretcher in ambulance.
    - Protocols for caring for the bariatric patient should be in place.

59 Behavioral health emergencies, 412

- Do not try to make accurate diagnosis in the field. Scene safety first

- Rule out organic causes

- Consider physical or chemical restraint when patient is uncooperative with assessment and alternative methods fail; in conjunction with law enforcement.

- For a patient to refuse transport they must have decision-making capacity, have organic etiology ruled out by reasonable field evaluation, no suicidal/homicidal/violent behavior, have a known psych history consistent with symptoms, and have some family/social/mental health support available. Many adult patients with *new* psychiatric symptoms will have organic etiology; transport should be encouraged (contact med control).

- NAEMSP and ACEP joint policy: important elements necessary for successful alternative transport destination include EMS medical director oversight, medical director-led program development/implementation/QI, and appropriate education.
    - Programs may result in 25% of patients being directly transported to psych ED's with high sensitivity in detecting need for medical evaluation.

- Field evaluation of suicidal patients includes
    - ensuring scene safety
    - empathic communication with the patient
    - directly asking about thoughts of self harm (especially if patient reports or exhibits depression)
    - administration of benzodiazepines or neuroleptics when appropriate
      proper restraint of the patient for safety (i.e., reducing risk of them jumping out of the ambulance)
    - knowledge of state/local statutes regarding involuntary transport.

- Acutely agitated patients must be approached with caution (scene safety) and high clinical suspicion (for organic etiology). Patient should be closely monitored for level of agitation and potential for violence.
    - Organic etiologies to address include hypoxemia, hypoglycemia, and intoxication.
    - Consider team approach with one responder acting as "negotiator" with adequate attempts to verbally de-escalate the patient. The negotiator should be calm and supportive and allow the patient to vent. A tacit "show of force" of the response team behind the negotiator can sometimes be enough to convince the patient to cooperate.

- NAEMSP has position paper regarding patient restraint, which may be undertaken to prevent the patient, the public, or prehospital providers from harm.
    - The three methods are verbal de-escalation, physical restraint, and chemical restraint.
    - The least restrictive method which is safe should be employed.
    - Key principles from the position paper include personnel safety, patient dignity, methods of restraint, indications for restraint, documentation requirements, and medical oversight & quality

improvement.

- The legal justification for physical/chemical restraint and transport against patient's will is based on the professional judgment by the EMS physician in charge that the patient lacks capacity to refuse treatment & transport.
    - Medical oversight must be involved with these decisions. There is usually much less medicolegal exposure in transporting a patient deemed to be a threat to self or others than leaving that patient unevaluated.

- Verbal de-escalation techniques include respecting personal space, not provoking the patient, establishing verbal contact, being concise & simple, identifying wants & needs, using active listening, setting limits, offering choices, and maintaining optimism.

- Ideally 5 people on the "restraint team" -- one for each limb + one for the head & neck.

- The patient should be warned he will be restrained for his own safety and given one last chance to cooperate. Two team members approach from front and behind. If the patient lunges to one side, the team members left behind can grab both arms, forcing the patient face-down to the floor by pushing forward across the team members' legs. The patient should be restrained face-up in the stretcher with one arm by the head and the other to the side.

- Restrained patients require constant monitoring, and restraints should not be removed during transport. Chemical restraints should be considered if the patient continues to struggle. Patients should never be transported in a "hog-tied" or prone position. Generally a good idea to have law enforcement officers present for restraint and transport, but they should not be able to dictate the evaluation and treatment of the patient.

- Chemical sedation employs the use of rapid tranquilization, usually in concert with physical restraint, in some situations in lieu of or prior to physical restraint.

- Ideal agent: Available IN/IM/IV, rapid onset, short half-life, limited respiratory depression, low side effects
    - Haloperidol most commonly-used neuroleptic at time of textbook publication. 5-10 mg IM/IV, onset 20 minutes IM, 5-10 minutes IV. Extrapyramidal symptoms (<10%) reverse with diphenhydramine.
    - Second-generation antipsychotics such as olanzapine may have decreased extrapyramidal symptoms but increased respiratory depression in intoxicated patients
    - Benzodiazepines are also commonly used, especially 0.05mg/kg lorazepam or 0.1-0.2mg/kg midazolam. Drug of choice for patients with for ethanol or benzodiazepine withdrawal.

Section X: Special Considerations

60 Intimate partner violence, 423

Scope of the Problem

- 1:4 women and 1:7 men have experienced severe physical violence
- Women are 3x more likely to report that they have been beaten, choked, sexually assaulted, or threatened with a gun or knife
- Intimate partner violence violence is a leading cause of injury to American women between the ages of 15 and 44 and is estimated to be responsible for *20–25% of emergency department (ED) visits by women.* 33% of female trauma patients are victims of abuse;
- Intimate partners commit 30% of all female homicides and 5% of all male homicides.
- Higher risk groups include women of color, immigrants, the disabled, young and those separated or divorced.

Cycle of Violence and Types of Abuse

- The cycle of violence includes tension building, violence, and honeymoon phases. It often occurs generationally, as well.
- There are many different types of abuse: physical, verbal, emotional/psychological, sexual, spiritual, financial/material (See Box 60.1)
- Abuse can have a range of health effects beyond physical injuries of broken bones, burns or bruises. Other manifestations can include pain syndromes, sleep disturbances, psychiatric issues, as well as pregnancy-related and sexual problems

EMS Considerations

- If EMS is activated through a 9-1-1 call for IPV, law enforcement should secure the scene before EMS access.
- On-scene safety concerns include:
    - Avoid confronting the abuser.
    - Do not place yourself physically between a couple who are arguing.
    - Ensure that an escape route such as the door is available.
    - Do not let the abuser get between you and your escape route.
- The goal of asking patient about abuse is to make a supportive connection and convey the message that abuse is a health issue. Empower the patient to make informed choices for her herself and her children. Do not force a disclosure. If the patient denies abuse, she will at least be left with the awareness that she can access EMS assistance if and when she chooses to disclose.
- If the woman discloses abuse, ask if she is safe now and where the perpetrator is located. Provide a 24-hr IPV hotline number. Make a safety plan based on her concerns and needs are at this time. Refer to a shelter. Know if you (as an EMS provider) are considered a mandatory reporter in your district.
- Preserve evidence and document well. Don't cut through bullet holes or stab wounds in clothing. Document the manner in which clothing is removed/altered and how furniture is moved. Use the principles of objective,

accurate, specific, legible and complete.

61 Sexual assault, 430

Scope of the Problem

- Sexual violence is defined as any form of sexual activity with another person without her or his consent
- Nearly 1 in 5 women and 1 in 71 men have been raped in lifetime in US
- Drug-facilitated sexual assault (DFSA) is the term used to describe cases of sexual assault in which the victim is unable to consent or resist because she has been rendered incapacitated or unconscious due to the effects of alcohol and/or drugs. These crimes are less likely to be reported to law enforcement.
- Use of weapons and brutality are reported more often in male sexual assault.
- Many victims of sexual assault to not suffer life threatening injuries; however, they do experience psychological trauma.

EMS Considerations

- EMS care should be directed at restoring the person's self-determination through decision making with respect to her care.
- It is important than EMS proceed on the presumption that an assault has occurred; it is not EMS's role to decide whether or not an assault occurred.
- The absence of injuries is as consistent with sexual assault as their presence.
- In cases in which DFSA is suspected, it is important that EMS document the patient's level of consciousness, affect, and any symptoms or signs of drug effects.
- Genital and/or anal injuries sustained in sexual assault can be difficult to visualize and therefore assessment of these areas should be left to a trained sexual assault examiner.
- Questioning should be kept to a minimum; EMS should only ask questions that are required to do a physical assessment. Hospital staff and/or law enforcement will conduct a more thorough exam and investigation.
- Try to preserve evidence, and document it. Document what the pt says about the encounter in quotes. Don't gargle/wash/or disturb any body surfaces that have come in contact with the perpetrator's body fluids/skin/hair, as it can be used as DNA evidence. If an oral assault has occurred, don't get food or drink until evidence has been collected. DNA forensic evidence is best collected within 72 hours. Don't remove clothing. If the patient must urinate/vomit/defecate, attempt to collect it in a plastic specimen cup.
- Be aware of legal obligations and reporting with respect to reporting to law enforcement
- If you collect evidence, keep it sealed and labeled with the date, time, location. Hand it over to law enforcement. This helps preserve the chain of custody.
- STI including HIV prophylaxis are time sensitive and should be considered.

62 Child maltreatment, 435

Scope of the problem

- The majority of child abuse cases suffered from neglect (78.5%), followed by physical abuse (17.6%), sexual abuse (9.1%), and emotional or psychological abuse (9%).

- It is estimated that 11-55% of pediatric fractures are secondary to physical abuse, with higher percentages in infants less than 1 year of age.

Clinical Manifestations and “Red Flags”

- The most common manifestations of child abuse are cutaneous injuries

- Bruising is rare in infants before they begin to walk or crawl

- Accidental bruising is more common to certain areas of the body: skin over bony prominences, knees, anterior tibia, forehead, hips, lower arms, spine.

- 10% of pediatric burns are secondary abuse. Most common abusive burns are scald/immersion burns. Delays in seeking care for burns may represent neglect. Reported time of the burn should be documented.

- Any mismatch with respect to history, a changing history, mechanism, appearance, and developmental level of the child should be documented.

EMS Considerations

- Any child with suspicious injury should be transported to medical care.

- EMS can provide valuable information about the scene and circumstances of the call.

- Most child abuse cases are reported long after the abuse occurred.

- Although it is preferable to talk with the child alone, don’t probe into the details. Just focus on a limited interview to ascertain areas of discomfort or pain, and to document their version of the story and timing.

- All states require mandatory reporting of suspicions of child abuse. EMS providers are mandated reporters, often sharing responsibility with hospital.

63 Ethical challenges, 439

Refusal of treatment and transport

- **Autonomy**: a core principle of medical ethics. Individuals are assumed to have the right to self-determination, even if their decision will result in harm to themselves (or even death).
- Patient must have the freedom to act without undue influence from other parties, including family and friends and must demonstrate medical decision-making capacity (see below).
- **Medical decision making capacity**:
  - Patient must have sufficient information about his/her medical condition
  - Patient must understand the risks and benefits of available options, including option not to act
  - Patient must have ability to use above info to make decision in keeping with his/her personal values
  - Patient must be able to communicate his/her choice
- Discussing with online medical direction (e.g. base hospital) helps to increase likelihood of patients agreeing to come to the hospital.
- Medical conditions can make patient impulsive, restless, angry and antagonistic, such as hypoglycemia, head trauma, or sepsis
- **Beneficence:** Providers should act to ensure the patient's safety and best interest (including if they believe patient lacks capacity or are a danger to themselves or others). Making such a decision may require the use of physical restraint or chemical sedation, and may require involvement from law enforcement officers.

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Triage Decisions

- Emergency Systems are designed to encourage best-use of scarce resources.
- EMS providers traveling en route to one patient should not make treatment rationing decisions ad hoc to stop for another patient. Instead, they should report in to dispatch what they are observing, and await instruction
- EMS personnel should also not dissuade patients from seeking transportation for medical care, as they are not trained to render diagnoses and definitive treatment. Exceptions would include specific protocols for alternate care/mobile integrated health, or under direct medical oversight. An EMS physician on scene may be able to "discharge" a patient from the scene.

Confidentiality

- All healthcare providers (including EMS) are subject to HIPAA and must maintain confidentiality
- Exceptions to law include the following:
  - Criminal investigations
  - Suicidal or homicidal patients
  - Suspected elder or child abuse
  - Public health threat

Truth telling and Error Disclosure

- Disclosing mistakes to patients is important even if no harm was done.
- Disclosure supports principles of truth-telling, patient autonomy, and informed decision-making.

- Apology should also accompany disclosure of errors.
- When discussing errors, EMS provider should focus the discussion on the health and safety of the patient
- All of the above should be done according to the local system's policies

Personal Risk

- Risk cannot be completely eliminated. However, an EMS provider must use judgement to determine reasonable versus undue risk and use caution to avoid endangerment.
- Although paramedics should act with the principle of beneficence, if patients or a scene present a direct risk to the healthcare team, the paramedics have an ethical obligation to not place themselves (or others) in danger.

Training and Research

- EMS providers operate with a significant amount of public trust and should not breech that trust
- Continued education and training is required to maintain quality of EMS care and should be in accordance with training standards.
- Practicing new procedures in living or dead patients must not be done without consent from patient or family members in order to respect patient autonomy and dignity
- Research may be conducted in the EMS setting. Informed consent regulations apply. However, recognizing the need for emergency research and difficulty to obtain informed consent in a timely fashion, the FDA and DHHS have developed standards for "Exception from Informed Consent" for emergency research. These standards should be followed for any applicable prehospital research study.

Treatment of Minors

- Minors (under age 18) are generally legally incapable of providing consent. Consent must be granted by parents or legal guardians
- Emancipated minors include the following:
  - Married
  - Legally separated from parents
  - Pregnant or have dependent
  - Armed Forces
- In certain states, EMS may treat non-emancipated minors (over age 14) for certain conditions with their consent alone. These conditions are:
  - mental illness
  - substance abuse
  - pregnancy or sexually transmitted diseases
  - Life-threatening circumstances
- Mature minor: usually 14 years and older, may be able to offer limited consent for his/her own care - the
- Minor care emergency exception - healthcare providers are able to treat minors in a timely manner to prevent morbidity and mortality if parents/guardians are not present = implied consent
- If paramedics believe a minor is *in significant and immediate* risk by parent's medical decisions (to not treat), they can treat and transport under temporary protective custody. This is a last resort.

64 End-of-life issues, 444

- EMS was designed to respond to life-threatening emergencies. However, now multiple patients (e.g., elderly, terminally ill, etc.) do not desire maximal interventions to prolong life. Additionally, years of cardiac arrest research have demonstrated futility of continued intervention in certain conditions of cardiac arrest.

- The basic ethical principles on which modern medicine is founded include respect for patient autonomy, beneficence, non-maleficence, and justice. These should be applied to end-of-life considerations.

- Both ACEP and NAEMSP have position papers stating the recommendation for all EMS systems to have a policy that addresses their response to end of life issues, documentation, and death in the field. (Figure 64.1 is an example of one such policy.)

- Advance directive: written document, completed by the patient when he/she has decision-making capacity, expressing future wishes and/or appointing a surrogate decision maker. Types: living wills and durable powers of attorney for health care - usually does not guide EMS

- DNR/DNAR and POLST - usually filled out by health professionals and guides both EMS and hospital care

- Differences between Advance Directive, DNR and POLST forms (Figure 64.2):

Document	Advance Directive	Do Not Attempt Resuscitation (DNR/DNAR) orders	POLST (Physician Order for Life Sustaining Treatment)
Who completes	Patient	Health professional*	Health professional*
Who needs one	All adults	Person with advanced illness	Person with advanced illness
When they apply	Future time	Pulseless and apneic person	Current time
Guide EMS	Usually not	Yes	Yes
Guide hospital	Yes	Yes	Yes

*After discussion with patient and/or surrogate decision maker and based on the patient's goals and values

Figure 64.2 Comparison of advance directives, DNR/DNAR orders, and POLST. *After discussion with patient and/or surrogate decision maker and based on the patient's goals and values.

- National EMT survey found that 89% are willing to honor state-approved DNAR order, and 77% had protocols for termination of resuscitation in out-of-hospital setting

- Hospice: Medicare benefit that focuses on the treatment of pain and other uncomfortable symptoms, as well as emotional and spiritual needs when a patient likely has less than 6 months to live and is no longer seeking curative treatment

- Grief support for family members is important for EMS to be able to offer. While family members often find the EMS providers to be compassionate and professional, their most common complaint is having questions left unanswered by EMS.. Therefore a system should consider a dedicated field-response for grief support

that can provide more information and allow providers to return to service.

- EMS providers often report feeling unprepared and stressed when delivering death notifications. Education and structured communication models have been shown to increase comfort level, confidence, and competence in delivering death notifications.

65 Termination of resuscitation in the out-of-hospital setting, 453

Starting, Withholding and Terminating Resuscitation

- There are three criteria that need to be met to start resuscitation (If not met, withhold resuscitation):
    1. Provider safety is assured
    2. The patient is not obviously dead (See box 65.1 below)
    3. The patient does not have a DNR order.

- There is a validated decision rule for termination of resuscitation (Box 65.2): The patient received the full resuscitation protocol and has not been transported from the scene and
    1. Did not receive a shock during the protocol
    2. Did not receive prehospital ROSC.
    3. Did not suffer EMS witnessed OHCA.

- Pediatric OHCA has fewer data re when to start and withhold resuscitation ->controversial

- Traumatic cardiac arrest has no validated rules for withholding or terminating resuscitation, though signs of obvious death is still a recommended sign of withholding.
    - It is important to consider a potential medical cardiac arrest being the cause of the trauma, especially if the trauma doesn't seem bad enough to cause arrest.

Box 65.1 Example of obvious death medical directive

Resuscitation is not warranted where there is evidence of obvious death as defined as:
Rigor mortis
Lividity
Transection
Decapitation
Decomposition

Box 65.2 Termination of resuscitation of non-traumatic adult OHCA at scene is recommended when:

The patient has received the full (BLS or ALS) resuscitation protocol and the patient has not been transported from the scene and:
1 Did not receive a shock at any time during the resuscitation, **AND**
2 Did not achieve a prehospital return of spontaneous circulation, **AND**
3 Did not suffer an EMS-witnessed OHCA.

Box 65.3 NAEMSP-ACSCOT 2012 position on withholding resuscitation in traumatic cardiopulmonary arrest

- It is appropriate to withhold resuscitative efforts for certain trauma patients for whom death is the predictable outcome.
- Resuscitative efforts should be withheld for trauma patients with injuries that are obviously incompatible with life, such as decapitation or hemicorporectomy.
- Resuscitative efforts should be withheld for patients of either blunt or penetrating trauma when there is evidence of prolonged cardiac arrest, including rigor mortis or dependent lividity.
- Resuscitative efforts may be withheld for a blunt trauma patient who, on the arrival of EMS personnel, is found to be apneic, pulseless, and without organized electrocardiographic activity.
- Resuscitative efforts may be withheld for a penetrating trauma patient who, on arrival of EMS personnel, is found to be pulseless and apneic and there are no other signs of life, including spontaneous movement, electrocardiographic activity, and pupillary response.
- When the mechanism of injury does not correlate with the clinical condition, suggesting a non-traumatic cause of cardiac arrest, standard resuscitative measures should be followed.

Source: Millin 2011 [43]. Reproduced with permission of NAEMSP.

Box 65.4 NAEMSP-ACSCOT 2012 position on TOR of traumatic cardiopulmonary arrest

- A principal focus of EMS treatment of trauma patients is efficient evacuation to definitive care, where major blood loss can be corrected. Resuscitative efforts should not prolong on-scene time.
- EMS systems should have protocols that allow EMS providers to terminate resuscitative efforts for certain adult patients in traumatic cardiopulmonary arrest.
- TOR may be considered when there are no signs of life and there is no ROSC despite appropriate field EMS treatment that includes minimally interrupted CPR.
- Protocols should require a specific interval of CPR that accompanies other resuscitative interventions. Past guidance has indicated that up to 15 minutes of CPR should be provided before resuscitative efforts are terminated, but the science in this regard remains unclear.
- TOR protocols should be accompanied by standard procedures to ensure appropriate management of the deceased patient in the field and adequate support services for the patient's family.
- Implementation of TOR protocols mandates active physician oversight.
- TOR protocols should include any locally specific clinical, environmental, or population-based situations for which the protocol is not applicable. TOR may be impractical after transport has been initiated.
- Further research is appropriate to determine the optimal duration of CPR before terminating resuscitative efforts.

Source: Millin 2011 [43]. Reproduced with permission of NAEMSP.

66 Family and bystanders, 462

- Family communication is essential in EMS while still respecting patient privacy concerns.
- Understanding family dynamics help help to partner with the patient to facilitate the best care possible
- Even with family present, a patient retains rights of autonomy and privacy. A family member, just because of his or her relationship with the patient, is not automatically entitled to medical information regarding an ill or injured spouse and may not understand the legal ramifications involved.
- Cultural competency is important as well in understanding and navigating family dynamics. The family may not want the patient's condition revealed to the patient him- or herself, such as in the case of late stage cancer, as seen in some Asian, Jewish, Italian, Navajo, Pakistani, and Hispanic communities [10] where cancer is seen as a curse and a social stigma
- Bystanders can be harmful or helpful depending on the situation.
- Lay bystanders can also be beneficial in providing CPR or recounting the history.
- The most challenging type of bystander to manage is often on scene physicians who are unfamiliar with EMS protocols and procedures. It is important to have a procedure in place to help manage physicians in the field.

Physician bystander, example protocol:

This EMS service would like to thank you for your effort and assistance.Please be advised that the EMS Professionals are operating under strict protocols and guidelines established by their medical director and the State of North Carolina. As a licensed physician,you may assume medical care of the patient. In order to do so,you will need to:

1. Receive approval to assume the patient's medical care from the EMS agencies online medical control physician.
2. Show proper identification including current North Carolina Medical Board Registration/ Licensure.
3. Accompany the patient to the hospital.
4. Carry out any interventions that do not conform to the EMS agencies protocols. EMS personnel cannot perform any interventions or administer medications that are not included in their protocols.
5. Sign all orders on the EMS Patient Care Report.
6. Assume all medico-legal responsibility for all patient care activities until the patient's care is transferred to another physician at the destination hospital.
7. Complete the "Assumption of Medical Care" section of this form below

Assumption of medical care

_____,MD; License #: _____.

(Please print your name Here)

67 Analgesia, 470

- Prehospital pain protocols should mandate pain assessment, tools for pain measurement, indications and contraindications for pain management, pharmacologic and non-pharmacologic measures, patient documentation and monitoring before and after analgesia, and transfer of information to destination facility.

- Options for analgesia: Opioids (fentanyl, morphine, agonist-antagonists), Nitrous Oxide, Ketamine, NSAIDs.

- Fentanyl is being used in more and more EMS systems because of its lack of histamine-releasing properties, short onset and offset, and lack of effect on cardiac contractility.

- Common pitfalls in prehospital pain management (and their solutions) include the following:
    - Waiting until arrival at hospital to give medication. It is OK to give, the medication will not mask the condition
    - There is no standardized dosage of meds. Use weight based protocols
    - Pain cannot reliably be gauged by facial expression/vital signs. Ask patient or use interpreter if needed.
    - Cumbersome protocols (such as requiring base hospital contact for all pain management) may delay or deter delivery of medications. Instead create protocols that permit initial, safe delivery of analgesia (to a maximum)
    - Using inappropriate techniques for painful procedures, such as “walking through” or describing each step, may magnify the pain experienced by the patient. Instead, distract patient if need to perform procedure.

68 Point-of-care testing in EMS, 477

Introduction of POC testing into EMS has 3 sub-issues:

- Is the test valid & reliable? Does the reliability translate to rugged prehospital conditions?
    - No point in doing test when pretest probability extremely low or high
    - Validity = how well POC performs compared to lab version
- Will it make a difference to patients?
    - Will it change clinical action? Does the system allow for it? (system responsiveness)
    - CQI must be in place; performance measures must be defined *a priori* and be measurable.
    - Effect on scene times?
- Is it within scope & education of EMS professionals?
    - Require extra upfront and ongoing training

<u>Regulations</u>

- Medical devices are in US are regulated by FDA. **Clinical Laboratory Improvement Amendments (CLIA)** sets standards for quality assurance & categorizes of POC tests based on how complex it is for the analyst to run it. CLIA categories include:
    - CLIA-waived – e.g. POC lactate using Lactate Pro device, home pregnancy tests, POC glucose, Urinalysis and fecal occult blood. Can be used without regulatory concerns.
    - CLIA – moderate complexity – majority (70%) of POC tests. Must be overseen by lab director (physician w/ lab training) or Technical & clinical consultant
- EMS personnel must have at least high school degree & documentation of satisfactory training
    - CLIA-high complexity – will not be used by EMS (regulatory barriers too high)
    - Not regulated by FDA-CLIA: non-invasive, breath tests, drugs of abuse, workplace monitoring (e.g. blood pressure) which can be used by laypersons

<u>Specific Examples</u>

- POC INR: expensive machine, $9/test, moderate CLIA complexity.
- Troponin: very expensive, moderate CLIA complexity, chest pain triage ("studies have shown increased detection and improved access to definitive care particularly for patients with non-diagnostic ECGs)
- Lactate: More affordable. Elevated lactate predictive of need for critical care
    - Trauma: detect occult hypoperfusion, trauma triage
    - Sepsis: sepsis screening protocols (coupled with prehospital notification, decreased mortality)
- CO: common in fireground environment. Two methods -end-exhalation breath meter and pulse co-oximeter. Can help in detection and transport decisions.
- Capnography: viewed by many as standard of care. Can help with titration of ventilation, ET tube placement, ROSC-detection, and more.
- Non-infrared cranial scanner: uses near infrared transcranial spectroscopy to detect ICH in adults & kids. Sensitivity 88.9% in EMS setting. May help with triage decisions.

69 Ultrasound applications in EMS, 483

Overview and Uses

- Not just for physicians, education is key.
- Improving triage decisions (especially during mass casualty, used in 1999 Turkish earthquake & 2010 Wenchuan earthquake)
- Avoiding unnecessary procedures
- Expediting treatment to correct facility

Specific Examples

- **Trauma**: FAST exam to detect to cardiac tamponade & intraperitoneal bleeding. Walcher et. al. demonstrated prehospital fast (PFAST) changed management in 30% of pts, was 93% sensitive and 99% specific for intraperitoneal fluid. Enabled permissive hypotension, decrease in unnecessary interventions, changed destination hospital in 22% of pts.

- **Pulmonary**:
    - Evaluation for pneumothorax (absence of lung slide) to either rule in or rule out need for needle thoracostomy
    - Detect pulmonary edema to help distinguish between COPD vs. CHF (B-lines)
    - Endotracheal tube placement (visualize b/l pleural sliding
- **Cardiac**:
    - Eval for pericardial effusion/tamponade.
    - Eval for cardiac activity in cardiac arrest (no activity poor prognosis, although have been survivors (1/32) so don't base on single scan with no activity)
- **Abdominal:**eval for AAA as etiology of shock
- **Obstetrics:** Eval for fetal HR when ambient noise high
- **MSK:** fracture detection

Protocol examples

- PAUSE: Prehospital Assessment with Ultrasound for Emergencies (heart/thorax)
- CAVEAT (*designed for military*): chest for pneumothorax, hemothorax, and pericardial tamponade, abdomen for FAST, IVC for volume assessment, Targeted extremity for fracture.

Section XI: Safety and Quality

70 Culture of patient safety, 491

- 1999 IOM report: “To Err is Human: Building a Safer Health System” brought to light medical errors
- Health care should be safe, effective, patient-centered, timely, efficient, equitable
- **Adverse event:** Occurrence that results in unintended and detrimental morbidity or mortality
- Adverse events are thought to stem from systemic weaknesses, individual behaviors, or a combination
- Minimal EMS data on adverse events, errors can occur in any step of EMS care
- Error: failure of a planned action to be completed as intended or use of a wrong plan to achieve an aim
- Errors are inevitable and culture must be changed to eliminate current disincentive to reporting errors, near misses, and adverse events
- EMS providers must have three areas of expertise: procedural, cognitive, affective, but the high emotional stress of EMS makes it happen in a compressed time frame
- To understand the nature of error in EMS, must have event reporting systems-example is FAA near miss error reports
- Important to have immunity from punitive action toward the reporter, in medicine and EMS this will be a major culture change
- Goal of a root cause analysis (RCA) is to find out what happened, why it happened, and what can be done to prevent in the future. Performed for adverse events, near misses, sentinel events
- Systems approach in patient safety: design devices/systems that minimize error
    - If someone administers narcan instead of epinephrine, the response is not to educate or fire the EMS provider, it is to change the markings so the ampules look less similar
- What are the high-risk areas in EMS?
    - 911 calls and EMS dispatch (interval data, pre-arrival instructions)
    - medication errors (miscalculation of drug dosage or wrong drug)
    - EMS access (delayed 911 access with not closest wireless PSAP access)
    - ambulance crashes (hazardous, although downward trend)
    - operator fatigue (affects traffic incidents and clinical care)
    - airway management (incidence of out-of-hospital unrecognized misplaced ET tubes is high)
    - hyperventilation during CPR (more likely with BVM)
    - hypoglycemia (repeat hypoglycemia episodes less likely within 48 hours)

- refusal of transport and non transport (should be conservative although no higher risk of death)
- diagnosis of AMI (appropriate interpretation and transport to PCI center)
- hospital diversion (potential to result in harm if transport delayed)
- data and EMS errors (national data set for errors)

71 A historical view of quality concepts and methods, 500

- The Evolution of Quality Concepts and Methods: In the early 1900s, there was a shift in industry and medicine towards concept of quality.

- 1910: **Flexner report**: a study of medical education in the United States and Canada.
    - Accused the industry of medical education with educational malpractice through "enormous overproduction of ill trained medical practitioners".
    - Stated that schools should have minimum admission & graduation standards, as well as adhere to principles of mainstream scientific knowledge. Resulted in the closing of over half of medical schools.

- 1910: **Codman, "End Result System of Hospital Standardization"** tracked every patient outcome by the attending physician and investigated the cause of poor outcomes. Lead to development of **minimal standard for hospitals** and investigation of hospitals by American College of Surgeons.

- 1920's: **Hawthorne Studies**: Carried out at Western Electric; Study of worker productivity that analyzed *processes* leading to the development of a finished product. Allowed for correction or conditions *before* defective product made. Statistically-centered focus on quality.

- **Pareto Principle**: 20% of the people in a jurisdiction hold 80% of the weath. Juran modified in 1940 to argue that supervisors control 80% of issues, while workforce controlled 20%.

- **MIL STD ("military standards")** Procedures developed in the 1940's that dictated sampling, machine calibration, schematic and quality control practices.

- 1950's: Development of th**e ISO (International Organization for Standardization)** published the first technical standards for manufacturing practices.

- 1970's: Donabedian introduces paradigm of **structure, process, outcomes** in assessing quality.

- **TQM (Total Quality Management)**: basic principle include management commitment, employee empowerment (teams, training), fact-based decision making (statistical process control), continuous improvement, and customer focus.

- 1980's: JCAHO (Joint Commission on Accreditation of Healthcare Organizations): accreditation required to be eligible for medicare/medicaid (1960's), a quality assurance plan becomes part of JCAHO inspection in 1980's.

- Foundation of quality control efforts re-invigorated in 1980's by 2 initiatives:
    - **ISO 9000**: see ISO above. Mostly international, poorly accepted in the United States

- **Malcolm Baldrige National Quality Award Program**:Developed in US; Malcolm Bridge National Quality Improvement Act of 1987 called for an award to be established by the U.S. Congress in 1987 to raise awareness of quality management and recognize U.S. companies that have implemented successful quality management systems. Included healthcare as one of these eligible categories. Criteria for quality management in healthcare included leadership, strategic planning, measurement, analysis and knowledge management, staff focus, process management and organizational performance results.
    - Motorola won Baldrige award with process call **Six Sigma**; "sigma quality level" are "ranges that account for some common variation occurring in a process, but allow for measurement and a greater level of specificity"; i.e. finding rare defects in high stakes manufacturing is important.
    - Six sigma projects prescribe sequence: **Define, Measure, Analyze, Improve, Control**.

- **Quality in Medicine**:
    - IOM is medical arm of National Academy of Sciences In 1999, published *To Err is Human - Building a Safer Health System* which documented magnitude and effect of medical errors in healthcare. Called for establishment of Center for Patient Safety.
    - *Crossing the Quality Chasm:Creating a New Health System in 21st Century*. Published in 2001, focused on need for redesign and use of systems approach to healthcare. Called for health care to be safe, effective, timely, efficient and equitable.
    - Value-based Purchasing: Deficit Reduction Act of 2005 called for CMS to develop a plan for VBP, i.e. pay for performance.
        - Medicare Improvements for Patients & Providers Act of 2008 awarded contract to National Quality Forum to establish core measures.
        - Affordable Care Act (ACA): Created accountable care organizations (not in text)

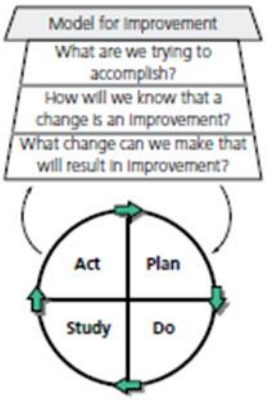
72 Defining, measuring, and improving quality, 509

Traditional descriptions of EMS quality (ie too specific, need continuous adaptive):

- patient-centric: administration of aspirin to chest pain patients
- paramedic-centric: number of successful versus failed intubations monthly
- community-centric: recognition of coronary ischemic discomfort for STEMI patients
- organization-centric: percentage of patients cared for by an organization who received oxygen.

Knowledge of variation: important to know what is “normal variation” within a system vs unexpected/unpredictable. Need to focus efforts on reducing special cause variation

- “common cause” variation -affects all people
- “special cause” variation –not common to all, and likely reflective of a system that is “out of control.”
- “human” factors contributing to the special cause variation? And how will they respond to the proposed changes? Will there be resistance?



Igure 72.1 Model for Improvement. Source: Langley G, Moen R, Nolan K t al. *The Improvement Guide: A Practical Approach to Enhancing Organization Performance*, 2nd edn. San Francisco: Jossey-Bass, 2009, p.24. Reproduced with permission of John Wiley & Sons, Inc.

The Model for Improvement (Deming)

- Aim: What are we trying to accomplish? “What?,” “By when?,” and “For whom?”
  - should be patient-centered
  - should be focused on a practice with wide special cause variation, ie some providers/communities perform well while others do not
  - should be evidence based and backed by solid, foundational literature and best practices
- Measure: How will we know that a change is an improvement?
  - should be patient-centered whenever possible.
  - should be specific and numerical
- Change: What changes can be made that will result in an improvement?
  - built upon an understanding of the system and knowledge of variation, influenced by knowledge, and informed by sensitivity to the human factors involved

- amenable to evaluation, meaning that the change itself can be measured in addition to the outcome.

Fishbone diagram (Smith)

Aka cause and effect diagram --start with problem as head and work backwards

Example branches: Methods, Equipment, People (Provider; patient), Materials, Measurement, Environment

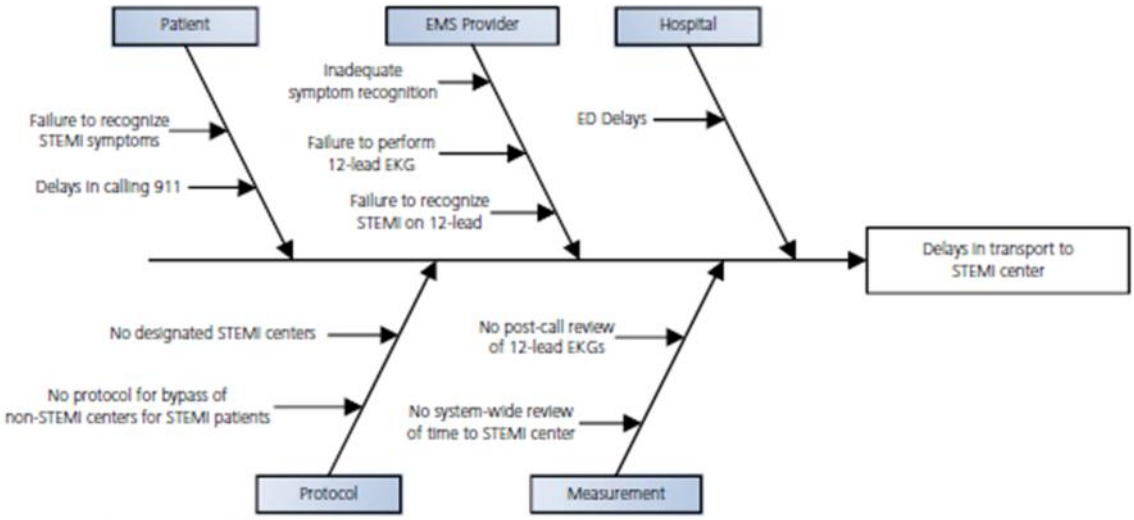


Figure 72.2 Fishbone diagram: delays to STEMI center.

Run chart (Smith):

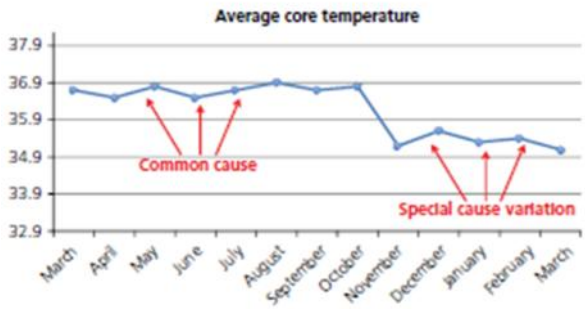


Figure 72.4 Dr Smith's run chart showing common cause variation and special cause variation.

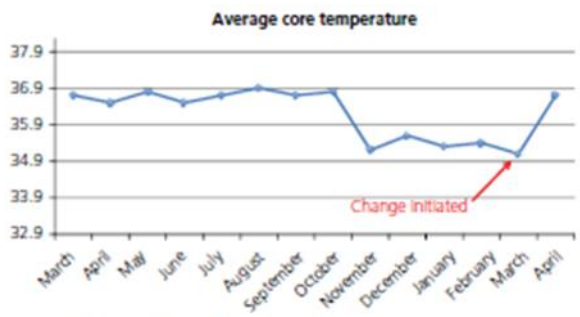


Figure 72.7 Dr Smith's run chart after implementing changes.

Driver diagram

Used to organize solutions to problems identified by fishbone. "what changes can be made that result in improvement?"

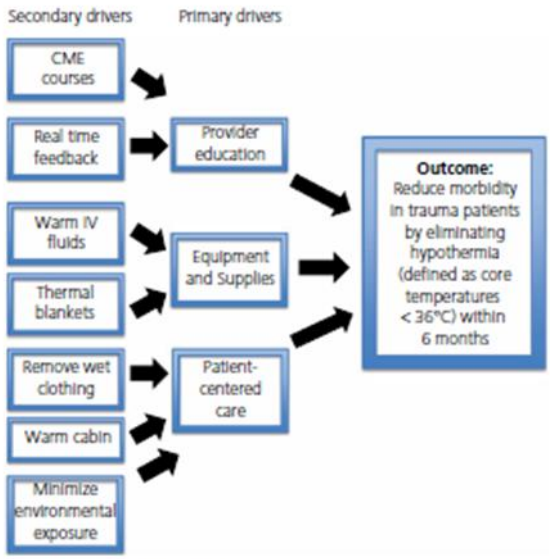


Figure 72.6 Dr Smith's driver diagram.

PDSA (Shewhart)

- Plan: identify the objective (aim and measure) and predict the outcomes or improvements of the change. Begin with small tests of change.
- Do: execute the planned change.
- Study: gather information to determine the effect of the test. visually assess the data using tools like run and control charts
- Act: quality improvement requires action. Decide whether to make adjustments and send the process through another PDSA cycle, or to adapt/abandon the changes made

73 Data management and information systems, 517

- At the enactment of EMS in 1973, there was no information systems component

- In 1994, NHTSA proposed 81 data elements important to an EMS information system (Uniform Prehospital Dataset)
    - This allowed EMS systems to benchmark themselves and contribute to larger data sets
    - Created a standard definition for each element

- In 1996, NHTSA published 'EMS Agenda for the Future' and as part of an integrated health care system recommended improved information systems including:
    - Uniform set of data elements and definitions
    - Developing mechanisms to generate and transmit data
    - Developing information systems to describe entire EMS event to track outcomes and cost effectiveness
    - Collaborate with other healthcare providers and community resources for integrated systems
    - Systems must provide feedback to those who generate data with research results, QI programs, and evaluations

- In 1991 AHA published Utstein criteria, standard OHCA dataset
    - First major document to specifically address EMS system performance and outcomes
    - Combined data from 911 dispatch, EMS system, hospital

- Formulation of NEMSIS (National EMS Information System) in 2001
    - National EMS database to document EMS service, personnel performance, and care for every EMS event in the nation
    - Establish electronic documentation
    - Establish a state EMS database and support state regulatory and disaster functions
    - Establish national database where state's data can be aggregated to support federal EMS needs

- 2012 with Version 3.0 of Uniform Prehospital Dataset

- IOM Report "Emergency Medical Services at the Crossroads" in 2006 addressed the need for standardized EMS data and information systems including:
    - Evidence-based categorization systems for EMS, EDs, trauma centers based on adult and pediatric service abilities
    - Evidence-based model prehospital care protocols
    - Evidence-based indicators for emergency and trauma system performance
    - Development and integrated hospital, public health, EMS, EMA, public safety data systems
    - Federal agencies funding emergency and trauma care research should target an increased share to EMS research with emphasis on systems and outcomes

- State/national trauma registries capture some EMS data, but more linking to be done
- National Trauma Data Bank (NTDB) has standardized dataset as well
- Cardiac Arrest Registry to Enhance Survival (CARES) focus on improving out-of-hospital cardiac arrest
- NHTSA has Crash Outcomes Data Evaluation System (CODES) which matches data from police, EMS, ED to provide medical and financial outcomes of MVCs->use this information to make highway safety decisions
- National Hospital Available Beds for Emergencies and Disasters System (HAvBED) national bed tracking to monitor surge capacity in MCI
- Emergency System for Advance Registration of Volunteer Health Professionals
- Health Alert Network (HAN) funded by CDC provides information and emergent health information, messaging system
- Important to identify data points that will allow linkage between two datasets
- Improved information systems allows for complete billing and reimbursement
- EMS Systems vary, but ideal size for efficiency is a population base of just more than 1 million people
- Data should have clear definitions and provide real-time feedback to system and EMTs • AEDs capture complex and sophisticated information on waveform and energy
- Three common types of software: front end (database), back end (report generators), web browser IS (enter, analyze, generate reports)
- Data entry->data use->performance improvements

74 EMS quality improvement and the law, 526

- Two main legal issues presented by performing QI activities:
    - Confidentiality
    - Liability

- Approach to Confidentiality
    - Reasons for confidentiality:
        - protect integrity of QI process
        - encourage candid
        - engagement and review
        - separate systems issues from individual
    - Public “opposition” to confidentiality --desire for transparent process and appropriate access to info about quality of care
    - Understand existing confidentiality statutes in your practices area
        - who conducts protected QI (single person, single agency, multiple agency)
        - (b) what is the extent of confidentiality protections (absolute v privilege that can be waived)

- Unless QI materials are made confidential by state statute, they are likely to be:
        - subject to subpoena and other forms of pretrial discovery,
        - admissible as evidence at trial (assuming the materials are relevant and otherwise satisfy generally applicable requirements for the admission of evidence), and
        - subject to public disclosure under the state’s freedom of information statute if they come into the possession of a state governmental agency.

- Confidentiality protection for EMS QI materials may also be available under federal law via PSO (Patient Safety Organizations)

- Public Safety Organizations
    - Created under 2005 Patient Safety and Quality Improvement Act (PSQIA) (amended the federal Public Health Service Act)
    - Comprehensive confidentiality for “patient safety work product,” which is defined broadly to include virtually all information
    - PSO must satisfy number of requirements to be certified by the federal government
        - collecting and analyzing patient safety work product from multiple providers in a standardized manner for comparison purposes
        - utilizing these data to provide direct feedback to providers and assist providers to minimize patient risk
    - EMS not specifically in statutory list of example “providers” under the PSQIA, but is defined broadly enough to include EMS personnel and agencies

- Practical Steps to Enhance Confidentiality
    - What are the defined elements of QI?
    - By whom is QI data collected? (method of data collection and discovery; What are written policies of QI body?)
    - How are records maintained and distributed? (markings “confidential/peer review”; distribution in advance vs on site, collect all copies of QI materials at end of meetings)

- Types of Potential Liability
    - **Defamation:** (libel or slander) claim requires evidence that the defendant, knowing that the information was false or at least negligently failing to ascertain the facts, transmitted to a third party false information regarding the plaintiff which harmed the plaintiff’s reputation. **Distribution of truthful information is not defamation.**
    - **Antitrust claim/Tortious interference:** claim of wrongful interference with business relationships by a provider who experienced licensure discipline and/or adverse publicity as a result of QI
    - Claim on part of patient that **QI was performed negligently:** proper protocols were not in place or an incompetent provider was permitted to continue to practice

- Immunity Statutes:
    - Persons covered (members of QI committee, investigators on behalf of committee, etc.)
    - Prerequisites to immunity (no malice, good faith that action was warranted by facts known);
    - Types of claims protected against (monetary damages only, civil claims, all civil and criminal)

- Immunity statutes do not preclude a plaintiff from filing a lawsuit, and does not even necessarily ensure that a lawsuit will be dismissed at an early stage (may dispute facts)

- Common Law Protection aka “privilege”: provides protection for communications that are made in good faith and in the reasonable belief that the communication was necessary in order to fulfill a moral or legal duty, provided the disclosure is limited to appropriate individuals and proper subject matter.
    - Similarly, where a person acts to protect a public interest or for other laudable purposes, he or she may be protected by the courts from a claim of interference with business relationships, especially if the defendant’s actions were reasonable in light of the threatened harm.
    - Must be no monetary gain on part of any member of QI. Common law privileges depend on facts of each case

- Practical Steps to Reduce Risk Of Liability: Follow QI body’s bylaws and procedures,avoid conflicts of interests or perceptions of conflicts of interest, Preserve confidentiality of QI records.

VOLUME 2: Medical Oversight of EMS

Section I: System Infrastructure

1 Principles of EMS system design, 3

- System design concepts: geographical scope, standards setting and enforcement, division of functions, production strategies, market allocation, consequences on chronic failure to perform, business structure, management level required.

- Key areas of system design: clinical quality, service quality, economic efficiency, accountability, improvement and resilience.

- Impacts of inferior system design: unequal socio economic service base, unequal response time performance, no incentive for growth, inability to match the right patient with the right resources, leaving the choice to the consumer.

- Services an EMS system should deliver:
    - Prevention and public education
    - Triage (dispatch prioritization)
    - Pre-arrival instructions
    - Medical first response
    - Ambulance response
    - Assessment and treatment
    - Medical transportation incl scheduled non-emergent stuff
    - Event coverage
    - Disaster services
    - Critical care transport
    - Air medical transport
    - Hazmat response medical support
    - Tactical response medical support
    - Community paramedicine

- **Type I ambulance**: Box on *truck* chassis. Front and back compartments are separated. Longer service life; larger size makes navigation difficult; heavier so less fuel efficient. Can refurbish and remount box

- **Type II:** van e.g. AMR truck. Smaller and better fuel economy.

- **Type III:** smaller box on *van* chassis. Have separate cab and patient compartment modules
- ALS response time within 8 minutes (arbitrary from AHA), starts from first call to dispatch for help to when ALS arrives on scene

- Tiered systems:
    - Benefits of all ALS: never have to worry about sending BLS unit to ALS call.
    - Downside: Calls are diluted so procedures also diluted. BLS/ALS tiered systems may actually be a good thing because fewer ALS folks doing more ALS procedures. May increase success rate (showed in Houston)

- Hospital destination policies:
    - See regionalization chapter. May be decent amount of questions on this. Medical director working with regional committee and hospitals to determine local policy (do not take STEMI to non-STEMI center)

- Important to understand response volume by time of day and day of week, geographical location of responses, use algorithm to locate resources.

- **Static deployment** -simplest and most common. Response units are positioned 24/7 in station locations chosen strategically based on historical patterns of call locations and call timing. This is most commonly used by fire and municipal EMS services. Comfortable staff and garaged vehicles

- **Dynamic deployment** -couples geographical and temporal data to determine how many units are needed to be available for that hour. Different tables may be generated for different months of the year. Special plans may be used during the timeframe when a special annual festival or sporting event takes place. Fewer hours of service from response units (called unit hours) are needed to provide the same level of response time performance compared to a static deployment strategy.
    - can save money by keeping crews busy during the entire shift, which increases their productivity for the costs of having them in service; however, keeping crews constantly busy without breaks and over longer periods of time creates a very poor work environment.
    - Technology is rapidly evolving to support increasing levels of sophistication in real-time deployment planning.

- **Hybrid deployment** uses combination e.g. some fixed stations along with some posts at key intersections. Crews can be rotated to station posts for a break to stretch, eat, use the restroom, etc. Systems that cover urban, suburban, and rural areas will often use static deployment in the rural areas and dynamic deployment in the urban/suburban areas.

- EMS System Design Factors: service area definition (high performance operation is service area population of 200K served by one ambulance provider), medical oversight, first response, ambulance service.

- High performance EMS system design: sole provider, control center operations, accountability, revenue maximization, flexible production strategy, status system management.

- System Assessment: Accreditation (CAAS, CAMTS, JCI). Using national EMS education and research agenda to guide policies and activities.

    - CAAS: gold standard. Not tied to billing. 911 services
    - CAMTS: same thing but only for interfacility
    - JCI: connected to but separate from joint commission --international

- Emergency medical services provider organizations should be held accountable for meeting fair and meaningful performance standards. When EMS providers are required by the system design to report their performance using valid and appropriate metrics, they will have a natural tendency to meet standards and improve over time.

2 Air medical services, 17

- Military evacuation of sick as early as 1915. Korea saw intro of helicopter-larger choppers in Vietnam and far forward (toward the combat area) trauma care in Afghanistan (Afghanistan with lowest mortality). Growth through 1970s-Civilian AMS in US.

- Growth:
    - 1992: 220 AMS in US
    - 2007: 312 AMS with >800 choppers and 282 fixed wing
    - 2012: 302 AMS with 946 choppers and 314 fixed wing

- 1972 first hospital based program Saint Anthony, Denver, CO

- 1996 White paper: “helicopter ambulances have not been adapted to civilian peacetime needs”

- Currently 2% all ambulance transports in US.

- Current philosophy: “care is critical”—qualities of aircraft used to match *highly-qualified personnel*. Actual out of hospital time is generally lower as well.

- Primary goal: give patients not in vicinity of advanced/critical emergency care a chance of survival.

- HEMS distribution of services: Interfacility 54%; Scene runs 33%, Other mission 13% e.g. transplant.

- 20% of the population estimated to need HEMS to achieve timely access

- Factors that have affected growth:
    - closure of EDs
    - Reduction in Level I and II Trauma Centers
    - Reduction in Specialist Availability, esp rural, esp NSG
    - Continued concentration of specialists in urban areas
    - Closure of rural hospitals
    - Overcrowding and diversion
    - Expensive in comparison with ground ambulance

- States must assume regulatory oversight. AMS and CCT represent particular expertise in emergency care, must be overseen by physicians, use of consensus guidelines

- Communication/integration of AMS resource within EMS system: clear and consistent method to request a helicopter; close coordination with 9-1-1. EMS MDs must be able to review and re-direct AMS traffic to appropriate use within system.

- Outcomes: fairly convincing data that flying a patient to far-enough away trauma center is beneficial

- At this time the literature support for primary air transport of non-injured patients is limited to logistical considerations.
    - usually n is too small to show benefit.

NAEMSP: Guidelines for Air Medical Dispatch (2009)
David P. Thomson & Stephen H. Thomas

1. Does the patient require minimization of transport time?
2. Does the patient require specific or time sensitive evaluation or treatment not available at receiving facility?
3. Is the patient's location inaccessible by ground transport?
4. Is the weight of the patient + crew within the allowable range?
5. For interfacility transfer - is there a helipad available?
6. Does the patient need critical care life support during transport?
7. Would using ground transport leave the area without ALS coverage?

Overtriage for AMS is necessary to maximize utilization of this resource.

Logistical issues for AMS:

1. Access, time and distance traveled
2. System issues
    a. Need for critical care
    b. Sparse ALS coverage area
    c. Disaster or MCI event
3. Clinical situations:
    a. Trauma (has best literature support)
    b. Non-trauma (literature support limited to logistical issues)
    c. Misc.
        i. Transplant
        ii. Search and rescue

- Possible HEMS benefits to EMS system:
    - Extension of Advanced Level of Care through region,
    - Provision of ALS "Backup" for parts of an Ems system with limited coverage
    - Minimization of Transport times
    - Direct Transport to Specialized Centers,

    - Transport Flexibility in Overloaded Hospitals,
    - Ability to Perform Unusual and Ad Hoc Activities. Providers can provide crit care

- IOM rec that states assume regulatory oversight of all aspects of AMS.

- **FAA oversight—FAR 135**—commuter and on-demand aircraft. Govern things like pilot rest, training, rules to follow in different airspace, etc. Responsibility rests on certificate holder —operator/company of aircraft.

- Med directors need to understand that final say defaults to certificate holder (i.e. safety over medical mission).

- Federal Preemption—"under federal preemption, AMS providers have overturned state regulatory efforts requiring aircraft specific equipment, hospital destinations, certificate of need requirement and CAMTS accreditation as requirement for licensing."

- States licenses AMS as ambulances, but states have no jurisdiction. FAA regulates aviation aspects

- Rapid growth of AMS in 80s led to increase in accidents. CAAMS (now CAMTS) formed to devise voluntary standards. Now 14 participating orgs and 133 air and ground services.

- Costs from $3-9M fixed costs, plus staff and flight crew and maintenance crew for variable costs.
    - *84% of costs of AMS go to fixed/equipment (opposite of ground EMS breakdown)*.
    - Must transport patient in order to bill for services.
    - Vendor-hospital issues revolving around 135 certificate can hold hospitals

- Crew configurations: most common = 2 medical providers (flight -nurse, -paramedic, -physician).

- Patients with air emboli—should fly at lowest possible alt (800 feet above ground).

- Most flights are at 1000-2000 ft.
    - However if weather bad, might need to climb to up to 5000 ft. Strong winds—motion sickness, use of antiemetics to patients ?to crew?/supplemental Crew?
    - Flight physiology addressed in separate chapter. PV=nRT

- Aircraft issues:
    - Helicopters: shorter distances but more mobility.
    - Fixed wing: longer distances but must land at airstrip—limited use. if truly emergent they can fly in more inclement weather and from more rural locales.
    - Space: limited-most aircraft up to two patients and two caregivers. Weight of providers, patients and equipment taken into consideration (recent lawsuit re: pt weight).
    - Hearing: loud—need headsets. Communication in advance critical (history taking/allergies, etc.).
    - Lighting: in daytime-great with sun-sometimes too bright. At night difficult.

- Electronic equipment—untoward effects on navigation systems. Must be certified equipment for use in air. Must test in advance.

- Operational challenges: Visibility, freezing precipitation, ambient temperature, landing zones, HAzMAT.

- Special capabilities:
    - Difficult Access Areas, Aerial Rescue, Aerial Reconnaissance (incident scene), Search, Aerial lighting, MCI, Mass gatherings, Go Teams, Hi-Rise Aerial Teams.

3 Interfacility transportation, 29

- Issue of choosing “closest” or “most appropriate” receiving facility:
    - medical home
    - level of care
    - specialty care

- Hazards of Transfer:
    - most associated with lights and sirens for ground, assoc w weather and air traffic for air.

- Vehicle types: ambulances (air and ground) and personnel (BLS, ALS, Specialty Care Crew)
    - Private vehicle (more common with peds)
    - Cab (and nowadays ride share companies)
    - Wheelchair/stretcher van

- Helps to have multiple medical directors due to complexity of specialty care needs, direct medical oversight/control less common. Primary medical oversight is the responsibility of the sending facility.

- Legal issues: EMTALA, which provider is responsible for patient during transport (sending physician), ride-along risks, deaths en route.

- EMTALA: Sending physician must perform medical screening exam (to determine if the patient is stable or in active labor). If the patient is unstable or in active labor then the hospital is obligated to provide care (regardless of the patient’s ability to pay) until stability has been achieved or active labor has resolved.

- If the hospital is unable to provide the necessary care, then the sending personnel must find a facility that can provide that care and arrange transfer.

- Exceptions: (can legally transfer an unstable patient or a patient in active labor if:)
    - patient requests transfer, after being fully informed about the risks and benefits
    - sending hospital is unable to provide a service that the patient urgently needs; the hospital has found a hospital that can provide the needed care and explicitly agrees to accept the patient; and the patient consents to the transfer after being informed of the risks and benefits of the transfer.

- Accepting physician does not have to be MD, but may be e.g. charge nurse for burn unit ICU.

- Trauma - systems should have considerable overtriage, but in more rural locations, patient’s may go to lower level hospital
    - Spinal injury: transfer for cord injury rarely time-sensitive but may help other injuries if polytrauma
- Cardiac - goal to minimize door to balloon time, also for LVAD, ECMO, etc.
- Neurologic - stroke center vs. comprehensive stroke center
    - Stroke patient’s outside tPA window may still benefit from transfer to stroke center (although not as

time critical).

- Pediatric or neonatal patients - account for a disproportionate number of transfers
- Burns - immediate life threats include volume depletion, infection, airway and polytrauma; other complications develop slowly
    - Patients should have foley catheter for fluid monitoring en route.
    - Sterile dressings decrease pain and keep burns clean.
- Obstetrics - almost always for fetus (Active labor = Unstable)

4 Legislation, regulation, and ordinance, 36

- **Statutes,** also called **laws, codes, legislation**
    - federal or state laws that have been created by acts of publicly elected members of Congress, state legislature
        - e.g. Connecticut will always have a level AEMT and we cannot get rid of it.
        - e.g. every ambulance must have Epipen (did not include fire apparatus/police)
    - Solution: e.g. State agency X shall establish rules/regulation surrounding Y problem.

- **Rules,** also called **regulations**
    - created by a state agency under authority provided in a state statute. Similar enforceability as statutes. Often more technically detailed than statutes and frequently are longer.
    - Much easier to change e.g. DPH is authorized to change rules pertaining to its dept

- **Ordinances** are municipal or local laws
    - May be created by a city, county, town, village, or borough under an authority delegated in state statute.
        - e.g. important EMS matters such as cost (budget), level of service, response times, vehicle and equipment specifications, quality management provisions, and similar subjects of EMS operations.

- Scope Model - National EMS Scope of Practice Model
    - Purposely vague to avoid having to update frequently. The Scope Model represents a floor rather than a ceiling -While a state can elect to add more education and skills to a particular level, the Scope Model sets a common expectation that states can have when EMS personnel move between one state and another.
    - States that have incorporated the Scope Model by reference do not need to reopen their legislative or rulemaking processes to make updates.

- EMS providers are “dependent practitioners” working within a state-licensed and authorized EMS Agency.
    - They must be authorized by EMS physicians to apply their skills, limited to a scope of practice. NOT working under medical director’s license

- The Education Agenda calls the verification of entry level competence by NREMT a “**certification**.”

- The document issued by the state EMS authority enabling a person to function is called a “**license**.”

- The majority of States now require NREMT certification as prerequisite

5 State EMS offices, 44

- Hwy Safety Act 1966 and EMS Systems Act 1973 established resources and structure for building EMS system—organized by the states.

- In majority of states the lead agency for EMS is the Department of health, which is preferred over Department of Public Safety (eg law enforcement). There are 4 required positions:
    - State EMS Medical Director - may or may not be a physician but if not they need a defined link to a physician for medical oversight.
    - State EMS System Director - execution of statutory responsibilities
    - State EMS Advisory/Authority Body
    - State EMS Medical Committee

- In CT, commissioner of public health is a cabinet level dept head. They then report directly to governor

- 2005 Survey of State EMS Agencies asked about structure and function.
    - Majority are overseen in state DPH, next greatest percent is in public safety, next (7.5%) as separate state agency.
    - Depending on location, goals may be more or less health vs safety oriented as well as different credentialing regulations.

- Each state oversees its own EMS standards, certification, vision etc. States may be able to waive or exempt an EMS agency or provider from requirements within its rules or regulations (usually this is for letting provider practice when in the best interest of the public).
    - **Requirements of a specific state statute must be followed.**

- All states' EMS offices are members of NASEMSO (National Association of State EMS Officials).
    - NASEMSO Mission- to support members in developing EMS policy and oversight.
    - Strategy is involving all states and territories as well as serving as national advocate.
    - Ultimate goal is to have orderly and coordinated EMS across the country

- An EMS Council, Committee or Commission may be advisory (such as Georgia's) or granted approval authority (such as California's); they work with the state EMS Director.

- Regional EMS councils are also common and influence training, equipment purchasing and local system design (sometimes in conflict with state bodies).

- Local EMS issues such as awarding calls and response zones to various providers differ from state to state

- **Standard** is mandatory vs. a **guideline** is suggested best practice

- Medical oversight is generally provided by a licensed MD but with little subject matter expertise required.
    - Medical record keeping requirements are found in state law.
    - A brief discussion of “invalid cars” aka gurney cars is presented as not being regulated by EMS.

- Most EMS providers fall under the protection of Good Samaritan laws as long as they are not paid(!)

- Staff volumes vary based on state. Lowest= 4 staff, highest=90.

- EMS medical directors should know their state regulatory offices—develop transparent communication processes, as two way communication may prove very significant going forward.

- Some states have developed mandatory statewide protocols:
    - Pros: Uniform standard of care, ease of education, up to date, evidenced based, local MD can spend time/energy into education, QI, other activities
    - Cons: Local Medical director loses control, may not recognize local needs, restricts “cutting edge” care, may not be up to date.

- Resource Management:
    - Human Resources - State Statute/Lead Agency typically sets requirements for certification, licensure, and reciprocity
    - Transportation - EMS vehicles are commonly licensed by the EMS systems they operate in
    - Financial - funding varies among states and may include money from state tax monies, cash funds earmarked by state (ie. MVD registration fees), licensing fees, federal funds.

- Facility and specialty care regionalization - in certain states, legislative authority is available for state EMS offices to assess hospital capabilities.
    - States generally recognize specialty receiving center using accreditation status provided by an organization or private entity (ie. ACS verified trauma centers), but some develop internal standards.
        - For example, in CT, anyone can call yourself a stroke center vs trauma center needs to be accredited (aka verified)

- National EMS Information System (NEMSIS) data elements collected from EMS agencies and create national data set for research, etc.
    - Additional sources of data include, death certificates, other vital statistics, insurance carriers, trauma systems, hospital data, etc.

- State EMS services need to use all-hazards-approach to participate in prep for large scale events
    - All types of disasters (not separate plan for e.g. lightning strike, and hurricane, etc).
    - However, if your area is more likely to have certain kind of disaster e.g. snow storm in CT that disrupts supply chains etc that is okay and is called an Annex
    - Scheduled mass gatherings

    - High profile events

- Resource sharing during disaster or MCI
    - Emergency Management Assistance Compact
    - NIMS
    - Other contract agreements

- EMS may have nontraditional role during disasters (ie. public vaccinations)

6 EMS personnel, 51

- "Scope of practice" (State)
    - Vested by state. What is legally allowed by licensed individuals practicing there

- Certification (NREMT)
    - Knowledge and experience base. Cannot perform tasks unless licensed to do so
    - National Registry of EMTs serves as the *de facto* national EMS certification agency. National certification is a distinct process separate from licensure – it identifies those individuals who have demonstrated the national entry-level standard for cognitive and psychomotor competence.
    - In order to be credible, the certification examination must be "psychometrically sound and legally defensible."

- Licensure (State)
    - Illegal to engage in an activity without the license, to falsely present self to the public as a qualified individual (title protection).
    - State EMS offices (or regulatory boards) serve as the state licensing agencies. State licensure ensures that the applicant demonstrates any additional elements of competency as required by the state, meets educational and experiential requirements, and passes generally required background checks.

- Credentialing (local)
    - Analogous to MD being credentialed to work at hospital.
        - e.g. medical authorization by a medical director
    - Local credentialing is the ongoing process of ensuring that an individual demonstrates and maintains all aspects of professional competency.

- Though EMS leaders and medical directors can be reasonably assured that applicants who possess national and state credentials have demonstrated entry-level competence in the cognitive and psychomotor domains, and have met statutorily required entry requirements and background checks, it remains the responsibility of local EMS leadership to ensure that EMS personnel have and maintain competence in the non-technical aspects of EMS care (reason why some systems have "check rides" with oversight before medical authorization)

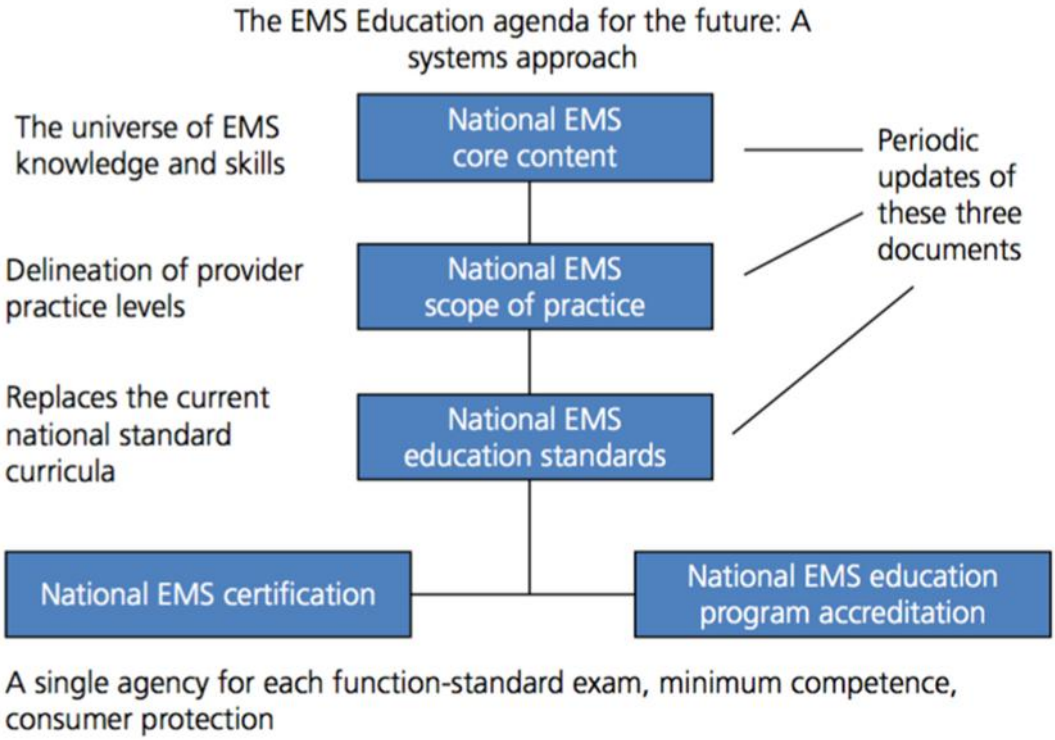
- The competency standard should not change by state, demographics, geography, rurality, agency type, or remuneration status of the individual being assessed. Same for volunteer or paid.

    - Administrative support: management staff involved in equipment, HR, policy development and quality assurance are all part of the career team.

    - Labor relations: Medical Director should stay out of labor issues.

- Unions can negotiate with management team. However, medical director =Patient Advocate, must keep interests of patients at forefront of concern. S/he can grant or remove clinical privileges for staff who are not fit to work with patients. Management deals with whether the person has a “non clinical” job. Stimulate career growth through programs like the Field Training Officer.

- Turnover: EMS has average or lower than average turnover for the healthcare industry.
    - It is wise to invest in individual development since the majority will stay in your system



*NREMT is contained with”National EMS certification” in figure above

What is wanted of Medical Director by prehospital personnel:

1.Support actions to the medical community
2. Provide more feedback (real time)
3. Be available to answer questions
4. Tell providers how important they are
5. Maintain perspective (ride alongs)
6. Clearly communicate expectations
7. Compare notes (seek feedback)
8. Provide clinical leadership (caring/compassion)
9. New technology (and appropriate training)
10. Teach
11. Keep an open mind when investigating complaints

12. Evaluate performance regularly
13. Create treatment protocols that focus on necessities
14. Create treatment protocols that are simple/easy to read/remember
15. Teach and guide rather than discipline

Medical director expectations of career personnel:

1. Patient comes first, always
2. Crews should do the right thing for the right reason
3. Be team-players, recognize that efficiency in getting back in service is a service to other providers on the team. Professionalism breeds professionalism.

7 Principles of finance, 60

- Initially federal funds provided resources to EMS after the EMS Act,
    - This is no longer the case and each agency has to find its own funding.

- State government provides regulation, training, licensure but also has budget constraints, although some do provide limited funding opportunities.

- Three truths:
    - price does not equal cost (transport cost $364, but Medicaid reimbursement only $75)
    - direct cost does not equal full cost
    - higher government support does not guarantee superior performance

- Most of the cost of EMS is the cost of labor. (Air is opposite --cost of aircraft is most)

- **Full Cost**=direct +indirect +shared
    - e.g.=direct (labor, medical supplies)+indirect (QI, admin)+shared (comm center)

- **Direct cost**: can be traced to actual delivery of particular service or product
    - e.g. fuel, medical supplies, labor

- **Indirect cost**: cannot be traced directly. e.g. admin labor, taxes, QI

- **Shared cost**:
    - Direct shared e.g. loaned vehicles
    - Indirect shared e.g. shared facilities, comm center

- **Marginal cost**: cost of one extra call
    - (“produce one additional unit of a particular service or product”).
    - Often nonlinear and depends on capacity
        - - things that go in your annual budget, not your daily variance report
        - e.g. ambulance with unused response capacity, being used to respond to one additional call is minimal. But if all units used, responding to additional call means calling in another crew and vehicle etc.

- **Fixed cost**: doesn’t change with increased production or call volume over e.g. budget year (time period)
    - e.g. medical director salary, rent (do not change with number of calls)
    - If increased unit production, fixed cost will contribute less to cost of transport (see below)

- **Step costs**: type of fixed cost. after max production capacity reached, additional demand requires purchase of additional capacity. Non-linear. Aka “step fixed costs” because it is the cost of adding additional unit *and*

the associated fixed costs

- e.g. ambulance purchase is called a step 'fixed' cost as an acknowledgement that, on a macro level, the number of vehicles does scale with call volume in a way that other fixed costs like buildings and admin don't. Think of calling in an extra doc in ED, helps temporarily but then creeps up again and you have to call another in, creates sawtooth pattern

- **Variable cost**: changes with each unit of production or activity e.g. fuel, maintenance, disposable medical supplies. Think preparedness cost. This cost is lower for EMS than that for other industries
  - Contributes more to total costs with increased utilization or production
  - All costs become variable if analyzed over long enough timeline

U: Utilization = number of transports

UH: Unit hour = fully equipped and staffed ambulance(s) on response or waiting for a response for one hour. e.g. 30 ambulances available for 24 hours is 720 unit hours

UHU: Unit hour utilization = #transports / (#ambulances X #hours)

$$\frac{\text{U(utilization)}}{\text{UH(unit hours)}} = \text{Unit hour utilization}$$

$$\frac{\text{Cost per unit hour}}{\text{U / UH}} = \text{Cost per transport}$$

- **Cost Per Capita**=total system cost/total population served
  - ->indicates cost to community, not Efficiency.

- **Depreciation cost**: accounting technique.
  - Tracks loss in value over timeline of useful life of asset. Aka amortized (amortized usu intangible vs depreciation tangible)

- EMS Revenue: tax subsidization, third-party reimbursement, patient payment

- **Economies of scale**: reduction in per unit cost 2/2 increasing size or scale of operation where the cost of producing the next unit of service is less than the average cost of previous units.
  - e.g. comms that can manage 10 units that consolidate a five-unit and neighboring four-unit system reduces per unit costs of dispatch.

- **Opportunity cost**: Reflects the foregone choice.
    - e.g. $15,000 per hour to train providers in CPR (option A) = same cost to provide 240 unit hours of ambulance coverage (option B) but at expense of the providers knowing latest CPR techniques (the value of A).

- **Sunk cost**: a cost already incurred that cannot be recovered.
    - e.g. “not throwing good money after bad.” to avoid future loss aversion

- Sources of reimbursement: Medicaid, Medicare, private, commercial ins, contracts

- Medicare fee schedule->national RVU x natl conversion factor(NCF)+local base rate (after implementation, more losers than winners with this reimbursement)

- Difficulties of uncompensated care: moral and legal responsibility to respond, but little ability to shift costs.
    - E.g. no reimbursement for intoxicated persons from on the city park (no fixed address, can’t bill)

- High-performance EMS systems: economic efficiency, response-time reliability, clinical performance, are directly interdependent

- Bundle billing: fire medic rides in with AMR BLS unit -AMR will share revenue to FD for ALS service. Needs pre-signed agreement. Legal “kick-back”

Section II: Clinical Leadership and Oversight

8 Medical oversight of EMS systems, 71

- 1966 white paper Accidental Death and Disability, the Neglected Disease of Modern Society [5]
    - Accidents are leading cause of death in ages 1-37.
    - 4th Leading cause of death at any age. The long term solution is accident *prevention*
    - Formed accident prevention council at national level

- DOT standardized training of EMTs (primarily) and paramedics and included requirements for physician oversight of the education of paramedics and the care they provide in the field.

- 1973 Emergency Medical Services Systems Act -no reference to the need for medical direction Department of Health, Education, and Welfare (DHEW) developed the 15 essential components of an EMS system, and omitted medical direction

- 1960s and 1970s, medical direction of EMS became a de facto standard anyway, especially for ALS providers. DHEW did eventually make medical direction for ALS a requirement for awarding grants.

- 1985 first NAEMSP Hilton Head

- 1988 the National Highway Traffic Safety Administration included medical direction as one of the ten essential components

- 1996 EMS Agenda for the Future- need for medical direction for all levels of EMS providers, a principle that was thereafter incorporated into the US Department of Transportation's national standard curricula for EMS providers, including those for EMTs.

- State requirements for EMS medical direction
    - Generally require medical direction for ALS, but not always BLS

Box 8.1 Generally accepted qualifications of an EMS medical director

- State licensure to practice medicine or osteopathy
- Board certification or preparedness in an appropriate specialty (emergency medicine desirable)
- Familiarity with state/local/regional EMS activities
- Training and/or experience in the clinical practice of EMS, EMS medical direction, and EMS research (EMS fellowship and EMS subspecialty certification desirable)
- Knowledge of all components of the EMS system and any relevant laws, regulations, policies, and plans including:
  - Emergency medical dispatch
  - Operations
  - Education and continuing medical education (CME)
  - Quality assurance and performance improvement
  - Mass casualty incident/disaster response
  - Labor relations, management, and fiscal oversight
  - Public health, wellness, and prevention
  - Occupational injury and illness
- Involvement in local/regional/state/national EMS organizations

Source: Adapted from Alonso-Serra 1998 [1].

Box 8.2 Authority and resources required by an EMS medical director

Authority to:

Grant, suspend, or revoke the medical credentials of EMS providers (with due process)
Approve medical equipment and protocols (including emergency medical dispatch)
Conduct quality assurance and performance improvement (including emergency medical dispatch)
Establish continuing medical education requirements to address local and quality improvement issues
Supervise all patient care
Provide input on operational and budget issues that affect patient care
Advocate for EMS providers, patients, and the EMS system
Designate base stations, trauma and specialty centers
Serve as the medical liaison with the community, state, and national organizations

Resources

Response vehicle
Communications equipment
Medical supplies and equipment
Personal protective equipment
Office space
Support staff
Compensation sufficient to fulfill the role
Liability coverage for administrative acts and malpractice

Appropriate title

Medical director and/or
A rank, such as assistant or deputy chief

- Competency =a provider's ability to safely and adequately perform patient care
  - -continuing ed particularly important for e.g. endotracheal intubation

- Credentialing: grants EMS provider privilege to perform a prescribed role and specific skills within a service based on competency.

- Local credentialing process must enable a medical director to immediately suspend or limit the privileges of an EMS provider and to develop a plan for remediation, if that is deemed appropriate.
  - Need due process available

- Quality assurance: ensures that performance is as it should be.

- Performance improvement: monitors processes and outcomes in an effort to augment and improve the overall quality of patient care

- QA plan should prescribe corrective action, elucidate root causes, and educate providers. Never punitive

- EMS patient care records "must" be linked with hospital outcomes. Very rare in real practice

- National EMS Information System (NEMSIS) defines EMS data elements and national database

- CARES data now mainstream. Some people draw the conclusion that "if we meet cardiac arrest benchmarks, we are probably doing other things well too."

- Potentially useful clinical benchmarks
    - aspirin for suspected cardiac chest pain
    - minimization of on-scene intervals for penetrating trauma
    - use of noninvasive ventilation for respiratory failure

- Field clinical supervision
    - Opportunity to mentor, engage in hands-on patient care, and learn firsthand about the challenges faced by providers

- NAEMSP addresses potentially controversial issues through its Standards and Clinical Practice Committee.

- Base station: hospital emergency department or health care facility that is designated to provide EMS personnel with direct medical oversight
    - receiving facility
    - sponsor hospital

- Regionalization: transport of patients to the hospital that is most appropriate for a patient's condition. "right patient, to the right hospital, in the right time, with the right care"
    - medical directors need protocols and must educate providers on criteria to e.g. go to trauma center

- Principal causes of work fatalities for EMS providers are transportation related
    - EMS medical directors should advocate for improvements in ambulance safety
        - on-scene safety
        - Wellness program
            - known to reduce injuries, absenteeism, deaths through the promotion of healthy lifestyles. Exercise/diet and tobacco cessation

- State Regulatory level:
    - may limit/require re protocol development, EMS provider certification and licensure, quality assurance, reporting of suspected abuse, EMS worker safety, the registration and management of controlled substances
    - may also impose educational requirements e.g. CME for directors (rare)

- Federal level:
    - EMS services must be registered with both the state and the DEA
    - Medicare reimbursement by the Centers for Medicare and Medicaid Services (CMS)

    - reimbursement for ambulance services by Medicare is limited to when ambulance transportation is provided and is medically necessary (transport by other means contraindicated)

- EMS data can identify trends in death, illness, and injury in the community

- Teaching e.g. CPR and injury prevention in community is helpful

- Direct medical oversight=Either physically or remotely present with prehospital providers rendering patient care during active communication.

- On scene medical direction benefits
    - Procedures (increased scope)
    - Differential dx (broader)
    - hospital destination (more accurate triage)
    - on-scene care to entrapped
    - mass gathering events (avoidance of need to transport all patients)

- 1970s VHF channels -limited range of transmissions and frequent interference. *(think VHS=old, U=new)*

- Eight UHF channels reduced interference, improved reliability, and enabled an increase in the use of analog ECG telemetry - increased by FCC via narrow banding.

- Benefits of online medical direction have not been clearly demonstrated outside of patient care refusals, with some potential in reducing emergency department overcrowding through transport destination decisions

Box 8.4 State and federal laws that may affect an EMS medical director

- State EMS laws enforced by the state EMS office
- State and federal laws on controlled substances enforced by the US Drug Enforcement Administration and states
- Laws on Medicare reimbursement as well as fraud and abuse enforced by CMS and the Department of Justice
- Clinical Laboratory Improvement Amendment (CLIA) – requires either a certificate or waiver to use glucometers and perform other diagnostic tests – enforced by CMS and states
- Civil rights laws and laws related to the Health Insurance Portability and Accountability Act and the Health Information Technology for Economic and Clinical Health Act – addressing health information – enforced by the US Department of Health and Human Services
- Food, Drug, and Cosmetic Act – regulating medications and medical devices – enforced by the US Food and Drug Administration
- Occupational and Safety Act enforced by the Occupational Safety and Health Administration and states
- Various civil rights and antidiscrimination laws enforced by the US Equal Employment Opportunity Commission
- Airline Deregulation Act – preempts states (and locals) from regulating the rates, routes, or services of air medical services – enforced by the US Department of Transportation

9 Leadership and team building, 85

- Need the 5 emotional competences:
    - Self-awareness
    - Self-regulation
    - Motivation
    - social awareness
    - social skills

- Replace the word "but" with the word "and". Provide feedback in private. Praise in public.

- Avoid writing a rule in reaction to a current situation.

- *How* you tell them is often remembered more than *what* you tell them.

- Thom Dick in 1990: The **STARCARE guidelines**:
    - **S**afe
    - **T**eam-Based
    - **A**ttentive to human needs
    - **R**espectful
    - **C**ustomer accountable
    - ***A**ppropriate*
    - **R**easonable
    - **E**thical

- Use Shewhart for dynamic processes. Best to avoid static displays such as bar charts, pie charts which could lead viewers to attribute something unusual to performance data that do not have anything special going on, and action based on these runs risk of decreasing performance, or doing what Deming called “tampering.”

- Appropriate: Was my care appropriate – medically, professionally, legally, and practically considering the circumstances I faced? Alignment with medical protocols is the easiest way to display this value.

- 7 Things That Matter (TtM) – Racht, Bourn, White from AMR on key performance indicators (KPIs):
    - Assuring safe patient care and transport
    - Cardiac arrest resuscitation
    - Reduction in pain and discomfort
    - Safe and effective maintenance of airway and ventilation
    - Relief of respiratory distress
    - Recognition of care of ischemic syndromes
    - Effective and timely trauma care

- **Outcome Measures** – those that come after process is complete (lagging)

- **Process measures** – those that drive performance to produce desired outcome (leading)

- Given the choice, we care more about lagging measures because those are outcomes e.g. CARES data.

- **Common cause variation** – variation inherent in the process

- **Special cause variation** – variation caused by something outside the normal process.

- 3 Signs of Special Cause Variation: (Balestracci)
    - **Trend** – six or more consecutive data points ascending or descending
    - **Run** – 8 or more consecutive points above or below the median
    - Point outside the upper or lower control limits on a Shewhart control chart (X axis: year. Month | Y axis: Dollars)

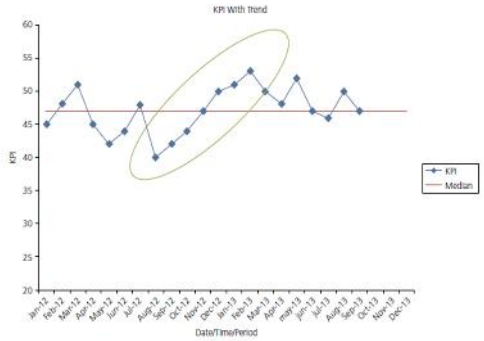


Figure 9.3 Special cause variation: a "trend."

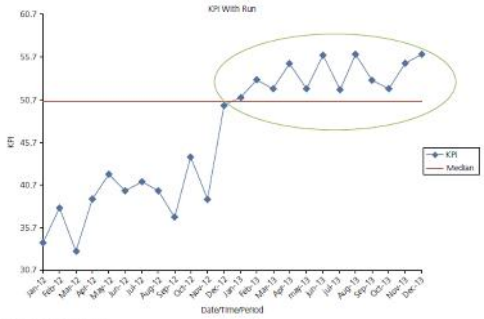


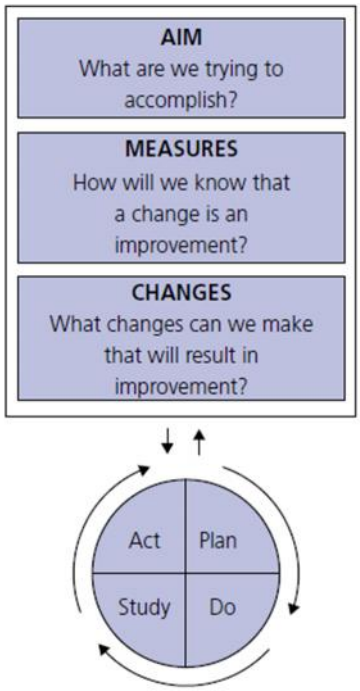
Figure 9.4 Special cause variation: a "run."

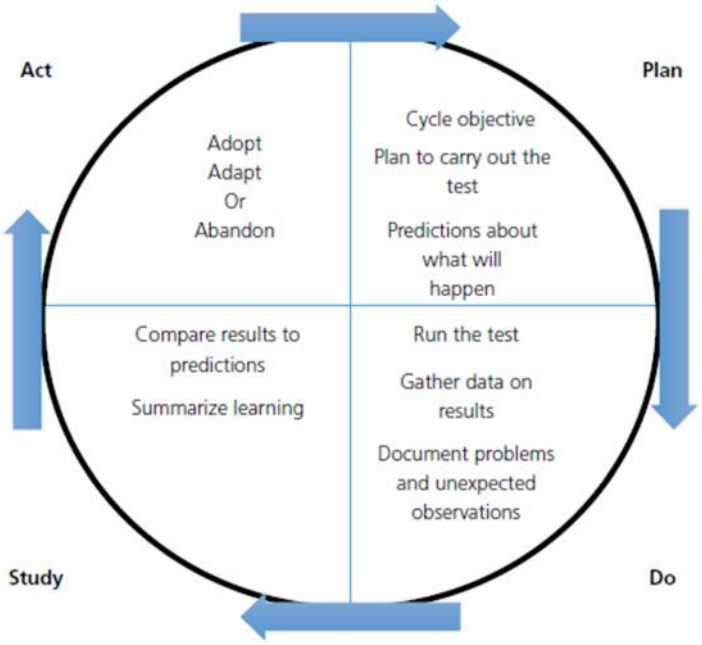
Model for Improvement: 3 Steps:

1. AIM – What are we trying to accomplish?
2. Measures – How will we know that the change is an improvement?

    -If it is not possible to produce data to support the AIM, it may be impossible to move forward with an improvement project. If you are unable to measure the thing that you are trying to improve, it is impossible to know if performance has improved.
3. Changes – What changes can we make that will result in improvement?

    -list at least 3





- Continue doing the PDSA cycle until your 'degree of belief' indicates that it is time to implement one or more change system-wide

- Training should then be done in many formats (classes, emails, audio, computer-based, etc.) and effectiveness of training assessed using the four-level effectiveness assessment (Kirkpatrick 1959)
    - Level I – Post-training satisfaction assessment
    - Level 2 – Knowledge retention assessment
    - Level 3 – Behavior change assessment
    - Level 4 – Clinical outcomes assessment

10 EMS dispatch, 94

- EMS Dispatch = First link in chain of survival for true life threatening emergencies

- Important items:
  - Systematized, scripted formal caller interrogation;
  - Systematized, scripted post-dispatch and pre-arrival instructions;
  - Clinical/situational problem descriptors and codes,

Box 10.2 The nine myths of medical dispatch

1. The caller is too upset to respond accurately
2. The caller does not know the required information
3. The medical expertise of the dispatcher is not important
4. The dispatcher is too busy to waste time asking questions, giving instructions, or flipping through card files or using automated protocols
5. Phone information from dispatchers cannot help victims and may even be dangerous
6. More personnel and more units at the scene are always better
7. It is dangerous not to maximally respond or to fail to respond with lights and siren
8. All you need to do EMD is protocols and training
9. We can do this ourselves (home-grow our protocols)

- Caller Breakdown:
  - 60% of callers are 1st/2nd party (patient or someone with the patient)
  - 25% 3rd party (someone outside who witnesses)

- Medical directors must ensure dispatchers understand policy, ensure compliance, ensure correct and effective application, Correct and improve any deficiencies identified

Quality Management Components:

- Selection-ability to read transcripts, follow instructions, carry out multiple tasks, exercise good judgment
- Orientation, initial training, and certification
- Continuing Dispatch Education-half-life of med knowledge is 5 years. EMD need relevant updates
- Medical Oversight-physician involvement and guidance essential in education, QM, policy
- Data Generation - random sampling of approx. 3% calls to drive review process
- Performance evaluation or case review and feedback—Essential component of continuous improvement.
- Recertification—necessary to maintain skills and “skin in the game”
- Risk management—legal equivalent to preventive medicine. All elements of EMD QM pertain to this.
- Decertification, suspension, termination-formal policies of expectations and requirements and then formal documentation of deficiencies and corrective actions needed

Supervision at Dispatch- On-site supervision to ID problems prospectively. All managers must be EMD trained as well, QM case review in part driven by on-site trend. Fundamental issue is protocol compliance.

- Case entry (primary survey)

- Key question (secondary survey)
- Selection of correct dispatch code
- Correct delivery of PDIs and PAIs

Compliance to Protocol

- Only 5-10% of centers provide completely correct PAIs from script in DLS. Medical director plays important role in maintaining compliance to formal PAIs
- #1 reason cardiac arrest missed by dispatcher is “making funny noises” aka agonal breathing

Pre-Arrival Instructions

- Important to follow scripted PAIs and minimize ad lib. Designed to be clear and direct. Helpful for EMD to maintain control and a public expectation

Dispatch Life Support

- Important knowledge, procedures and skills used by EMD in providing care through PAI (pre-arrival instructions) —BLS and ALS principles appropriate to each situation

Psychological components: Drives home point of stress experience by caller and how EMD can predict these responses and mitigate. Phenomena include:

- Hysteria threshold of caller;
- *“the repetitive persistence methodology”- maintains control;*
- Bring the patient to the phone problem;
- Re-freak event;
- Nothings working phenomenon;
- Paramedics aren’t coming;
- Relief reaction;
- Gap theory - pauses may be perceived as lack of confidence/control by caller. Compliance with medically approved protocols decrease length and frequency of gaps.

The areas falling under the medical director’s purview are as follows.

- Continuing dispatch education
- Medical oversight
- Performance evaluation and case review
- Decertification, suspension, and/or termination

Dispatcher Configurations:

- Horizontal: team-based call-taker goes through protocol, radio dispatcher takes info/decides priority
- Vertical: each EMD responsible for catchment area (less effective)

Medical Dispatch Priorities: “Medical Urgency Science”

- Each question asked to satisfy one of 4 Objectives

    - Gleaning info necessary for appropriate response assignment
    - Identify conditions requiring PAI
    - Obtain info required by response personnel to preplan and address scene and patient
    - Scene safety by minimizing hazards and risks to patients and personnel

Symptom vs. Diagnosis Based Priority Dispatch

- Diagnosis lists such as heart attack, anaphylaxis, heat stroke, etc., are not dispatch priorities and dispatcher/caller has to select diagnosis
- Priority dispatch uses chief complaint indices that are symptom based

Priority Dispatch Responses = Judicious and balanced use of limited resources. Requires non-arbitrary adherence to protocols. Priority dispatch, has created several issues:

- Response configuration
- Response mode
- Referral to alternative care
- Economics of response
- Politics of response
- Personnel satisfaction/burnout
- Responder and public safety (L&S)
- Prioritization risk management and legal concerns

Maximal Response Dilemma—you can't send maximal response to everything. Leaves resources unavailable for future calls.

Emergency Medical Vehicle Collisions – can't send HOT responses to everything, as it endangers public safety. Therefore, again use prioritization to make safe response time

Tiered Response and Justification

- Goal to get the right thing/people/skills to the right patient at the right time
- Not really linear but prioritization of time and skills needed

Baseline response example All actual response assignments are decided by local medical control and EMS administration		
Level	**Response**	**Mode**
ECHO	Closest apparatus—Any (includes truck companies, HAZMAT, or on-air staff)	HOT
DELTA	Closest BLS engine paramedic ambulance	HOT HOT
CHARLIE	Paramedic ambulance	COLD
BRAVO	Closest BLS engine BLS ambulance (alone HOT if closest)	HOT COLD
ALPHA	BLS ambulance	COLD
OMEGA	Referral or alternate care	

Figure 10.8 An example of baseline response choices to the determinant levels. Source: *Principles of EMD*, 5th edn, ©2000-2014 International Academy of Emergency Medical Dispatch. Reproduced with permission.

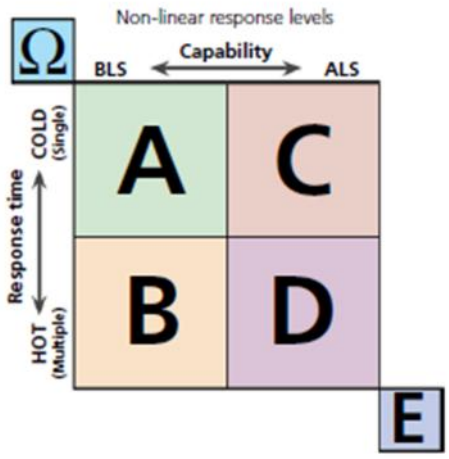


Figure 10.9 Determinant response matrix. Source: Medical Priority Dispatch System v13.0, ©1979-2014 International Academies of Emergency Dispatch. Reproduced with permission.

Understanding Determinant Terminology: provides ranking within chief complaint to direct level of response required as well as speed and priority

Avoiding Response Code confusion – don't use duplicate names of things between MPDS and local protocols

Prioritization versus Screening - Screening allows for a "no send" option. Dispatch prioritization allows only for "what" to send, not "whether" to send

Response Theory and Local Development – need to incorporate local and political elements in determining local response patterns to MPDS categories

General Rules of the response Planning Process: Ask these questions:

- Will time make a difference in outcome?
- How much leeway exists for this problem?
- How much time saved by responding hot?
- What time constraints are present in system?
- When patient gets to hospital will time saved using lights-sirens be significant compared to time spent awaiting care?

11 Communications, 113

- One of 15 critical components of modern EMS system with EMS Act 1973

- Necessary elements of an EMS Communications system:
    - Service to persons requiring assistance,
    - Mgmt information to EMS system leaders
    - Integration with Public Safety (law fire, etc.) in day to day needs and in disasters
    - Collaboration with other organizations in health care
    - Service to community including quality service and accountability and medical oversight

- Comms may look different from community to community.
    - Examples: Rural v urban, different geographic issues define capabilities by scenario.

- Comms does not just mean "911 dispatch" – could mean e.g. home phone access, community paramedicine

- Access—911 – mostly universal number in US. Improves access by improving awareness. Integrated all emergencies –health and public safety.

- Wireless Communications and Public Safety Act of 1999 (911 Act) took effect with the purpose of improving public safety by encouraging and facilitating the prompt deployment of a nationwide, seamless communications infrastructure for emergency services. One provision of the 911 Act directs the FCC to make 911 the universal emergency number for all telephone services.

- E911-system: landline calls automatically give *location* to dispatcher. Problem with cell phones—still need location discussion. The FCC is rolling out E-911 in phases:
    - **Phase 0** - This is the basic 911 process. Wireless calls are sent to a PSAP. Service providers must direct a call to a PSAP even if the caller is not a subscriber to their service.
    - **Phase I** - The FCC's rule requires that a phone number display with each wireless 911 call, allowing the PSAP operator to call back if there is a disconnection.
    - **Phase II** - The final phase requires carriers to place GPS receivers in phones in order to deliver more specific latitude and longitude location information. Location information must be accurate within 164 to 984 feet (50-300 meters).
        - Without Phase II, a caller's location can only be narrowed down to the cell from which the call originated. When Phase II is implemented, a cell-phone user's phone number, or Automatic Number Identification (ANI), and the address and location of the receiving-antenna site will be sent to the E911 Tandem, the switch that routes 911 calls to the appropriate PSAP based on the ANI-defined geographic location.
- Dispatch—EMD protocols to help identify more urgent problems that need "lights and sirens" over other less urgent issues. Centralized dispatch saves money

- Medical Oversight Communications: Different depending on system and needs (taking into consideration distance and interference)
    - Offline v online medical control/consultation.
    - Scope of oversight varies by system: treatment, destination, AMA, medication recs. Med oversight and field providers can use variety of comms methods (radio, phone, cellular). Intro of video

transmission is new

- Patient care records—Providers can share data of prehospital phase with hospitals.
    - PCRs should be kept with patient's hospital medical record.

- NEMSIS has helped to unify a "data dictionary" that most states have agreed to use.
    - Education re: PCR should stress one that is "accurate, precise, comprehensive, legible, objective and time-sequenced."

- Administrative Records—important for operations of EMS crews but also for tracking and responding to quality issues, customer complaints etc.

- Integration with Public Safety organizations—Three different structures for EMS comms centers:
    - 1. A single center houses all staff for dispatch and comm of EMS, police and fire;
    - 2. Comms center is located in PD or FD with EMS dispatch responsibility;
    - 3. Each Pub Safety has separate dispatch. Importance of using an integrated comm. system and routine no matter what structure is chosen.

- Major Incident Communications—Emergency Communication is central to any major incident/disaster response.
    - Robust system must be able to operate and coordinate with multi agency response easily and under stress.
    - Procedures should resemble day-to-day patterns for ease of use.
    - Emergency system must be able to block or shut down non-essential communications.
    - Redundancy is important.
    - Use of incident command system for appropriate flow of information is useful.

- Interoperability w other public safety orgs overseen by DHS which also developed SCIP Statewide Communications Interoperability Plan to enhance local interop developments –enhanced local abilities 2008-2011.

- Radio frequency coordination is common problem locally and nationally. FCC regulates use of radio frequencies by public safety organizations as well as others. FCC has designated separate Emergency Medical Radio Service for several frequencies including traditional Ems channels.

- **VHF: Simplex** - can only send messages *one at a time.* Beneficial for rural, frontier, suburban. Range depends on power output, antenna height, repeater placement.

- **UHF: Duplex** - allow for two-way conversation (at once). 463-468-MH. Good in urban environment because of better *penetrance*. Need repeaters or microwave systems.

- **Repeater:** receives low level signal and retransmits it at higher level/ power --> covers longer distance. Repeater= base station.

- 700MHz and 800MHz Trunked Systems: Blend of two-way radio technology and computer controlled transmitters.
    - Less interference - computer searches for open frequency when call is made. Compatibility difficulty - FCC allowed different equipment design.
    - In some areas, vehicle repeaters are not allowed, limiting functionality.
    - Have limited range and may significantly increase rural system cost to purchase more tower based antennas.

- HEARnet System: VHF. Generally, for emergent/disaster hospital to hospital communication. Hospitals, blood bank, dispatch, EMS offices. Should have independent power supply

- Other communication options:
    - Land and Mobile Phone. Superior clarity. Provides confidentiality. Capability of multimedia messaging. Provides alternate communication in radio 'dead zones'. *Will not function in disaster situations*. Difficult to efficiently coordinate users during an incident
    - 2.4-5.9-GHz Systems--"Hotspot" wireless areas. Provides fast broadband voice and data transmission. Requires 'line-of-sight' connection, making non-urban systems too expensive. Security and transfer speed issues abound at 2.4-GHz, whereas *4.9-GHz is secured for public safety*
    - Fiber-optic
    - Land Mobile Satellite Communication - Omni-directional antenna for improved communication. Very expensive but may be alternative in rural areas.

- Future Directions: Cognitive or Software defined radio (SDR) • Will scan channels to find which are in use when transmission is needed. Will change the channel or spectrum of channels (vhf, uhf, satellite, cellular) based on which has best strength/connection. Will consolidate all devices into one 'Smart Radio'.

- Overall increased situational awareness: Increased use of GPS, Enhanced 911 for cell & VoIP, More involvement of video and data 'pull' & 'push'. Picture, video, GIS mapping, real time. utilization, status automation. Use of "reverse 911" systems to alert and give direction to the public (before they initiate access 911 system).

- FirstNet - nationwide public safety broadband network
    - Created under the Middle Class Tax Relief and Job Creation Act of 2012 (MCTRJCA) as an independent authority within the National Telecommunications and Information Administration (NTIA).
    - Purpose to establish, operate, and maintain an interoperable public safety broadband network. To fulfill these objectives, Congress allocated $7 billion and 20 MHz of valuable radio spectrum to build the network
    - AT&T awarded bid for FirstNet - but is not yet up and running
    - A handful of states as of 2017 have opted in Arizona and Kansas, US Virgin Islands, Arkansas, Iowa, Kentucky, Maine, Michigan, Montana, Nevada, New Jersey, New Mexico, Virginia, West

Virginia and Wyoming.

- Criticised by some as a poor use of money

12 Emergency care regionalization, 123

- **Regionalization**: formation of coordinated system of care across a geographical area that combines all necessary components to optimize patient outcomes.
    - improves patient outcomes in STEMI, trauma, (maybe stroke, at least for rehab)

- **Categorization**: Classification of facility capabilities against accepted standards.
    - should be initiated before formal facility designation occurs.

- **Designation**: is the formal selection (usually the state) for patient referral and transfer.

- The time-critical diagnosis concept seeks to *avoid the creation of three separate systems* (stroke, trauma, and STEMI) within a state or region, since the individual components of the system (EMS, local and regional hospitals, and various bureaucratic and oversight entities) play essential roles for all of these clinical cases.
    - It is far more appropriate and cost-effective to coordinate all the critical cases within the emergency medical care system under a common banner of time-critical diagnosis.
    - This allows resource sharing and coordination at many different levels and decreases duplication.

- **Bypass**: decision to avoid transport of an out-of-hospital patient to a particular hospital facility when transport to a more distant facility will provide more optimal care in the setting of clinical time-critical diagnosis cases in which care at the more distant facility will most likely improve the patient's outcome.

- **Diversion**: an act taken by a hospital facility that informs field providers that transport to that facility should not occur. Most commonly occurs when the patient traffic in the emergency department of that facility is of such a magnitude that additional EMS traffic could endanger either the current patients in the facility or the patient being transported. Diversion is commonly defined as an action that is allowed as a courtesy from the EMS medical director of that EMS system. *Diversion leads to worse patient outcomes, and prolongs prehospital portion of care.*

- Public Law (PL) 101-590 Trauma Care Systems Planning and Development Act --supports regionalization only $5 Million in 1992. Senate committee found mortality of severe injury in rural areas 3 to 4 times that of urban areas.
    - trauma centers with specialized physicians and equipment *immediately available on a 24-hour basis*. Also required were methods to *identify severe trauma victims* in the prehospital phase
    - addressed the issue of authority, effectively diminishing the threat of legal challenges to development and implementation of designation schemes. But financial burden caused by the large numbers of uninsured or indigent patients brought to designated facilities, compounded by inadequate reimbursement rates, still presented a great barrier to regionalization

- HR 727 TCSP&D Act Amendments passed in 2001 (9/11) and 2007 gave additional funding of $8-12 Million through year 2012. However, failed intentions, and support for regionalization slipped from fiscal federal support back to state and local level

- Overarching agency must be identified with legal authority to oversee the political and administrative processes needed for a regional system to succeed.

- Oversight committee must allow for the input of expert stakeholders and to encourage their participation in the design and refinement of system processes.

- In the absence of federal dollars and legal authority, plans for regionalization through facility designation usually fail.

- Organizational silos need to be acknowledged and resolved. Leadership focused on improving patient outcomes through decreasing the time from symptom onset to definitive care is the key to bridging the gaps between provider groups.

- EMS medical directors have to ensure that their personnel appropriately identify stroke and STEMI candidates while avoiding “overtriage” when possible

- It is important for EMS medical directors to monitor their systems for overtriage decisions and to minimize those instances where possible through initial and continued education based upon quality improvement benchmarks.

- Clear protocols are needed at every level within the emergency medical care system to allow for early identification, moving care forward, simultaneous processing, and field triage of patients to the correct destinations.

13 EMS–public health interface, 134

- Epidemiology is “the study of the occurrence and distribution of health-related states or events in specified populations, including the study of the determinants influencing such states, and the application of this knowledge to control the health problems”

- Identifying health priorities in a community - community needs assessments
    - Nonprofit hospitals must perform community needs assessment overy 3 years to maintain tax-exempt status

	Host	Agent	Physical environment	Social environment
Prevent	Physical fitness Shift length Substance abuse Education Knowledge Skill proficiency Capability Risk threshold	Vehicle design Equipment design Vehicle testing Equipment testing Ergonomic consideration Vehicle maintenance Equipment maintenance	Hands-free devices Ergonomic design of vehicle interior	Public expectation for response times Call prioritization Driver training Culture of seat-belt use Emphasis on speed Emphasis on lights-and-siren use Availability (lack of) consensus on vehicle design standards Availability (lack of) driver training standards
Event	Distracted EMS driver Fatigue Seat-belt use Risk-taking behavior	Speed Lights-and-siren use Stability of vehicle in transit	Weather Agitated or violent patients Character of interior surfaces Road conditions Traffic Curious onlookers	Seat-belt use Driving habits Willingness to recognize error
Postevent	Pre-existing conditions Physical fitness	Prevention of fire risk Escapability of the cabin Crash information collection Stability of the vehicle after collision	Post hoc analysis of event Root cause analysis Availability of emergency responders (for ambulance crash)	Error recognition Error reporting Behavior change Human factor analysis

Figure 13.1 Example of Haddon Matrix. Source: Brice 2012 [13]. Reproduced with permission of NAEMSP.

- EMS Agenda for the Future: EMS is the intersection of public safety, public health, health care systems

- Merging of fields EMS/PH: hurricane response, World Trade Center attack, avian influenza

- Public health relies on epidemiology to help organize the information through describing the occurrence, distribution, and control of disease in a population

- Bioterrorism syndromic surveillance, e.g. anthrax, plague

- Other syndromic surveillance examples: SARS, pandemic influenza

    - Fire and police departments already work with prevention, EMS is a natural partner
    - Immunizations by EMS providers an example

- Community Paramedicine and Mobile Integrated Healthcare
    - Programs across the country are seeking creative ways to utilize the unique skill set of paramedics and their position within the communities.

14 Political realities for the medical director, 140

Case Studies

- Unification of Denver EMS System (1979) – sought to have formalized control of fire-fighters who served as first responders, Fire chief vetoed as saw as loss of control. Medical director engaged in direct observation and participation of firefighters, reviewed the document and made acceptable to firefighters, and was issued as an executive order by the mayor. Took two years
- Paramedic Presence at the Stapleton International Airport. Area at airport had increasing demand for EMS services, but large number of calls were fraudulent or refused services. Put paramedic unit at the airport on golf cart so could respond to and triage calls, but did not require ambulance to be dispatched, so would not tie up that resource. Able to improve overall system performance without increased cost. Took probably another two years. Glacial pace

- Power Blocs, Vectors and Pressure Points
    - power blocs are present in all communities, important to identify them in order to make changes in system.
        - may consist of mayor, EMS providers, fire chief, patients, state health dept, etc
        - visualize power blocs as 'power vectors' with magnitude (force) and direction, exert pressure in ways that will realign vectors on parallel course toward desired EMS agenda

- Philosophy, Perspective and Bias – 5 political senses require mastery:
    - A sense of mission – should be defined, amalgamated and articulated
    - A sense of tradition – history of the community and the service
    - A sense of position – position of the medical director in the organization, community, and the position of the service agency
    - Humor
    - Timing – introduction of new ideas and programs should take advantage of other changes being introduced in the community, institution, or agency

- Preparing Yourself
    - achieve excellence in: academic, operational, administrative, clinical, and community relations

- Principles of Action
    - Sustaining the Drive – Energy of medical director is expended in overcoming resistance of the status quo to move the system to higher performance and greater accountability
    - must acquire skills of other professions including teaching and business to augment own innate talents
    - As often as possible, give credit to others for the success of the system.

- "Never satisfy a bureaucratic need completely. To do so will cause bureaucrats to forget you. Partial solutions enable an occasional reminder to the bureaucracy of your importance as a problem solver, and your inadequate funding"

- “Project academic passion with political neutrality--acknowledge medical imperatives while achieving political equanimity”.

15 EMS physicians as public spokespersons, 146

Basic Assumptions:

- The EMS physician is the appropriate spokesperson and has received clearance to make the statement.
- In cases of specific patients, notify patient and family first
- Reporting proactively may minimize the effect of the information that would be eventually disclosed to the public
- Be a sincere patient advocate

The Challenge of Bite-Speak

- Often have only seconds to make point
- Choose words wisely and economically
- Brevity and bullets do it best

The Effective Sound Bite

- Three part format: definitive opener, short core explanation, parting resolve
- Often only 10 seconds total – so message must be succinct
- Avoid repeating negative aspects of the question – focus on the objective you wish to communicate

Dealing with Print vs Electronic Media

- Electronic media allows information to be rapidly reproduced and disseminated – will allow the interviewee to shape response to evolving story and catch up on issues being examined
- Print stories – may consider asking interviewer to call back after writing the story, to check for accuracy and if the point was understood, but have limitation of strict deadlines. Ensure quotes are correct. May want to talk slower and reiterate important points during interview for print.

News Conferences

- “press conferences” used to announce new programs or initiatives
- should be no longer than 10-15 minutes
- limited to 3 or 4 speakers
- Question session following, but also allow for directed interviews following
- Statements limited to 2 minutes per speaker
- Avoid obvious redundancies, but can reiterate the point
- Individual speakers should show broad-based support, and each should be a ‘fresh perspective’ on the topic
- Media advisory should be sent 1-2 days ahead of time, limit to one page with who, what, when, where format
- Speakers may include: Master of Ceremonies, Expert Speaker, Counterargument expert, Person to ‘bear witness’, ‘how you do it’ person, demonstration (visuals for camera)

16 Legal issues, 160

- Initial focus of legislation was immunity for the rescuer.

    - Eventually laws were passed to protect the trained rescuer and professional paid responder, as well as the “Good Samaritan”.
    - Governmental immunity also became a strong shield from liability for public agencies.

Legal Physician-EMT relationship = Supervision (rather than agency)

- Physician has responsibility to properly oversee practice as a supervisor. EMTs are not agents of the medical director.
- EMT’s are the “agents” of EMS provider agencies and employer (agency) is liable for the actions of the EMT under the doctrine of **respondeat superior** but are supervised by the EMS Medical Director (they don’t practice "under the license of" the MD).
- **Vicarious liability** - (master is liable for the actions of their servant) this is not the relationship between the medical director and the EMT
- Delegated practice - widely used to describe the relationship between physician and EMT, but in most states (except Texas), there are no statutes that authorize a physician to “delegate” skills in their practice to another health care provider

Licensure is the permission to perform an act by a competent authority, as opposed to a certification, which is the formal assertion of some fact (EMT’s would seem to be licensed, but this varies by state).

They do not practice “under the license” of the medical director, but instead under their supervision, with permission of the governing body.

- EMS medical director responsibilities of training, supervision and retaining EMTs could potentially open them up to liability if performed negligently.

EMS usually under State and Local Law - several areas of Federal laws and regulation providing MD accountability:

- If part of employment hierarchy - may be named in lawsuits regarding employment disputes
- Sexual harassment
- Medicare fraud and abuse (eg transport necessity)
- HIPAA
- Civil rights (includes due process) "1983 actions" -Protection is not found in malpractice insurance

Scope of practice

- State statutes and regulations often determine the scope of practice and require certification of the EMT by the Medical Director. State regulation differs state-to-state regarding medical director relationship to prehospital providers.
- Statute-generally say DPH can propose regulation
- Regulation -stated by lawyers
- MD is accountable to the state licensing board for his/her medical control functions.
- Immunity laws include sovereign immunity for government employees and Good Samaritan laws, which vary

from state to state, excepting the Aviation Medical Assistance act of 1998.

- Case law = common law, have been used against medical direction for lack of protocols for non-transport.

- Professional (e.g. Practice) vs. administrative (e.g. Reimbursement) areas of liability.

Areas of liability:

- failure to perform responsibilities
- negligent supervision
- including failure to utilize lawful authority for supervision.
- Not meeting or knowing the patient is not an adequate defense (the Arizona “curbside” EKG consult with resulting liability example).
- Medical Directors need the ability to limit the actions of those that they supervise.
- Special duty may exist on the part of dispatchers, especially problematic in directing responders to enter locked domiciles. Special duty does not exist if agent of government
- Response must be appropriate and timely, volunteer status of responders is no defense.
- Importance of ICS and scene safety on scene management.
- EMTALA/COBRA issues include non-diversion of ambulances in route to a facility or on facility grounds and no "parking".
- MD’s are responsible for non-transported patients.

- Summary of principles for non-transports:
    - have a policy
    - train on the policy
    - do audits to hold accountable
    - have online medical control involved
    - be cautious with restraints
    - use a legally correct release form

- Some discussion of ability to transport a patient against their will by virtue of a "qualified privilege" to protect against charge of false imprisonment.

- Ability to comprehend risks of refusing treatment (capacity) better language to use than competency, which is a legal definition.

- Minimum provisions of contracts
    - responsibilities
    - authorities
    - chain of command
    - terms of payment
    - insurance
    - clear jurisdiction over aspects of practice that affect provision of care

17 Due process, 182

Case law – from the decisions of judges in various courts

- Federal: Supreme Court > US Court of Appeals (Federal and DC circuit) > US District courts
- State – similar structure. Highest state appellate court determines law for that state

State Legislation

- State Administrative Procedures Act – state law to provide for due process procedures. Proved an expeditious, inexpensive, and thorough review of issue without the potentially prolonged procedure involved in court proceedings. Less formal format.
- State Constitution – have requirements for due process of law or its equivalent

Due Process of Law

- gives every person the right to present reasons why the government should not deprive them of life, liberty, or property.
- Expansion of this in 1970 following Goldberg v Kelly – found that person had right to notice and hearing before government agency could terminate welfare benefits.
- Extends to employment termination, licensure and certification terminations, disciplinary actions, the withdrawal of medical authorization, and credentialing. Also required to QA and QI review.
- Concept stems from Magna Carta (1215)
- Fifth Amendment – prohibits federal government from depriving any individual of "life, liberty, or property without the due process of law"
- Fourteenth Amendment - prohibits state from depriving any individual of life, liberty, or property without the due process of law
- No definition of 'Due Process' given in the constitution

- **Procedural** due process of law – deals with the process of procedural fairness

- **Substantive** due process – prevents government from interfering with rights

- Elements of due process: Set forth by Judge Friendly. Not all elements are required in a given situation.
    - Unbiased tribunal
    - Notice of the proposed actions and grounds asserted for it
    - Opportunity to present reasons why the proposed action should not be taken
    - Right to call witnesses and have counsel
    - Right to know the evidence against you
    - Right to have decision based only on the evidence presented
    - Record of the proceedings
    - Statement of reasons for the action taken

Governmental action: Procedural due process of law applies only to actions taken by a government and do not extend to private conduct abridging individual rights

- Civil Rights Act of 1871 – Section 1983 – A person that is deprived of a constitutional right by a person acting under the color of state law can sue the 'state actor'
- Volunteer fire and ambulance companies, private ambulance companies, medical directors may be considered to be engaged in state action and thereby are required to provide procedural due process

Ambulance companies – whether they are required to provide due process of law depends on the particular facts and circumstances under which the company operates

- Many cases with variety of outcomes on whether are state entities or not

Medical directors

- May be considered to be engaged in state action as the medical director position may be required by state law

Medical review committees – serve as a unique and valuable tool for conducting quality assurance and quality improvement reviews of EMS practices and procedures.

- Proceedings are often confidential to shield sensitive medical information.
- Are often subject to due process as function under state statutes and regulations.

National accreditation entities – ex National Registry of EMTs is a private credentialing agency, but is probably not considered to be a government action , although many states rely on them for credentialing of EMTs

An Opportunity to Present Reasons why the Proposed Action Should Not be Taken

- Gives the party against whom action is proposed a fair and full opportunity to challenge the basis for the action and to present that party's own evidence
- Hearing will be provided, may be telephone, video conference, in-person, etc
- Allows party to examine evidence against them

Life, Liberty, or Property:

- Life Interest – limited to capital cases
- Liberty Interest – freedom from bodily restraint, right to the pursuit of happiness (worship, marry, raise children, acquire knowledge, etc.)
- Property Interest – interest in employment, a license, or a certification may be qualified as property interests

-Employment and licenses as a property interest:

- for an employment relationship to be a property interest there must be a legitimate claim of entitlement such as tenure, a fixed-term contract, implied promise of continued employment
- EMT License – becomes valuable personal right and therefore cannot be denied or abridged except after due notice and a fair and impartial hearing before an unbiased tribunal. EMT cannot have license revoked or limited without due process.
- Some actions can be considered so insignificant that they do not require due process, but this is not always clear or consistent. Warning letters, transfers with no change in pay, reprimand letters, and some short suspensions may not require due process, but some may consider any possible violation of constitutional

right, no matter how insignificant, to be a matter which requires due process.

The liberty interest:

- Arises when an employment action is taken that damages the employee's ability to obtain employment. (ex. immorality, dishonesty, alcoholism, incompetence)
- Damage to reputation alone does not ordinarily represent a due process interest
- Healthcare Integrity and Protection Databank (HIPDB) – established in 2000 as a part of HIPAA – state and federal agencies are required to report licensing and certification actions, including revocations, reprimands, censures, probations, suspensions, and any other loss of license, whether by voluntary surrender, non renewability, or otherwise.

Impartiality of Tribunal – Should be unbiased forum: Fair and impartial

- agency that initiates the disciplinary proceeding may also judge whether the violation occurred
- Government officials serving on a tribunal are presumed to be conscientious and fair-minded, and earlier involvement in the investigation should not disqualify them.

Notice – individual should be given notice of the proceedings against them, these should include:

- the grounds for the actions proposed to be taken
- the type of action proposed
- the provider's rights
- must state all the facts and circumstances on which the proposed discipline is based
- Should have proof of delivery: hand delivery with affidavit, certified or registered mail with signed return receipt

Time for Hearing – ideally hearing should take place before the provider is deprived of the protected property interest

- In cases of public health, safety, and welfare that put the public at significant risk, action may be taken before due process
- A summary proceeding should be held as early as possible so that there is reasonable assurance that the situation presents a significant enough threat to warrant the revocation of a property interest before the hearing.

Standard of Proof – pivotal facts supporting the decision need to be established:

- "Proof beyond a reasonable doubt" – highest burden of proof, usually only applies in criminal prosecutions. Generally is not a workable standard in administrative due process proceedings
- "A Preponderance of Evidence" – matter is more likely than not. Usually considered a sufficient level for due process purposes in medical disciplinary proceedings.
- "Clear and convincing evidence" – more than a preponderance of evidence but less that beyond a reasonable doubt

Right to Counsel – There is no procedural due process right to counsel

- Administrative procedure acts and agency rules may provide the right to representation by counsel
- Government has no obligation to provide this counsel in these cases

18 Risk management, 192

Internal components: safety, training, health, wellness, personnel and equipment management.

External Components: prevention, public education, perception of the public.

Prehospital Risk Management

- Risk assessment - Monitor all high frequency, high risk encounters, e.g. Non-transports, ETI's.
- Initial Training - solid foundation
- Pre-employment screening - assess medical knowledge and patient care skills
- Medical Supervision - medical accountability
- CME
- Quality Management - continuous action loop (starts with protocols)
- Patient Expectations - influenced by locale, socioeconomics, cultural influences
- Patient Care Incident Management - part of the job as medical director, could lead to potential liability if not performed
- Patient Care Incident - should have comprehensive mechanism for dealing with these

Develop pre-loss (e.g. protocols) and post-loss (e.g. good investigations) strategies.

Initial training and the liaison between training program medical director and system medical director emphasized.
Robust system orientation prior to (local) accreditation emphasized.

- Aligning patient and prehospital crew expectations discussed.
- Medical director must have final authority on the evaluation of the clinical aspects of the incident.

Box 18.1 Incident investigation checklist

- Discussions with involved EMS crew members
  Name/date:
  Name/date:
- Documentation of discussions with EMS crew members
- Discussions with other personnel (patient, physician, etc.)
  Name/date:
  Name/date:
  Name/date:
- Documentation of discussion with other personnel
- Crew member incident reports
- Patient care record (delete name and assign number)
- Other appropriate documentation
  Photographs
  Tape transcripts
- Equipment or products causal to the incident

Documentation of the prehospital encounter critical, especially for patient non-transports, and incident management.

Elements of a risk management program:

1. Identify risk exposure,
2. Evaluate risk potential,
3. Rank and prioritize risk,
4. Determine and implement control actions,
5. Evaluate and revise techniques as needed.

Potential findings: environmental influences, safety factors, training, employee clinical performance or behavior, judgment error, equipment deficiency or failure, incomplete documentation, patient expectations, protocol or policy problems, actions of other providers, or direct medical oversight-use root cause analysis to determine which factors are involved (not always "human error")

Remedial education actions may be warranted, and may include CE. EMS risk management systems should include literature reviews.

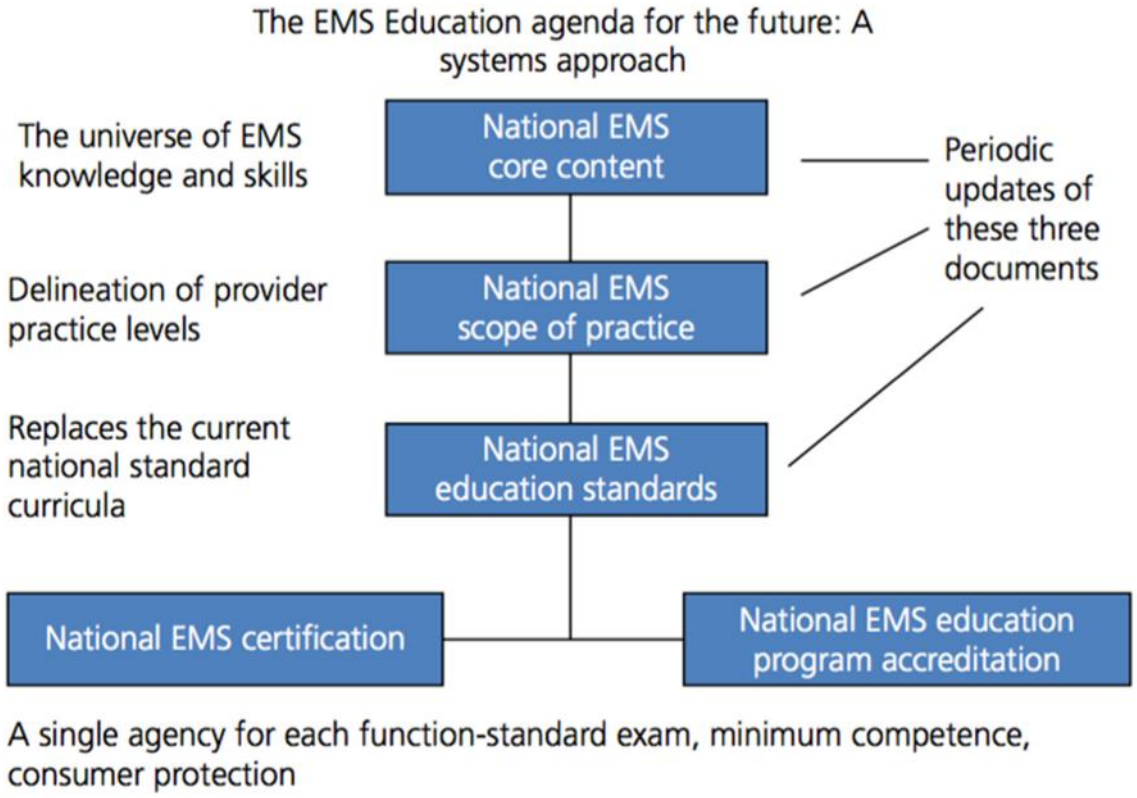
Risk Management is a proactive as opposed to reactive strategy.

19 EMS provider education, 2010

- To approve the medical and academic qualification of the faculty, the accuracy and quality of the medical content and the authority to assure that faculty teach established medical practices

- Routinely review student performance and progress, and attest that students have achieved the desired level of competence prior to graduation.

- Bloom's taxonomy: a classification of learning objectives with three domains of educational activities or learning:
    - cognitive (knowledge)
    - affective (attitude)
    - psychomotor (skills)



- Critical component of medical director role: ensure high quality of care and professional standards. National in scope, but allowing for regional and local flexibility.

- Medical Director should be involved in determining scope and delivering curricula, but may not be a primary instructor due to educational delivery experience.

- Delivery through community colleges is an excellent model for training due to the accreditation of the curriculum, existing infrastructure, and for potential for college credit.

- January 1, 2013: a paramedic candidate must graduate from a CAAHEP- accredited program in order to take the NREMT paramedic examination.

- NREMT updates the exam item database frequently. Exam items are based on a practice analysis at each level and are completed every 5 years as required by the NCCA. Test items are validated which is a reason for the cost of the exam.

- Separate accreditation exists for CME: CECBEMS (national)

20 EMS provider wellness, 211

- The EMS Medical Director is responsible (leader) for agency wellness program and monitoring process

- The components of provider response to a stressful incident are:
    - Physical, Emotional, Cognitive, Behavioral
    - These can be acute or delayed

- Effects of a poor response to the stressful event:
    - Unhealthy Behavior
    - Personal problems
    - Long-term health issues
    - Burnout

- Supportive post event steps:
    - Emotional Support
    - One on one debriefing

- Factors associated with at risk individuals
    - Old age, High experience levels
    - Working for a commercial service
    - Greater denial of hostility
    - Higher levels of hostility

- Stressors in the prehospital setting
    - Work hours - Long and Irregular
    - Sleep deprivation and interruption
    - Financial Stressor and salary pressures
    - Personal safety from violence

- Wellness program components
    - Regular exercise
    - Proper rest between shift cycle
    - Proper diet
    - Continuing education on coping mechanisms and stress reduction techniques
    - Better communication and organized collegial support
    - Specific shift scheduling - rotating in a clockwise fashion with 48 hours off between night and day shifts
    - Avoiding 24 hour shifts in areas where significant rest is not possible can help to mitigate shift work effects
    - Conflict resolution concepts

    - Violence reduction techniques
    - Situational awareness
    - De-escalation techniques
    - Self-defense and personal protection measures

- Steps to be taken by MD/resources for EMS Medical directors for wellness programs:
    - Local resources on ongoing training and wellness programs and refer when necessary
    - Familiarize with laws governing employee relations and fitness for duty
    - Collaborate with ongoing surveillance and maintenance wellness programs and interventions

21 Occupational injury prevention and management, 217

- Occupational fatalities among EMS workers are estimated to be 2.5 times higher than rates experienced by the general public
- Back injuries are most common
- MVC most common liability (37%) and most common cause provider fatality.
- Half of drivers involved in crashes have been involved in multiple crashes.
- Approx 5% ambulance providers have been involved in MVC
- Patient dropping 2nd most common
- Injuries leading to lost work time more common in EMS than in fire and police
- Violent patients are common and up to 60% of EMS providers have been assaulted by a patient

22 Ambulance safety, 222

- Epidemiological triangle
    - Host
    - Agent
    - environment
- Haddon matrix-for each factor: host, agent, environment.
    - These are evaluated pre-event, event, post-event. This creates a 3x3 matrix (shown below)
- Three E's of Intervention:
    - Education (easiest, poor compliance),
    - Enforcement (law support, punitive measures),
    - Engineering (built into equipment, no active participation)

	Human/host	Vehicle/agent	Environment
Pre-event (preinjury)	Fatigue Poor driver training Impaired hearing Alcohol/substance abuse Non-use of seat belts Distractions Stress Poor driving skills Diesel fume exposure Smoking Speed	Poor maintenance Poor design Inappropriate tires or tire pressure Lack of functional seat belts Lack of driver's compartment airbags	Poor visibility Hazardous conditions Urban vs rural Inadequate agency policies and/or enforcement Inadequate funding for research and prevention
Event	Employee's health Resistance to energy	Protruding objects Sharp corners Unsecured equipment	Lack of vehicle restraining walls/rails on roadside
Post-event	Employee's health Priority given to other's care over self-care	Presence of hazardous materials	Availability of ambulances Trauma center

- Ambulance crashes cause 59% of all EMS occupational fatalities, the rate of transportation-related occupational injuries for EMS personnel is more than 30 times higher than the national average, and crashes involving ambulances produce twice as many casualties as the national average.

- Most crashes occur during emergency use and most serious injuries are in patient compartment. Highest risk locations at intersections and traffic signals.

- Backup alarms - button

- Black box --beeps with dangerous driving, less money required for vehicle maintenance

- Recommendations:
    - Fatigue: shorter shifts, training on fatigue
    - Driver Training: research is needed to determine recommendations
    - Use of Red Lights and Sirens: Warning Lights and Sirens (WLS) are overused, implement tiered dispatch protocols to reduce WLS. But problems with implementation due to concern about not getting to critical patient quickly if information is inaccurate, need in congested areas, patient perception to not be taken seriously.
    - Passenger Restraints: Seatbelt use is the law, but many personnel refuse to wear for patient care or other reasons, need better education
    - Driving History: check driving record at start of employment and periodically recheck
    - Vehicular Design: lack of standards to rear compartment of ambulance, most dangerous area and least regulated
    - Vehicular Operations: black box-real time monitor of speed, acceleration, seatbelt use

23 Medical surveillance of emergency response personnel, 231

- Greater and more varied dangers facing today's EMS workforce—threatening their health and lives.
    - Examples: MCI/Active shooter, Epidemics, Toxic Inhalation (e.g. World Trade Center).

- World Trade Center Medical Monitoring and Treatment Program
    - Goals of a medical Surveillance program:
        - Early recognition of hazardous exposure-related occupational disease
        - Early intervention and treatment
        - Effective management of occupational disease process
        - Illness prevention

- Several federal regulations, agencies, documents provide guidance of design and operation of Medical Surveillance Program (OSHA, CFR, EPA, Natl Fire, etc.)

- Current OSHA Requirements for implementation of Medical Surveillance Programs (MSP):
    - For employees who may be exposed to hazmat at or above Permissible Limits (PELs) for 30 days or more
    - In absence of PELs, for employees working at levels above published exposure levels for a substance
    - Employees who wear a respirator for more than 30 days/yr
    - Hazmat employees
    - All employees who are injured because of exposure to hazmat

- EPA includes volunteers working for govt agency

- Success of surveillance program requires: clear definition of mission, components and procedures for surveillance before, during and after exposure.

- MSP require dedicated staff, medical screening, periodic exams and monitoring

- Must maintain employee records for minimum of 30 years post retirement/termination of employment

- Responders entitled to access records within 15 days of request

- Initial employment exam, depends on institution—in addition to health questionnaire, Immunizations, exam might include the following:

- NFPA 1582 is general occ health stuff for fire.
    - VS including Ht, Wt, BP pulse, RR
    - CXR to screen for pre-existing abilities
    - PFTs
    - EKG
    - Vision Test
    - Auditory
    - Blood (liver kidney), CBC, electrolytes, UA

    - Drug, pregnancy, etc.
    - Annual or Periodic Examination

- On-scene medical monitoring—may depend on incident
    - Rest requirements
    - PPE
    - Rehabilitation areas needed—different agencies might be primary host during incident, some variability
    - Periodic re-exams
    - Range of services—include mental health

- Exposure specific exams

- The 2015 edition of NFPA 1584 (rehab) will reflect an evidence-based deemphasis on electrolyte replacement, will note a daily acceptable caffeine limitation of 400mg per member, and will recommend against any consumption of energy drinks (not to be confused with sports drinks) by emergency responders.
    - applies in training as well as responses

- NFPA 1581 = infectious ("thou shalt have an infectious control officer")

- NFPA 1583: health and fitness

24 Prevention and intervention for psychologically stressful events, 236

- EMS work contains a significant amount of physical and emotional strain. Long hours, low pay, burnout and PTSD.

- Critical Incident Stress Management (CISM) and **CISD** (debriefing) are well received, but there is little evidence that they make a difference with PTSD, and *may have paradoxical effect (eg don't force re-exposure.)*

- Axiom: a well-managed, well-run organization will find its way through even the greatest challenges

- Healthy organization: management, command, supervision

- Psychological First Aid-contact and engagement, safety and comfort, stabilization, information gathering, practical assistance, social supporter connection, coping information, collaborative services linkage

- NFPA 1500 (health and safety standard for fire service agencies) mandates all agencies provide an employee assistance program (EAP)-access to behavioral health assistance

- Current recommendations:
    a. Immediate assistance (psychological first aid)
    b. Early, reliable, non-intrusive assessment: Trauma Screening Questionnaire (TSQ)
    c. Stepped care (treatment matched on level of clinical need)
    d. Evidence based treatment of clinical conditions (psychological benefits of cognitive behavioral therapy)

- Basic protocol to manage stressful situations: experience of posttraumatic event (PTE)->supervisor hot wash (timeout)->TSQ screening (if > 6 positive then referral)->complete assessment->treatment by specialty clinician

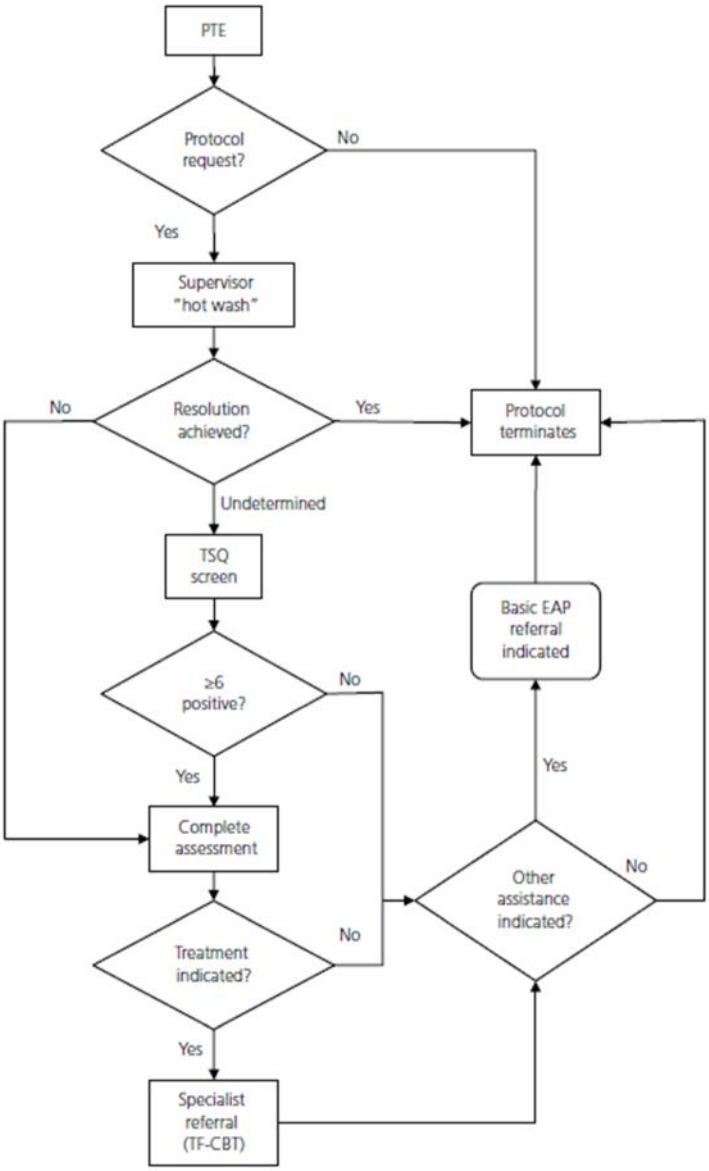


Figure 24.1 PTE protocol flow chart. PTE, potentially traumatic event; TF-CBT, trauma-focused cognitive behavior therapy.

25 Protection of EMS personnel from occupationally acquired infections, 243

- HBV Vaccine now essential for HCPs. 3 doses then check titers. If non-responder, needs boosters then check titers again. If still non-responder, must be aware of status, as may need HBIG if exposed. Need waiver if refuse before first patient contact

- Unlikely to ask details from charts e.g. page 247. The route of transmission, however, may be fair game.

- Anthrax:
    - Cutaneous: contact with spores
    - RT (inhalation of spores)
    - GIT (ingestion of spores – rare)

- Botulism:
    - GIT: ingestion of toxin-containing food
    - RT: inhalation of toxin-containing aerosol

- Ebola hemorrhagic fever:
    - As a rule infection develops after exposure of mucous membranes or RT, or through broken skin or percutaneous injury

- Plague:
    - RT: Inhalation of respiratory droplets

- Smallpox:
    - RT: inhalation of droplet or, rarely, aerosols and skin lesions (contact with virus)

- Tularemia
    - RT: inhalation of aerosolized bacteria
    - GIT: ingestion of food or drink contaminated with aerosolized bacteria

- Ryan White Act - need ICO infectious control officer.

- NFPA 1582 -standards on comprehensive occ medical program for FDs

- NFPA 1581 -standards on fire dept infectious control program

- Mandated report: believe exposure occurred; or healthcare facility identifies infectious agent

- HCV:
    - Not as infectious as HBV and many patients are asymptomatic—unaware of infected status but may lead to worse disease as well as more chronic states.

    - No reliable PEP available. Some respond to interferon.
    - No vaccine

- HIV:
    - only 5% of HCP exposures are to HIV+ blood.
    - Low transmission rate.
        - Percutaneous: 0.3% rate of transmission.
        - Splatter: 0.09%.
    - Rapid testing to assess status of HIV and HCV (and HBV) in exposed and in source patient
    - Antiretroviral PEP given to all exposed to HIV+. If source will not consent to testing, give PEP.
    - Current recommendations eliminated attempts at correlating the severity of an exposure with the components of the PEP. If PEP is indicated, the same first-line or alternative regimens are used, regardless of any specific characteristics of the exposure incident.

- Tuberculosis:
    - Droplet transmission, additional resp precautions needed (M95).
    - EMS personnel should maintain suspicion in patients with pulm symptoms and high risk factors.
    - Reportable illness, therefore EMS should be notified by hospital if TB patient later identified and recognized to have arrived via EMS.
    - CDC Recommends for HCP yearly TB screening via PPD.

- Varicella
    - Recommendation is for vaccination to prevent or diminish illness.
    - If non-immune person is exposed, then vaccine can be given within 5 days of exposure.
    - If the nonimmune person is pregnant or immunocompromised, then VZIG should be given to prevent disseminated VZV.

- Bacterial Meningitis: universal and droplet precautions when transported suspected patients.
    - High case fatality for N. meningitidis (10%).
    - PEP should be administered when close unprotected contact occurs (mouth to mouth, intubation, vomiting, secretions, coughing).
    - Close contact is only when the HCP was <3 feet from patient for >8 hours.
    - PEP should be given once a case is confirmed via CSF.
    - HCP cannot work until 24 hours after PEP given.

- Recommended Immunizations: Childhood, HBV, MMR, VZV, TdaP boosters, TB skin testing.

Section IV: Extraordinary Circumstances

26 Incident command system and National Incident Management System, 257

- ICS: key to interface between EMS and public safety entities.
    - “anti-bureaucracy” (bureaucracy being marked by formalization, specialization and hierarchy)
    - capable of handling unstable situations with potentially catastrophic outcomes
    - highly reliable
    - virtual organization.

- NIMS is designed to coordinate multi-agency, multiple jurisdictional responses to large scale emergencies.

- ICS developed in the mid-70’s by Firefighting Resources of California Organized for Potential Emergencies (FIRESCOPE) to deal better with multi-jurisdictional wildland fires.

- ICS is modular and scalable.

- All responsibility for every aspect of response to an incident belongs to the Incident Commander until it is specifically delegated.

- Unity of command important (each team member reports to only one person).

- Unified Command utilized when multiple agencies with multiple jurisdictions respond to an incident but this does not overrule the IC’s command role).

- Span of control dictates that no one supervises more than 3 to 7 other persons.

- Job Action Sheets should be available to each command team member to use as a documentation and decision-making reference (for the first few hours of the incident--JB emphasis).

- Orderly transfer of command is needed when discrete phases of a response are completed.

- **Sections** are organizational levels with responsibility for a major functional area of the incident, e.g. logistics.

- **Branches** are used when the number of divisions or groups exceed the recommended span of control, e.g. EMS branch. Service and support are branches of logistics. Think tree diagram
    - eg. Medic treating patients on scene would be in medical BRANCH of ops SECTION.
    - eg. Fly car EMS MD’s would be in service BRANCH of logistics SECTION.

- **Divisions** are used to divide an incident geographically
    - e.g. West division. Sides of railroad track or floors in a building.

- **Groups** are established to divide the incident management structure into functional areas of operation.

- **Units** are organizational elements that have functional responsibility for a specific activity
    - eg. supply unit. Unit can be multiple strike teams or multiple strike forces

- **Single resources** are defined as an individual piece of equipment with its personnel components
    - eg. ALS ambulance

- **Task Forces** are combinations of mixed resources with a common communications capability and a leader.
    - eg. riot with cop car, 1 engine, and 2 ambulances working together.

- **Strike Team** is a set number of similar resources with common communication and a leader.
    - Eg. 5 tankers for water supply.

- Command staff include Safety, Public Information and Liaison Officers. Liaison helps
    - eg. the power guy who is helpful but not familiar with.

- Safety officer is only person who can override incident commander

- **"unified command"** is instituted with senior representatives of each stakeholder agency or government present in the command post who serve as the IC for their jurisdiction or agency.
    - The unified command speaks with one voice as the IC for the situation, and any differences in priorities or tactics are worked out among the individual ICs that make up the unified command. This maintains unity of command, because each responder reports to a single supervisor, but it also maintains a pathway of expertise.

- Joint Information Centers are usually established in large incidents to coordinate the efforts of the responding agency's PIOs. Usually off site.

- ICS **sections** are Plans, Operations, Logistics and Finance. FLOP (rarely use F and L)

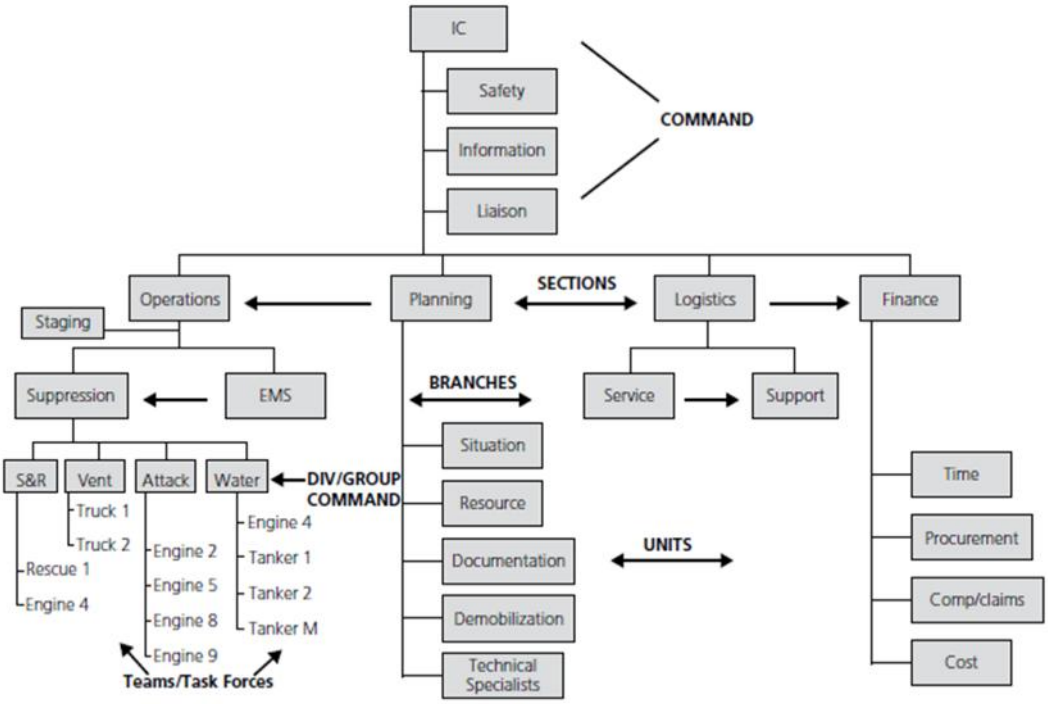


Figure 26.4 Large-scale event chart. Organizational chart for a large-scale event involving fire suppression, rescue, and medical care of civilian casualties. Standard terms for levels of management are shown in bold.

27 Medical management of mass gatherings, 264

- Sports events coverage since 1965 Univ. of Nebraska football games cardiac arrests and antiwar protest coverage since Vietnam war 1971.

- Public health awareness since 1984 LA Olympics heat injuries.

- Demand for medical services quantified by
    - per 1K spectators
    - adverse weather
    - spectator intoxication
    - inadequate H20 + heat
    - contaminated food
    - violent spectators
    - competition stress.

- Rock concerts longer than 6 hours with mobile spectators (mosh pits and crowd surfing - which, of course, make the concert worthwhile) associated with more medical calls.

- Patient Presentation rate (PPR) per 1,000 is a common metric.
    - Normal PPR at mass gathering is 0.5-2

- Challenges of care at MG's
    - coordination of multiple agencies
    - densely clustered populations
    - potential for MCI.

- Medical Director with responsibility for all care given is a must to maintain the standard of care at the event found in the surrounding community. May not need to be on site for smaller events.

- Pre-event reconnaissance emphasized, including reviewing prior iterations of the event's medical records.

- EMT level of care at a minimum; special attention to cardiac arrest possibility as potential for survival is relatively high

- Frequency of demand for medical care per attendee decreases as size of event increases.

- MDs should be on site if transport limited or long, large # of spectators or high risk of injury activities. MD onsite may decrease need for transport.

- EMTs most valuable in mobile roles.

- Fixed on-site facilities must meet fire and other applicable building codes, locations announced to event participants, and have provisions for security.

- Intravenous patient transport resources are needed if treatment facilities are more than a :05 walk with pedestrian transport, e.g. gurney or wheelchair.

- Extra venue patient transport should include non-ambulance vehicles.

- Heat relief and the provision of potable water intertwined; at least 1 source of free potable water for every 1.5K participants.

- Ecological considerations in response are important as well
    - e.g. poison ivy dermatitis, ill-tempered snakes, rabid bears, cantankerous lions, the occasional maladjusted tiger. Oh my!

- Techniques for Effective Alcohol Management (TEAM) instituted at all MLB stadiums in 1993.

28 Disaster preparedness and management, 272

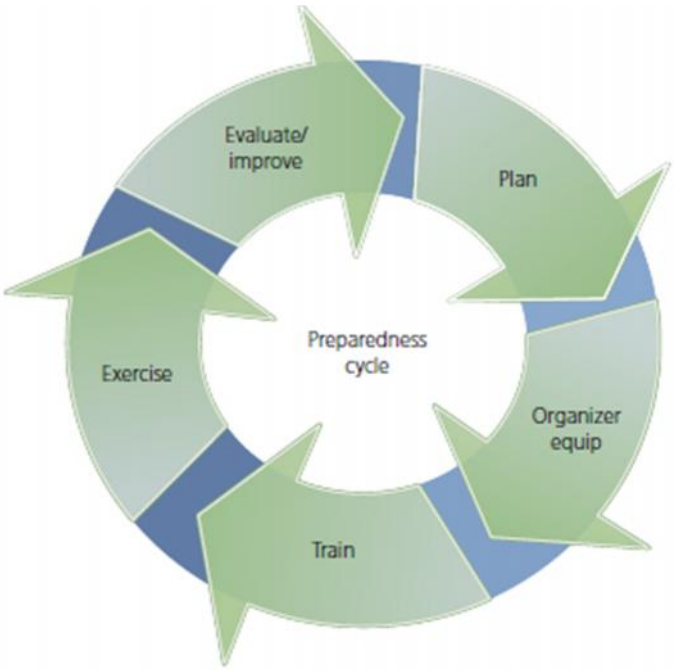


Figure 28.1 The preparedness cycle – actions taken to build preparedness for catastrophic events. Source: http://www.fema.gov/national-preparedness-cycle

- Delineation of egress/ingress routes for both medical casualties and equipment resupply encouraged.

- National Disaster Medical System
    - federal system coordinated by the Department of Health and Human Services (DHHS), in partnership with the Department of Homeland Security, the Department of Defense, and the Department of Veterans Affairs to provide disaster medical care
    - deployable response teams, patient movement, and definitive medical care.

- DHHS provides funding for training, exercising, and equipping all deployable teams. It coordinates the activities of NDMS with other public health and medical response activities (ESF 8)
    - ESF 8 is where EMS and public health falls (and DMATs). Emergency Support Function. Subsection of NIMS

- The Department of Homeland Security, through FEMA, develops NDMS mission assignments in the context of the NRF, and funds NDMS operations under the Stafford Act.

- The Department of Defense (DoD) is responsible for patient movement using the US Transportation Command (USTRANSCOM).

- NDMS Team members are volunteers and maintain their readiness, education, and training without pay. They are required to maintain the certifications and licensure appropriate for their discipline. Personnel can be activated as intermittent federal employees, which affords them pay, workmen's compensation coverage, and protection under the Federal Tort Claims Act in which any civil complaints are defended by the federal government. Certifications and licensure are recognized in all states when members are federalized.

- National Disaster Medical System response team assets include the following.
    - Disaster medical assistance teams (DMAT).
    - DMATs are composed of professional and paraprofessional staff organized and resourced to provide medical triage, treatment, and preparation for transport when needed.
    - Teams are composed of 35–50 personnel, including physicians, nurses, mid level practitioners, paramedics, behavioral health specialists, logistical support personnel, and others.
    - Teams are designed to be self-sufficient for 72 hours, with personnel typically deploying for 14 days.

- National medical response teams (NMRT). NMRTs are trained and equipped to respond to *weapons of mass destruction* incidents. They are designed to provide patient decontamination and specialized treatment and care for survivors of *CBRNE events*.

- International medical/surgical response teams (IMSURT). IMSURTs deploy at the request of the Department of State to treat survivors of disasters outside the borders of the continental United States.

- Disaster mortuary response teams (DMORT). DMORTs are composed of individuals from a variety of disciplines who are deployed to provide technical assistance and personnel to identify and process deceased victims, under the guidance of local authorities.

    - Disciplines represented include funeral directors, medical examiners, pathologists, fingerprint specialists, forensic odontologists, mental health specialists, and others.
    - The federal government also maintains three deployable disaster portable morgue units (DPMUs)

- National veterinary response teams (NVRT) also exist to take care of the little critters

29 The federal medical response to disasters, 278

- Resources may not arrive in time to be useful

- Disaster declaration may only be made by governor or designee, e.g. state public health director.
    - Then president tells FEMA yes please help.
    - decides which ESFs are activated. (8 is HHS, medical stuff).
    - FEMA can also activate annexes, e.g. tribal relations if casino burned down

- Surgeon general via public health service has deployable resources eg
    - RIST - regional incident support team
    - NIST - national incident support team
    - RDF - rapid deployment force
    - EMG - emergency management group
    - IRCT - incident response coordination teams

- Local jurisdiction responsible for organizing and managing the emergency response

- **Stafford Act**: provides funding and resource allocation mechanism through FEMA

- **NRF** - National Response Framework
    - Core document (who, what, how),
    - 3 sets of annexes (Emergency Support Function, Support, Incident)
    - guides the nation's all-hazard response

- Emergency Support and Function **ESF 8**: Public Health and Medical Services, HHS coordinates
    - ESF-8 purpose is to coordinate federal assistance for state, tribal, and local jurisdictions with respect to public health and medical aspects of a disaster.
    - Mental health, behavioral health, substance abuse, veterinary and animal health, as well as fatality management are among the considerations included in ESF-8.
    - National Disaster Medical System/DMATs are part of ESF 8

- **Emergency Management Assistance Contracts**: if a state's resources are overwhelmed, governor declares state of emergency detailing needs through EMACs, temporary licensure recognition in other states

- **Economy Act**: authorizes one federal agency to request support of another

- **Posse Comitatus Act**: prohibits military from being directly involved in domestic law enforcement, does not apply to National Guard or Coast Guard

- **HSPD -5**: Homeland Security Presidential Directive federal govt will assist state and local authorities when their resources are overwhelmed or federal interests involved, work together using NIMS

- **HSPD 8**: established policies to strengthen all-hazards preparedness capabilities of US

- **Emergency Management Assistance Compact**
  - Created in response to Hurricane Hugo
  - Covers all US states, territories, possessions, and the District of Columbia
  - If a state's resources are overwhelmed, that state's governor will issue a declaration of emergency specifically detailing the circumstances and remedies requested from other states through the EMAC.
  - Temporary recognition of licenses, certifications, and other permits from the sending state by the receiving state.

- **Stafford Disaster Relief and Emergency Assistance Act (Stafford Act)**
  - Establishes ability of the federal government to provide an orderly and continuing means of supplemental assistance to state and local governments to alleviate the suffering and damage that result from major disasters or emergencies.
  - Primary legal authority for federal participation in domestic disaster relief operations.
  - President may direct federal agencies, including most cabinet-level departments, to support disaster relief operations.
  - Federal government may be directed to provide assistance in one of three different scenarios:
    - Presidential declaration of a major disaster
    - Presidential order to perform emergency work for the preservation of life and property
    - Presidential declaration of emergency
- **Pandemic and All-Hazards Preparedness**
  - Creation of a National Health Security Strategy and the development and acquisition of medical countermeasures.
  - Re-authorizing statute, the Pandemic and All-Hazards Preparedness Reauthorization Act (PAHPRA), continued and expanded the ASPR's role in administering the Hospital Preparedness Program and addressing/enhancing medical surge capacity, and authorized funding for Project BioShield and other critical public health and medical activities
  - Authorizes the Secretary of Health and Human Services to temporarily waive or modify certain provisions of those programs during a presidentially declared disaster or national emergency.

- **Homeland Security act of 2002**
  - Established the Department of Homeland Security and gave it the authority and responsibility to coordinate all federal homeland security activities.
  - Multiple agencies merged into this single department. FEMA had been primarily responsible for coordinating the federal response to major incidents, and was one of the entities integrated into the DHS.

- **National Guard**
    - National Guard forces are allowed to perform civil support operations that are funded by the federal government, while remaining under the control of their governor. Examples include weapons of mass destruction civil support teams (WMD-CST) and Presidential/Secretary of Defense approved operations (e.g. the Border Security Mission in the Southwest).

- **Homeland Security Presidential Directive 5 (hSpD-5): Management of Domestic Incidents**
    - Assigns Secretary of the DHS as the principal federal official for domestic incident management in response to and/or recovery from terrorist attacks, major disasters, or other emergencies.
    - Federal government will assist state and local authorities when their resources are overwhelmed or when federal interests are involved.
    - Established NIMS and the NRF.

- **Presidential Policy Directive 8 (ppD-8): National preparedness**
    - Recognizes the shared responsibility of the government (local, state, and federal) as well as the business community and individual citizens in fostering a secure and resilient nation.

- **Homeland Security Presidential Directive 21 (hSpD-21)**
    - Addresses preparedness for natural and man-made catastrophic health events that overwhelm the capabilities of immediate local and regional response and health care systems. Eg., pandemic influenza, NBC attack.

30 Special considerations in disaster zones

- Altered standard of care: It is ethical for a physician not to persist, at all costs, in treating individuals “beyond emergency care,” thereby wasting scarce resources needed elsewhere.

- The decision not to treat an injured person on account of priorities dictated by the disaster situation cannot be considered a failure to come to the assistance of a person in mortal danger. It is justified when it is intended to save the maximum number of individuals.

- Examples of potential disaster response strategies which would require providers to operate beyond their typical scopes of practice include:
    - allowing community pharmacists to give vaccinations against a pandemic influenza strain
    - permitting surgical residents or physician assistants to perform procedures independently at a field triage station
    - allowing paramedics to administer medications in a hospital-based emergency department
    - asking a nurse to temporarily return to clinical practice after ten years of retirement.

31 Prehospital triage for mass casualties, 288

- Mass casualty triage occurs when there is more than one casualty, and provider must decide where to place available resources. Concepts adapted to civilian use from military organizations.

- Nearly linear relationship between over-triage and poor patient outcome.

- Decisions regarding selection of triage system, typically decided at the local level, leading to concerns about interoperability. This spurred the creation of the Model Uniform Core Criteria (MUCC); minimum standards that triage systems should incorporate to ensure interoperability. In July 2013 this was established as a national guideline by the Federal Interagency Committee on EMS.

- Most triage systems utilize the following 5 categories: immediate (red), delayed (yellow), minimal (green), dead (black) or expectant (no color given).

- SALT (Sort, Assess, Lifesaving interventions, Treatment and/or transport) endorsed by ACEP, and currently the only triage system known to be compliant with MUCC. initial life-saving rapid interventions include hemorrhage control, airway opening, needle chest decompression and auto-injector antidotes (only if within provider's scope of practice).

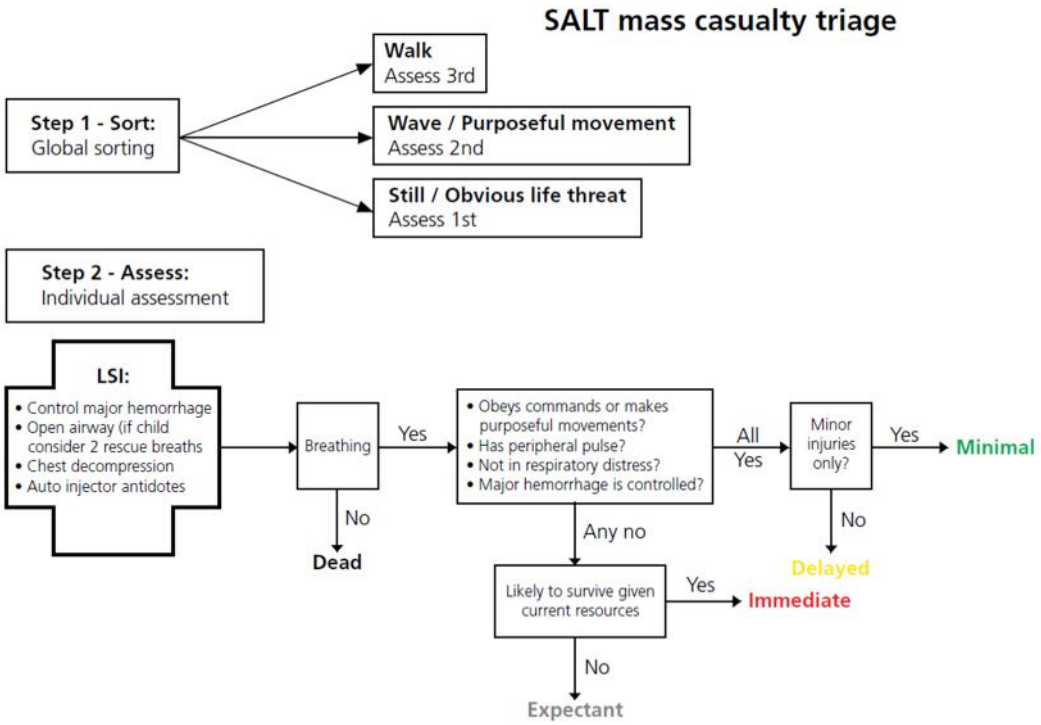


Figure 31.1 SALT triage scheme. LSI, life-saving interventions.

- START triage is currently the most widely used in the United States:

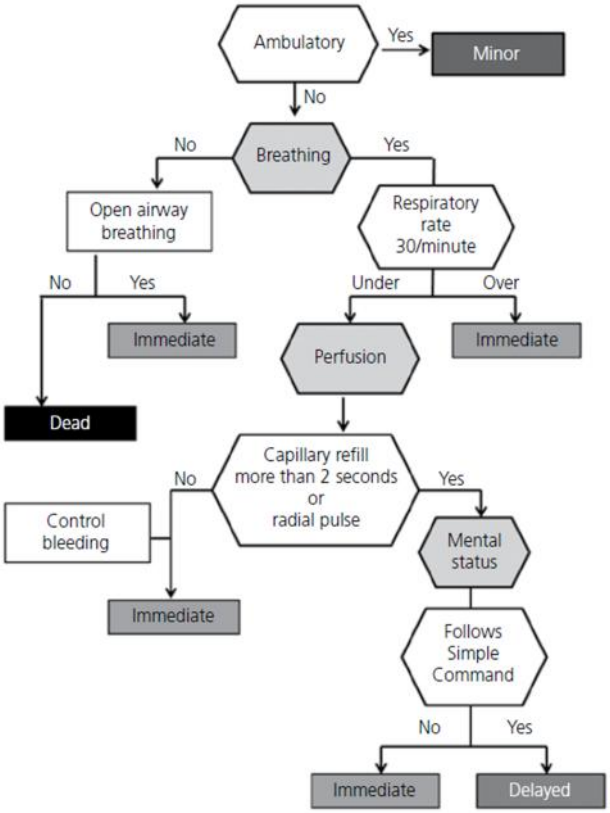


Figure 31.2 START triage algorithm.

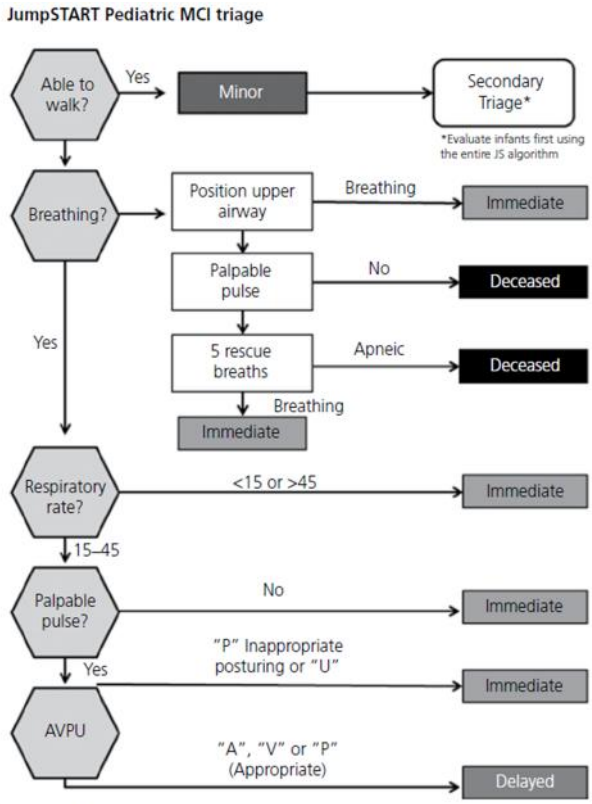


Figure 31.3 JumpSTART pediatric triage algorithm. AVPU scale: alert, voice, pain, unresponsive (used by EMS responder to determine patient's level of consciousness).

- Whichever system you use, needs to be able to change bidirectionally e.g. yellow to red by folding is better than previous stickers that replaced and covered up previous triage category.

- Casualties should be re triaged at each phase and level of care. Reprioritization is dynamic and may change based on available resources, patient conditions or scene safety issues.

32 Mass casualty management, 292

- After 9/11, excessive money has been spent on stockpiles - durable medical equipment, medications, specialized vehicles, and communications systems. Recent studies have lead to questions about the cost-effectiveness of this approach.

- Money may be better spent to enhance a system's "All Hazards" capacity. This includes spending on infrastructure, personnel, protocols, and processes.

- Command - used to organize individual assets and personnel

- The **National Incident Management System (NIMS)** provides consistent approach for all levels of government and the private sector to work together to prepare for, respond to, and recover from domestic incidents.

- **HSPD-5** identifies core concepts of NIMS:
    - The incident command system
    - Multiagency coordination systems
    - Unified command
    - Training
    - Identification, and management of resources (including systems for classifying types of resources)
    - Qualifications and certifications
    - The collection, tracking, and reporting of incident information and incident resources

- Medical director is usually in advisory or consulting role to incident commander during a disaster. The medical director is not the primary medical provider, nor do they assume on-scene command. Their role also includes the responsibility for the agency's mitigation and preparedness strategy.
    - Identify key resources, personnel and agencies, and develop collaborative relationships
    - Develop policies and protocols that address daily operations as well as surge-level operations (training and evaluation should be reflected in this).
    - Implementing a data and communication infrastructure that addresses daily prehospital needs and is scalable during MCI.

- Mitigation activities - reduce potential for a disaster to occur or reducing potential impact.

- Preparedness - activities that enhance an organization's capabilities to respond to and recover from disaster.

- Common points of failure tend to be fundamental aspects of disaster planning:
    - Communications systems
    - Resource distribution

    - Organizational structure

Policy, protocol and training development for MCI

- Well designed MCI protocol should reinforce responder's ability to recognize and escalate an MCI, establish roles in command structure and appropriate allocate transportation resources (often resources get consumed by low acuity patients leading to delay in transporting sickest).
    - Quantify and define an MCI - even a small MCI can overwhelm an ED
    - Dispatch of appropriate transport, communication, supplies
    - Emphasis on role of triage and transportation officers
    - Triage systems
    - On-scene transport decision tools - including even distribution of patients (leapfrogging). We anticipate that better distribution of patients will have a positive effect on patient morbidity and mortality. No data to support this.
    - Patient tracking
    - Continuity of everyday 911
    - Mutual aid and interagency response
- Medical directors should account for rare but extremely disruptive events (extreme weather, biologic attack).
- Medical director must provide training and drills
- Evidence based improvement requires periodic formal evaluation. Trend toward greater robustness through large scale drilling.

Intelligence and Communication Infrastructure

- MCI plan should account for failure of cellular systems, wireless electronic medical records systems and patient tracking systems
    - Prepare for 800mHz and VHF radios
    - Paper and pencil backups as necessary
- Interoperability may be a major issue - leading to a weak point in communication during MCI
- Medical director role in MCI communication is mainly in mitigation :
    - The medical director, as a liaison to other agencies, state agencies, health care leaders, and EDs, can use role as patient advocate to help unify technology and policy.
    - Should facilitate ability to collaborate and communicate
    - Consultant to translate issues of staffing, diversion, surge capacity, etc.

Incident Command Structure

- Triage: quickly and consistently assess and catalogue patients. The simplicity of all the systems e.g. SALT, START allows them to be taught to every level of prehospital provider.
    - Establish staging areas
    - Establish patient collection points

    - Establish temporary treatment areas
- Treatment : on-scene care is necessary for both critical and noncritical patients awaiting transport.
    - Non-transporting ALS resources should be directed to treatment areas, freeing up ALS resources for critical transports.
    - Medical director should be used for advanced procedures and guidance for treatment questions
- Transport:
    - Transport officer, should attempt to distribute patients to multiple locations when possible.
    - Noncritical patients should be directed to alternative sites (level II or III Trauma centers).
    - Communication strategy should allow for continuous feedback from hospitals to EMS.

Resource Escalation

- Request for additional resources should be escalated up through ICS structure. It is most effective to bolster everyday activities and form collaborative partnerships. Mutual aid may be called on to provide on-scene assistance or help with providing community EMS resources.
- Recovery
    - Includes disaster aftermath up to return to normal operations.
- Patient tracking and reunification:
    - Tracking is in **purview** of the medical director and robust tracking mechanisms should be in MCI plan
    - Account for failures and build in redundancies
    - Medical director should work with local and national **organizations.**

- Mental Health - Medical directors should be highly sensitive to the mental health needs of first responders. Should consider transitioning involved providers to employee assistance or crisis intervention resources.

- After-action Review - critical component of MCI recovery
    - Sooner is better, events are fresh
    - Begins with fact finding and information gathering
        - 911 and radio communication
        - Initial ICS structure and any changes
        - Patient contacts and times, and transport and distribution
        - Apparatus response
        - Adequacy of supplies
        - Hospital communications

- Healthcare coalitions - create roundtable for health care partners to share and collaborate. Large metropolitan areas are increasingly using coalitions as a critical piece of MCI infrastructure.

- Social Media - EMS and healthcare agencies should have media presence for information distribution (likely through PIO)

- Vulnerable populations - MCI planning must account for vulnerable subgroups.

- 2007 study - 0nly 13% had pediatric plans
- Also have to consider dialysis patients, elderly, and patients with access or functional needs.

33 Mass casualty evacuation and patient movement, 303

Three overlapping phases in a cycle of planning for mass patient movement:

- Development of an estimate
    - Physical characteristics - weather, terrain, etc
    - Transportation nodes, demands and networks
    - Casualties
    - Resources required to move patients and the resources available
- Generation of a plan from that estimate
- Execution of the plan

Disaster medical evacuation variables:

- Compromised medical facilities
- incident-related injuries or illnesses
- Preexisting conditions, including those residing in medical facilities
- Exacerbated problems from disruption of care
- Impact on vulnerable populations

Casualty collection points

- may be established at sites a safe distance from the immediate threat, with access to transportation networks.
- Ambulances are collocated here or staged nearby.

Ambulance Exchange Points (AXP) - casualties transferred from one mode of transportation to another. AXPs should have easy access to highway or road network, loading areas, medical support, communications, security, and landing zones.

- Situation dictates type of transportation asset has to change (ie. boats during Katrina)
- Time and distance factors may determine the best way to maximize lift capacity is to set up an AXP
- Federal coordinating centers used to transfer patients from evacuation flights to local hospitals are AXPs
- AXP may serve as a hub, maximizing evacuation capacity by receiving from multiple casualty collection points for longer distance transport.

If demand for evacuation resources exceeds available resource - request for assistance passed to the state, who may:

- coordinate deployment from intrastate areas that are not threatened
- execute contingency contracts with EMS providers
- Activate National Guard
- Request assistance from other states using the Emergency Management Assistance Compact (EMAC).

State governor can declare a disaster and request a declaration from the President

- The Robert T. Stafford Disaster Relief and Assistance Act gives president ability to declare a national

disaster and authorize use of federal resources.

- Federal assistance for medical evacuation falls under ESF-8 of the National Response Framework.

Using NDMS, patients are distributed to NDMS-member hospitals throughout the US

NDMS

- partnership between Departments of
    - Health and Human Services (HHS)
    - Defense (DOD)
        - Patient movement and evacuation
    - Homeland Security (DHS)
    - Veterans Affairs (VA)
- Managed by HHS. Activated by the HHS Secretary in response to a public health emergency.
- Began in 1980s as mechanism to bring back mass casualties from a large scale conflict and as a way to respond to a large civilian disaster
- VA and DOD regulate patient flow through over 60 Federal Coordinating Centers (FCCs) across the country.
- Network of over 1900 civilian hospitals nationwide voluntarily --reimbursed at 110% Medicare rate for each NDMS patient
- Global Patient Movement Requirement Center (GPMRC):
    - responsible for regulating patients from hospital to NDMS member hospital.
    - Patient Movement Request (PMR) is generated at the hospital and forwarded to state or local EOC who forwards request to GPMRC.
    - GPMRC coordinates with airport of embarkation, FCC, Mobile Aeromedical Staging Facility (MASF) to ensure patient is accounted for from one hospital to another.

34 Temporary treatment facilities, 313

Historically military field hospitals were established to care for wounded during battle

- Baron Dominique Larrey (Surgeon in Chief) in Napoleon's army considered father of modern military medicine and EMS)
- Can range from collection points to fully capable EDs to full field hospitals such as the 300 bed National Mobile Disaster Hospital developed by FEMA

- The type and design varies depending on the need: commonly at events to *treat and release minor issues (decreasing demand on EMS)*, also first responder rehab (rest/rehydration up to full-scale clinics at prolonged events like forest fires)

Planned events

- Type of event, expected attendees, and environmental conditions play a factor in needs, but major considerations include:
    - Minimal support requirements (power, water, lighting, and adequate space)
    - Expected demographics
    - Distance from and capabilities of nearby medical facilities
    - Alcohol or other intoxicants
    - Security concerns (ie. political events)
    - Multijurisdictional coordination

Surge capacity: The ability to manage a sudden, unexpected increase in patient volume that would otherwise overwhelm current capacity.

- Temporary facilities may be used to support hospitals and EMS systems in a disaster. This concept came to the forefront during the 2009 flu pandemic
    - Commonly called "alternative care facility" (ACF) or "alternative care site"
        - Goal of keeping less ill patients from the hospital, reserving scarce resources for where they will do the most good.
        - Colocation next to hospital is debatable and may be easier to manage logistically but does increase risk of overwhelming the ED and main facility.
    - Temporary facilities do take some time to set up, so some advanced warning is helpful (planned event, approaching hurricane, pandemic, etc), whereas they're not quite as efficient for no-warning events
        - Best created and deployed at community or coalition level (or higher) since a single facility/organization may have trouble providing adequate staff or supplies
        - Often needed long past the acute phase of disaster, especially if infrastructure is damaged.
        - Credentialing of providers should ideally take place prior to the event.
            - Medical Reserve Corps: www.medicalreservecorps.com
            - Emergency System for Advanced Registration of Volunteer Health Professionals

(ESAR-VHP): www.phe.gov/esarvhp

Basic functions and operations of temporary facilities

- Should be a coalition level project
- SOP should have defined trigger point for activation by EMS or other components of medical system to activate a temporary medical system. Also, trigger for when to demobilize.
- Must have understanding of incident management system model for interoperability
- Ingress and egress of patients, staff, and transport units
- Identification of facility location and hours of operation
- System to track patients, and system for maintaining medical records
- Communications (redundancy important in case of disaster or MCI)
    - Way for PIO to contact public regarding location and hours of facility
- Staffing - advanced training as well as just in time training
    - Scope of practice does not change during a disaster
- Fixed structures vs deployable or field temporary
    - Fixed structures require check of structural integrity and restoration of utilities
    - Temporary include: pop-up, inflatable, shipping containers
    - Predesignated location - may be subject to rules and regulation, such as the Joint Commission and Americans with Disabilities Act
    - Should expect to have to follow all the usual rules and regulations of any other facility. Some high-level officials can suspend certain regulations in a disaster, but it is not a guarantee, and should not be expected
- Some federal DMAT teams have pre-developed and cached shelter facilities available
    - DMATs designed to function self-sufficiently for 72 hours
- Perishable supplies may be able to be exchanged with supporting hospitals/agencies, and stored in a manner to protect shelf life
- Trying to get people to bring own medical support devices and caretaker to help

Section V: Special Hazards

35 Medical support for hazardous materials response, 323

- 75% Hazmat events are at **fixed** chemical facilities. The few that are transportation-related are generally ground transport-related.

- Approximately 2000 patients per year, usually with respiratory or eye exposure.

- Levels of PPE:
    - A Vapor/Aerosol Protection. Includes SCBA → only level that includes vapor protection
    - B Gas, some vapor/aerosol (with SCBA external)
    - C Liquid (with APRs) e.g. what we have in ED decon room. Still has respiratory protection. Cartridge must match type of chemical/category. Cartridges that cover more chemicals last less time.
    - D Usual Work Attire (provides heat protection in the case of firefighters but not chemical). Includes MRSA/trauma gowns
    - Note: You don't need to wear any PPE while setting up decon because by definition you are in uncontaminated warm zone

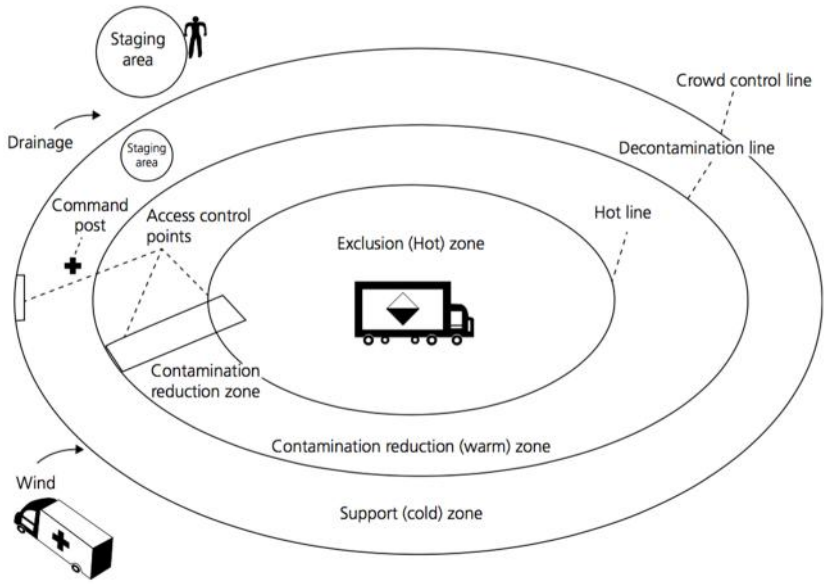


Figure 35.4 NIOSH/OSHA Decon set up illustration

- **AB**sorption = using pads or absorbent towels to wipe the chemical off an area

- **AD**sorption = the use of activated charcoal or other adsorbents to minimize the effects of chemicals
    - Adsorption is a process where the product is chemically adhered to the adsorbent material. This is not to be confused with absorption in which the product is simply “soaked up.”

- LEPC = local emergency planning committee: every town should have one to track what chemicals are where in the town

- MSDS: material safety data sheets

- Title 49 of the Federal Code of Regulations: requires hazmat placards, but they may not be readily visible to first responders

36 Chemical properties of hazardous materials, 334

Types of contamination

- **Primary (source**) contamination vs **secondary (patient contact)** contamination
- **Overt exposure** - obviously contaminated or exposure is known
- **Covert exposure** - not obvious or no immediate knowledge of contamination

Categories (CBRNE)

- **Chemical** (**C**BRNE) - Usually overt; patients usually need formal decontamination.
- **Biological** (C**B**RNE) **-** Biological agents including bacteria, viruses, and biological toxins.
    - Almost always covert. (Exception: anthrax scare events that occurred in the wake of the 2001 anthrax attack)
    - Consider prophylactic treatment of the biological exposure for responders
- **Radiation/nuclea**r (CB**RN**E) - Ionizing radiation is an energized particle (alpha particle, beta particle) or wave (x-ray, gamma ray) released from a nuclear or radioactive material, capable of breaking covalent bonds.
    - Ionizing radiation can cause illness when the covalent bonds of e.g. DNA are damaged.
    - Exposure to radiation alone *does not result in contamination* but can cause significant tissue damage → decon and PPE not necessary
- **Nuclear events** - can result in the release of radiation as well as the release of radioactive and nuclear particles with the potential to cause contamination and radiation-related injury. Contamination with radioactive material does not represent an acute medical emergency - onset to symptoms is delayed. So, remove the nuclear material ASAP, but stabilizing medical care should not be delayed for complete decontamination.
- **Enhanced conventional weapons** (CBRN**E**) - thermobaric weapon such as fuel-air bomb. Produces significantly greater blast. Consider blast injuries etc.

Categories of hazardous materials - Note that solids are least likely to cause widespread contamination and require less complicated decontamination procedures and a lower level of PPE, while vapors and gases will have the greatest potential to cause morbidity and require higher levels of PPE.

- **Solids** occupy a fixed volume and shape. Large solids are less likely to cause contamination as they are easy to detect and more difficult to move. However, small solids such as dust particles may be easily transferred from a single source to another object or individual and result in both primary and secondary contamination in an overt or covert manner. Usually **Level D PPE** with a simple particulate face mask is sufficient to protect responders from secondary contamination. Decontamination requires only removal of the solid. Washing with soap and water may be required to remove very small particles of a solid contaminant (exception: solid aerosols e.g. anthrax).
    - **Melting point** =temp at which the solid becomes a liquid. Most important physical property of solid
- **Liquids** occupy a fixed volume but not a fixed shape. Usually **Level C PPE** is sufficient. Liquid hazardous materials can be absorbed through skin or mucous membrane → decon is critical (exception liquid

aerosols).

- **Boiling point** = temp at which liquid becomes gas. Most important physical property of a liquid.

- **Gases** do not occupy a fixed volume or a fixed shape. Unless absorbed by a liquid or porous clothing, secondary contamination is rare. Usually **Level A or B PPE** is required to protect responders.
    - **Density** relative to ambient air is most important physical property of gas as it determines tendency to either disperse or settle in low-lying areas.

- **Aerosols** are very small solid or liquid particles which, when released into the air, remain suspended for a period of time, and thus behave like a gas. Responders should assume that **Level A PPE** is required to protect them from exposure. If the solid or liquid is not absorbed through the skin, Level B or C PPE with a "clean" air supply may be sufficient. Decontamination of aerosolized liquids or solids will likely require removal of the victim from the source and full decontamination using soap and water, etc
    - **Mass** determines amount of time these particles remain in the air.
    - **Solubility:** the ability of that substance (the solute) to dissolve in another (the solvent).
        - Determined by the relative polarity of the solute to the polarity of the solvent → *"Like dissolves like."*
        - Skin is made of cell walls with a lipid bilayer, so water-soluble molecules are less likely and lipid-soluble molecules are more likely to be absorbed through the skin.
        - Mucous membranes are opposite (water soluble will be more easily absorbed)
    - **Water solubility**: Because water is the most common solvent used in the decontamination process, this is very important. Water is a polar molecule, so will dissolve any other polar molecule or water-soluble molecule. Non-polar molecules will require an emulsificant (e.g. soap) to make micelles.

37 Radiation and radiation injury, 339

• **Irradiation**: radiation enters and passes through the body as a field

• **Contamination**: radioactive materials collect on the outside of the body

• **Internal exposure**: radioactive materials enter the body

Alpha and beta rays have low penetration ability; gamma and neutrons have higher penetration.

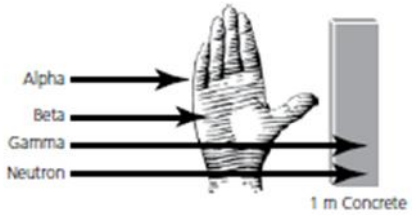


Figure 37.1 Relative penetration in human tissue of ionizing radiation.

Radiation safety officers are good sources of information for EMS/disaster planners.

Exposures:

- **Radiation received by any object decreases as the square of the distance from the source**
- Defenses include decreasing exposure time, increasing distance, and employing shielding.
- 5 mSV or 5 rem (Roentgen Equivalent in Man) is the accepted baseline of exposure with acceptable risk.

Prognostication:

- **Absolute lymphocyte count** (less than 500 in under 24 hours) and the rapid development of nausea/vomiting are associated with the LD50 of radiation exposure (in the 200-300 REM range).
    - Rapid development of symptoms, and presence of CNS symptoms are associated with lethality
- Bone marrow suppression is maximal at about 30 days post exposure.

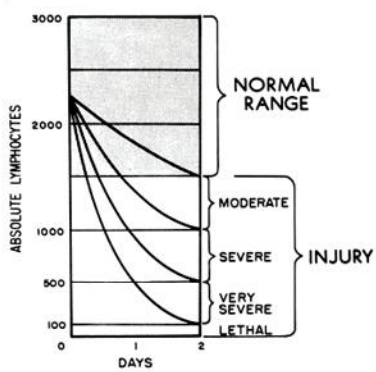


Table 37.2 Signs and symptoms of radiation exposure

	Whole-body radiation from external exposure or internal absorption					
	Subclinical Range		Clinical, sublethal Range		Lethal Range	
	0–100 rad	100–200 rad	200–600 rad	600–800 rad	600–3,000 rad	>3,000 rad
Nausea, vomiting	None	5–50%	50–100%	75–100%	90–100%	100%
Time of onset		3–6 hours	2–4 hours	1–2 hours	<1 hours	Minutes
Duration		<24 hours	<24 hours	<48 hours	<48 hours	Not available
Lymphocyte count	Unaffected	Minimally decreased	<1,000 at 24 hours	<500 at 24 hours	Decreases within hours	Decreases within hours
Central nervous system function	No impairment	No impairment	Routine task performance cognitive impairment for 6–20 hours	Simple and routine task performance cognitive impairment for >24 hours	Rapid incapacitation may have a lucid interval of several hours	

Source: summarized from Department of Veteran Affairs Pocket Guide, Terrorism with Ionizing Radiation General Guidance. Bethesda, MD: Armed Forces Radiobiology Research Institute, 2003.

Nuclear detonations:

- In nuclear detonations, most energy is dispersed in light, thermal and mechanical energy with 5% left for immediate ionizing radiation and 10% in fallout
- The light is long-range flash that can permanently blind people who inadvertently look at the flash or at a reflection
    - The blink reflex takes approximately 200 milliseconds
- The thermal pulse generated by the detonation fireball (infrared) comprises 35% of the energy from detonation
    - Any surface exposed to a near-field thermal pulse will experience heat at a rate of 10 calories/cm2, which can cause spontaneous combustion
- Immediate fallout in the 24 to 48 hour range is highly radioactive and best protected against by sheltering in place.
- **REACTS team** should be consulted for responses
- Contaminated patients are NOT a threat to providers as long as material outside of the body is cleaned off
- **Decontamination NEVER takes priority over treatment**
- **Special skills are NOT needed to treat radiation casualties.**
- Greatest hazard is likely an overwhelming number of worried well. Have them put clothes in bag, take shower, and bring bag to predetermined location

Final pearls:

1. **Prevent ingestion of radioisotopes at all costs, even at the cost of communication.**
2. **Focus on time, distance, and shielding when responding to any radiological incident.**
3. **Remember that time of exposure is linearly cumulative, but exposure is reduced by the square of the distance.**
4. **Simple decontamination means mechanical removal of materials, and most comes off the patient or the worker with removal of clothing.**

38 Weapons of mass destruction, 349

Bombings not all that rare (1,600 to 2,400 per year in US) and injuries are primarily caused by the blast:

Table 32.1 Categories of explosive injuries

Category	Mechanism	Injury type
Primary	A form of barotrauma, unique to explosions, which causes damage to air-filled organs	• Blast lung • Tympanic membrane rupture and middle ear damage • Abdominal hemorrhage and perforation • Globe (eye) rupture • Concussion
Secondary	Trauma caused by the acceleration of shrapnel and other debris by the blast	• Penetrating ballistic (fragmentation) • Blunt injuries (rapid deceleration) • Eye penetration
Tertiary	Casualty becomes a missile and is propelled through the air, with typical patterns of blunt trauma	• Fracture and traumatic amputation • Blunt chest and abdominal trauma • Impalement • Closed and open brain injury
Quaternary	All other explosion-related injuries, illnesses, or diseases which are not due to primary, secondary, or tertiary mechanisms	• Burns (flash, partial, and full thickness) • Crush injuries • Exacerbation of underlying conditions (asthma, angina, etc.) • Inhalation injury
Quinary	The intentional addition of agents that may result in injury	• Radiation • Chemical • Biological (including suicide bombers with hepatitis or HIV)

Contamination is also a consideration (e.g. biological if a suicide bomber, radiological (or “dirty bomb”) more of a logistics issue than a direct threat from radiation (due to public concern, decontamination of large numbers of people/property, etc.))

Explosions are mechanical (e.g. steam under pressure), chemical (two solids combining to form a gas with a larger volume than the solids, resulting in light, sound and pressure) or nuclear (atoms being split or fused together).

The **detonation velocity** is the speed with which the chemical explosive reaction takes place: if very slow this is combustion, if instantaneous it is a detonation.

Three effects of an explosion:

- **Thermal** (seen as a fireball) releasing heat, the least damaging of these components,
- **Pressure** (1st component: positive pressure wave with a visible shock front preceding it, dissipates rapidly with distance, 2nd component: negative pressure wave, as air moves in to fill the vacuum caused by the positive pressure wave--slower than 1st component but powerful; “punch and pull” effect),
- **Fragmentation:** pieces of the device or debris that are pushed by the shock waves and cause injury when striking the body.

Explosive classification based on detonation velocity: less than 1.005 meters per second are classified as **“low explosives”**; these are usually propellants that if not enclosed would burn not explode (e.g. pipe bombs)

“High explosives” have a faster detonation velocity and are classified according to the degree of sensitivity”, or the “insult” needed to make them detonate:

- Primary high explosives are very sensitive and are used for materials like blasting caps
- Secondary high explosives need more insult to detonate and are often “boosted” by a small amount of more sensitive explosives. Oklahoma City: blasting cap (primary) plus small amount of TNT (booster) inside of an ANFO--ammonium, nitrate, fuel oil--explosive (secondary).

Improvised Explosive Devices (an explosive device that has not been manufactured): need an initiator and an explosive; EOD technician needs to know how the device functions in order to disarm it.

- **Victim-activated devices** (e.g. car bomb with pressure sensor in seat) used to target specific individuals
- **Time-activated devices** (e.g. train bombs) that target classes of individuals, e.g. commuters
- **Command-activated devices** that require the bomber to be surveilling the device.

Secondary devices: target responders to the primary device and must be considered in any response

Bomb suits are protective but restrict movement and increase the likelihood of heat stress. The most important factors for the medical response are preparing the technician for response periods in the suit, monitoring him/her during their time in the response, and knowing how to rapidly remove the suit to provide medical care.

Common blast injuries if the device detonates are tympanic membrane rupture, amputation, pneumothorax, air embolism, GI tract and hand injury.

Robots are being used more and more in this work; they often contain portable X-ray machines.
Safe distances are 10’ behind, 36’ on the sides and 100’ in front.

Section VI: Special Environments

39 Tactical EMS, 355

- NAEMSP endorsed integrating EMS capability into tactical EMS teams in 2001.
- In 1995, the most common form of support for tactical teams was a civilian ambulance on standby, 94% of whose personnel had no tactical training and 78% had no medical direction.
- Without proper training and equipment to handle these dangers, traditional EMS providers may become patients rather than caregivers. They may also compromise other aspects of the mission (e.g. Waco example of operational security compromised by pre-alerting an EMS service resulting in subsequent loss of surprise factor and death of 4 law enforcement officers.)
- **Zones of treatment:**
    - **Hot zone** - hostile environment. **Patient extrication, opening of airway, and control of life-threatening hemorrhage** = only acceptable treatments. Same as **"Care Under Fire**" in TCCC
    - **Warm zone** - area of potential or indirect threat. Medical care here is risk/benefit ratio. Corresponds to "**Tactical Field Care"** in TCCC
    - **Cold zone** - standard EMS care. Learning weapons safety important for TEMS personnel in order to render a weapon safe if necessary when removed from a patient's possession. Corresponds to **"Tactical evacuation care (TACEVAC)"** in TCCC

- **Less Lethal Weapons (LLWs)**
    - **Oleoresin capsicum (OC) or pepper spray and Ortho-chlorobenzylidene malononitrile (CS) or tear gas** are two primary examples: produces ocular pain, lacrimation, blepharism, as well as possible rhinorrhea and dyspnea. Focus on decontamination, removal of contaminated clothing, irrigation, and for CS,moving air.
    - **Kinetic impact projectiles -** rubber bullets, etc. Treat as typical trauma
    - **Noise/flash diversionary devices** (NFDDs) - flash bangs etc. Can produce blast trauma, tympanic membrane rupture, burns. Can also start fires.
    - **Conduction energy weapons (CEWs)** - stun guns etc. TASERs (common brand) deliver 0.36J of energy at 50K volts over 5 seconds. Injury risks for these weapons include puncture wounds and blunt trauma from falls. Study found 99.7% with mild injuries or none at all.

- **Other considerations**
    - Exposure to hazardous materials (including booby traps) must be considered in TEMS.
    - Excited delirium patients may be encountered by TEMS personnel = acute onset bizarre behavior accompanied by incoherent shouting, hallucinations, hyperthermia, combativeness, extraordinary strength and paranoid delusions.
    -
    - Medical providers should be stationed close to, but protected from the action and *should not carry a firearm unless* they have the level of training and ongoing proficiency to carry the firearm (difficult to maintain with medical requirements) (e.g. sworn law enforcement status).

TEMS providers can provide preventive and primary care to team members

Box 39.1 Unique TEMS attributes

Zones of care
Weapons safety and less lethal weapons
Hazardous materials
Forensic evidence collection
Preventive medicine
Primary care
Special equipment
Tactical training

Box 39.2 Unique TEMS skills

Commander's medical conscience
Medical threat assessment
Remote assessment methodology
Sensory-deprived/overload patient assessment
Medicine across the barricade
Hasty decontamination procedures

40 EMS on the fireground, 363

Four roles for EMS on firefighting ground:

1. Standby for possible illness or injury of FF. Standby regulated by federal regs: Hazmat, PPE, etc. Minimum of one ambulance deployed. If that one responds to patient, another should replace on stand-by function since there may be immediate danger to life and health (IDLH) so HAZWOPER, 29 CFR 1910.120 regulations apply. Positioning optimal for exit and also not blocking fire apparatus important.
    a. **HAZWOPER, 29 CFR 1910.120 regulations**: transport- capable EMS unit must be on scene
    b. **NFPA 1500** - transport - capable EMS unit must be on scene, ALS providers preferred
2. Treatment and transport of ill/injured FF
3. Management and staffing rehab area
4. Transport and treatment ill/injured civilians

NFPA 1582 requires that fire dept physicians participate in operational safety matters and that they collaborate with EMS medical directors on procedures for medical support of firefighters at fire incidents.

Physiology of Structured Firefighting:

- Strenuous physical work at extreme heat to 700F, 100% relative humidity.
- PPE bulky but necessary pants, coat, hat, gloves, SCBA (self contained breathing apparatus), decreased peripheral vision. PPE rated with THL and TPP
    - THL: total heat loss measures evaporative heat transfer or breathability outlined in NFPA 1971
    - TPP: thermal protective performance measures thermal insulation outlined in NFPA 1971
- **Physiologic changes**
    - HRs elevated starting with time of initial alarm. Does not correlate with energy expenditure or temp rise
    - Live exercises increase CV demand more than mock exercises - Peripheral vasodilation and sweat loss lead to significantly reduced stroke volume within 20 min
    - Disproportionate upper body strength used due to axes
    - Exposure to CO and other toxins during exercise → ST changes on EKG
    - Core temp rises even after FF is no longer being exposed to heat
- Treatment and transport of ill and injured: increased risk of cardiac event, burns, and MSK injuries (most common)

Fire Ground Rehabilitation: Standards are in **NFPA 1584 -** Rehab is medical care for firefighters on scene, not civilian victims

- Establish triage VS for initial and reassessment, include “general appearance”
- Establish protocols to determine which FFs require immediate transport from rehab (e.g. HR > 160).
- Ensure medical providers in rehab have designated authority to detain FF in rehab/transport as seen fit
- Provide advice regarding rehydration
- Provide advice/guidelines re: passive and active cooling

- Figure 12.1 Flow through Rehab Area: Registry/Accountability, SCBA storage and trade out, rest and refreshment, medical eval area, ambulance staging

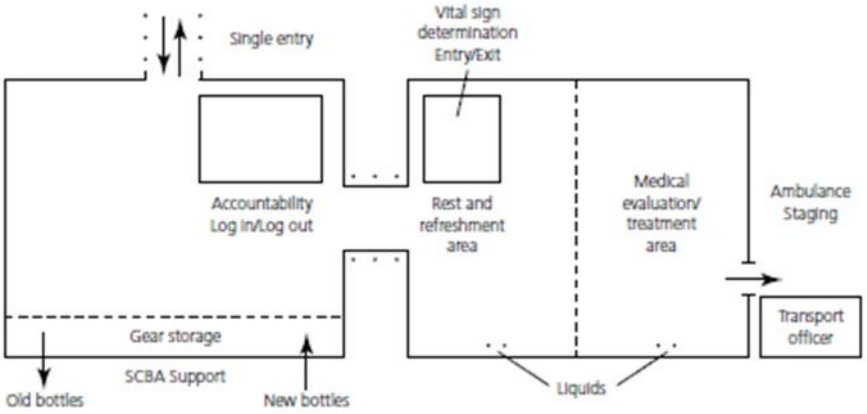


Figure 40.1 The model rehab area. This accommodates the various key functions performed in and around the rehab sector, including accountability, doffing of PPE, replenishment of SCBA cylinders while the firefighters are in rehab, medical triage, rehydration, and medical monitoring.

- During rehab, assess for following: CP, SOB, Palpitations, irreg pulse, AMS, Skin changes, Temp changes, elevated pulse > 150 or BP > 200/130
- Rehydration and nutritional support: **1L loss in initial 20 min**. **2L/ hr loss during intense FF**.
    - Prehydrate
    - 8 oz sports drink first rotation to rehab, then 8 - 32oz over 2 hours post-op
- Considerations for fluids: avoid extremes of temp of liquids. Avoid high osmolality > 350 mOsm/L
- Gastric emptying capacity, paradoxically, decreases as the firefighter becomes more dehydrated and heat stressed → could lead to emesis
- Solid foods often necessary for prolonged support. Have easily digestible foods: 30-60g complex carbs; also consider easy proteins and fats.
- 10 minute minimum rest and rehydration before returning to duty, 20 min if triage vital signs outside accepted parameters. Longer or transport if vitals remain outside >20 min

41 Confined space and limited access situations, 373

Key points:

- Gather patient data as early as possible via family and verbal communication
- Monitor the effects of the rescue efforts on the patient(s). Be aware of things such as dust, CO.
- Secure equipment that is likely to be needed
- Begin physical assessment as soon as any physical contact is possible.
- Initiate stabilization but IV access and supplemental oxygen should only be applied if clinically indicated, due to issues of space, equipment, and line tangles, and time.
- Reevaluate the patient after each significant move, particularly if advanced airway management (e.g. intubation) has been performed.

Confined space - limited or restricted means for entry or exit; not designed for continuous employee occupancy e.g. underground vaults, tanks, storage bins, manholes, pits, silos, process vessels, and pipelines.

OSHA **"permit-required confined space"**: contains or has the potential to contain a hazardous atmosphere; contains a material that has the potential to engulf an entrant; has walls that converge inward or floors that slope downward and taper into a smaller area which could trap or asphyxiate an entrant; or contains any other recognized safety or health hazard, such as unguarded machinery, exposed live wires, or heat stress.

- Before entry, identify any physical hazards.
- Before and during entry, monitor for oxygen content, flammability, toxicity or explosive hazards as necessary.
- Use employer's fall protection, rescue, air monitoring, ventilation, lighting, and communication equipment according to entry procedures.
- Maintain contact at all times with a trained attendant visually, via phone, or by two-way radio. This monitoring system enables the attendant and entry supervisor to order you to evacuate and to alert appropriately trained rescue personnel to rescue entrants when needed [5]. Note the last phrase of the last item: appropriately trained rescue personnel.
- Employers must provide rescue service personnel with personal protective and rescue equipment, including respirators, and training in how to use it. Rescue service personnel also must receive the authorized entrants training and be trained to perform assigned rescue duties and at least one person must be trained in first aid and CPR. Need to drill at least once annually. "Planning to rely on the 911 emergency phone number to obtain these services at the time of a permit space emergency would not comply" with regulations

Common injuries associated with collapsed structure victims include fractures/lacerations, closed head injuries, multisystem trauma, and dehydration.

- Crush injury, which may be followed by compartment syndrome and/or crush syndrome. Vol 1, Chap 34
- Blast injuries are also fairly common in this setting, particularly in bombings; see Vol 1, Chap 32.
- Rescue efforts (such as the use of power saws) can resuspend dust particles in the air. Dust airway impaction has been reported to be the cause of death in some earthquake victims.

42 Care in the wilderness, 377

Wilderness: defined as a minimum 1-2 hour transport time, but also factors in the unique skills, expertise, and equipment needed to manage the patient and extrication process, or need to transport specialized equipment to austere environment.

Wilderness medicine: care of patients in a remote, austere, or wilderness setting. Most often unexpected and opportunistic care. Teaching focuses on the ad hoc use of materials at hand, which may or may not have been originally purposed for medical care. There is a recognition that minimal medical equipment may be available since medical care is only one consideration among many for recreational or professional trips.

WEMS: a team that has specifically configured itself to provide medical care in specific geographic areas or missions with a specific duty and maintains a formal wilderness medicine certification to do so (subsection of wilderness medicine). WEMS retains some of the ad hoc and improvisational spirit of general wilderness medicine, but since the entire purpose of the WEMS operation is rescue and medical care, choosing the most appropriate equipment specifically for medical care, and absolute familiarity with that equipment becomes paramount. WEMS providers are functioning within the defined health care system

National Association of EMS Officials (NAEMSO) identifies all EMS providers operating in remote or austere conditions as being "operational," specifically citing ski patrols, wilderness search and rescue teams, and fast or open water rescue teams as well as tactical EMS and urban search and rescue teams.

Long history of wilderness medicine from different sources, starting with Nat Ski Patrol.
Scope of Practice more clearly defined with the following levels in 2000/2005:

1. **Wilderness First Aider** - 16-24 hrs of training
2. **Wilderness First Responder (WFR)**: 50-80 hours training. Trained to recognize potentially life threatening illness/injury, basic first aid and splinting, possibly some medication administration (e.g. epinephrine, glucose), possibly some protocol application (e.g. CPR termination, dislocation reduction);
3. **Wilderness EMT (WEMT):** 150 hours of training, adds on to WFR plus all components of EMT-B;
4. **Wilderness Intermediate/Paramedic:** WFR+ EMT-I or-P, plus other procedures (Foley catheters, etc.);
5. **Wilderness Physician**: "necessary care within the limitations of surroundings".

Direct and indirect oversight: Direct difficult due to communications. Indirect more likely→need for protocols, training and importance of case review. Specific discussion of protocols: Wound care (including FB extraction); CPR termination after 30 minutes (unless hypothermic); Joint reductions (focus on dislocations from indirect trauma so as to reduce likelihood of manipulating fracture); Selective Spine immobilization (similar to NEXUS criteria, purpose is to figure out who can walk out even with potential spine injury. Having all on a backboard impractical in wilderness); Anaphylaxis and severe asthma mgmt. Parameters for Search and Rescue

Terminating Resuscitation in Austere Environments

“BLS TOR rule” developed by Verbeek:

1. Arrest was not witnessed by EMS personnel
2. No shock was delivered
3. There was no ROSC prior to ambulance transport.

Showed a positive predictive value of 99.5% for death and specificity of 90% (or higher)

43 Telemedicine and emerging telecommunications, 392

Telemedicine/telehealth: the use of medical information exchanged from one site to another via electronic communications to improve a patient's clinical health status. This includes teleconsultation, tele-education/tele mentoring, telemonitoring, and telesurgery.

Transmission of information can occur in real time (synchronous) or be interacted with at a later time (asynchronous or store-and-forward).

Examples:

- **Prehospital thrombolytic therapy in Europe:** reduced time delay of treatment by approximately 1 hour but also reduced 1-year mortality by 30% compared to those STEMI patients who received in-hospital thrombolytics. But in the absence of a CT scanner in the field, telemedicine examinations by emergency physicians or neurologists have not been compared to examinations and decision making over stroke center referrals by trained EMS personnel
- **Refusals**: when a patient was able to speak to a physician, there was a higher likelihood (35%, versus 3% when the patient spoke only to the EMS provider) that the patient would be transported to a hospital.
- **Role in decreasing overtriage of air:** Markov study showed that helicopter transport is cost-effective only if it reduces the relative risk of death in seriously injured trauma patients by at least 15%. In Taiwan, video telemedicine screening led to 36.2% reduction in the use of air transport, resulting in a total annual savings of US $448,986.

Telemedicine provides a way to not only collect patient information electronically but also to track the patient and transmit all data wirelessly to downstream medical facilities. In Germany, Plitschke et al. described the development of a system using bar-coded triage tags that allow all the information collected to be transmitted wirelessly to the incident command center, telemedicine centre, or receiving hospital. This reduces the redundancy of collecting the same information as the patient goes from the scene to the ambulance and finally to a receiving hospital. It also can help notify the receiving hospital staff of the patient's status as they are able to see all the vital signs and initial treatment started in the field. More recently, Gao et al. have developed a platform known as the miTag (medical information tag)

Tactical - helmet cameras to offer clear visuals of wounded or injured soldiers

Section VII: Advancing Knowledge

44 EMS research basics, 403

EMS often has to rely on non experimental approaches, surrogate settings, or systems research (involving complex interrelated questions, and large amounts of data from multiple agencies, collected in a poorly controlled

environment.

Another direct benefit of conducting research is that the patients enrolled in studies often have better outcomes than patients not enrolled in studies. This often holds true even for the patients in placebo or “no treatment” study arms or when the study intervention is not proven to be advantageous. There are a number of possible reasons for this: clinical information tends to be more closely followed, ancillary testing and care are optimized, and harm versus benefit is more closely monitored.

Every research question should pass the “So what?” test and be clear and focused.

- **Hypothesis** is a declaration to be proved or disproved.
- **Null hypothesis** = no difference exists between two (or more) groups being studied
- **Randomized controlled trial (RCT)** is not always possible or even desirable in EMS

MEDLINE and CINAHL (Cumulative Index to Nursing and Allied Health) databases are of particular value to EMS lit review

Study Design Questions

1 Does the study follow participants over time? (Cross-sectional or longitudinal)
2 Does the study intervene with participants? (observational vs interventional)
3 Does the study look at events that already occurred or as they occur? (prospective or retrospective)

- **Cross-sectional** - measures all study variables at the same point in time (or during a brief interval, perhaps a week or a month), providing a “snapshot” of data. e.g. surveys

- **Longitudinal** - examines variables over time by following patients. Very few studies follow patients through multiple EMS encounters over time

- **Observational** - monitors what is happening but makes no attempt to influence outcomes or otherwise intervene in the events being studied.

- **Interventional** - imposes a change or perturbation and studies the effects

- **Prospective** - events of interest have not yet occurred when the patient is identified

- **Retrospective** - events of interest have already occurred at the time of patient identification

- **Descriptive** - simplest. e.g. correlational, case report, case series, and cross-sectional survey

- **Case study** - only one individual with a presentation or disease

- **Case series** - multiple patients with a presentation or disease

- **Cross-sectional survey** - aka prevalence study. Exposure (risk factor) and disease status (outcome) of participants are measured at the same time as a snapshot. Not usually possible to establish a cause–effect relationship

- **Case–control study** - patients are identified by their outcome (e.g. survivors versus non survivors of major trauma). Usually retrospective. Best design for rare outcome e.g. cardiac arrest survival. Bad choice for rare exposure e.g. cric. Care must be taken to develop a hypothesis prior to analyzing the data. Temporal relationship can be challenging to establish as well (chicken or egg). Can contain sampling and measurement bias

- **Cohort study** - the group starts out together (with or without the exposure) and moves forward through time toward an objective (the outcome). Groups should be the same aside from the exposure – often a challenge and cannot be known with certainty, confounding observations. Cannot already have the outcome of interest at the time of selection. Usually prospective, so temporal sequence can be established. Can study exposure's effect on multiple outcomes. Good for studying rare exposures but not rare outcomes.

- **Before–after study** - data are collected before some sort of change is implemented in the system and after. Ontario Prehospital ALS Study (OPALS), utilized the before–after design in several phases to study whether ALS improves patient outcomes

- **Experimental** aka **clinical trials** - Similar to cohort studies, except exposure status is specifically assigned. After identifying potential participants, measuring baseline characteristics, and checking to be certain the outcome does not already exist, the participants are each randomly assigned to either receive or not receive the study treatment or intervention and followed over time to see which develop the outcome or disease of interest. Ethically, the researcher must be confident that there is not a clear benefit or harm from receiving the study intervention based on current knowledge (recognizing the trial may detect said difference).

- **Cross-over trial** - each participant gets the treatment for a certain period of time and, after a washout period (i.e. a period of time where the effects of the treatment are removed), each enters the other arm of the study. Can account for both known and unknown factors that might affect outcome. Costly and time consuming

Note: longitudinal, interventional, and prospective studies are of greater value in assessing causal relationships – "this affects/changes that" – than are cross-sectional, observational, or retrospective studies. This benefit comes at an expense: the more powerful designs are generally harder to perform, are often more expensive, and are usually more time consuming.

Other important terms:

- **Correlational** - aka aggregate or ecologic. Assesses rates for a population (without causality)

- **Ecological fallacy** - group characteristics are assumed for individual subjects. e.g. in Vietnam War the survival rate for trauma patients increased and the average time to definitive care decreased when compared to the Korean War. This did not prove a causal relationship between survival and time to definitive

care, but it suggested potential benefit.

- **Sampling bias** - can occur when cases and controls are selected. In practice, subjects are usually identified through a single source (e.g. trauma patients from a single hospital trauma registry) which may miss cases who do not present to that source. Also challenging to select controls - should be the same as cases in all respects *except* presence of the disease.
- **Measurement bias** - presence of the disease influences the retrospective assessment of exposure. e.g. cases may be more likely to remember an exposure than controls because they are sick (recall bias).
- **Blinding** - used in clinical trials to limit assessment bias
- **Assessment bias** - beliefs held prior to or outside the experimental question that influence judgment regarding the subject's outcome
- **Single-blind** - subjects cannot tell which therapy is being used
- **Double-blind** - both subject and outcome assessor do not know participant's group assignment
- **Triple-blind** - subject, assessor, and care provider unaware of the participant's group assignment
- **Placebos** or shams are substances or devices that are intended to be physiologically or functionally inactive but appear identical to the active therapy that is being studied.

45 Informed consent for EMS research, 410

- **1974 National Research Act:** first public bioethics policy in the US (response to Tuskegee syphilis study)
- **National Research Act:** impetus for the creation of the Belmont Report
- **Belmont Report (1979)** led to the development of the first guidelines for human subject research and also defined institutional review boards (IRBs). Identified the ethical principles of **beneficence, justice, and respect for persons**

Table 45.1 Central principles of the Belmont Report and application to research

Ethical principle identified in Belmont Report	Standard for conduct of human subject research
Respect for persons	*Concept: Ensure subjects have free choice to participate in research* The right to make an informed free choice to participate in research AND The need for special protections for those potential research subjects with diminished autonomy (children, prisoners, pregnant women, and those in subordinate positions)
Beneficence	*Concept: Do no harm while maximizing potential benefits and minimizing potential risks* Potential risks to subjects (physical, psychological, legal, economic, or social) should be as minimal as possible while accomplishing research objective AND Potential benefits may be difficult to quantify, and are often greatest for society or future patients. When possible benefits should be maximized
Justice	*Concept: Promote fair study recruitment* Risks should be distributed so that all populations both bear risks and receive potential benefits. Risks must not be borne by one population (such as economically disadvantaged individuals) while benefits are received by a different (such as economically advantaged) population

- **Common Rule** (1991): the defining federal policy for the protection of human subjects. Standard of ethics to which nearly all academic institutions hold their researchers regardless of funding source. FDA also has regulations for protection of human subjects which conform in large part to the HHS regulations; however, research involving drugs or devices may be subject to additional FDA regulations

- **Institutional review board:** required for all research involving human subjects. IRB can determine if exempt or minimal risk (expedited review).

Note that only a modest evidence base exists to support many prehospital treatments and evidence to support practices currently in place is often lacking making it difficult to define a standard of care difficult for many conditions.

Exception From Informed Consent in emergency research (EICER/ EFIC) - a series of rules designed to protect patients but also to facilitate research. Addresses the issue of conducting emergency research when subjects may not be able to consent to participate due to the nature of their illness or injury. In 1993, a series of incidents raised concerns about research misconduct and prompted a presidential directive to investigate these offenses which resulted in the Office of Protection from Research Risks (now the Office for Human Research Protection) issuing a call for IRBs to stop all federally funded studies that did not involve obtaining prospective informed consent, and FDA also halted all resuscitation research in the United States for almost 4 years.

Final Rule (1996) - a response to the above. Created a mechanism by which prospective research can occur in emergency situations if it meets certain conditions.

Box 45.1 Conditions under which the exception from informed consent for emergency research may be used

A life-threatening situation exists
Available treatments are unproven or unsatisfactory and scientific evidence is necessary to determine safety and effectiveness of the intervention
Consent is not feasible due to the subject's medical condition
Treatment must be given before it is possible to obtain consent from a legally authorized representative (LAR)
There is no reasonable way to identify prospectively those likely to become eligible subjects
Risks and benefits must be considered to be reasonable
Participation holds some prospect of direct benefit to the subjects
The investigation could not practicably be carried out without the waiver of prospective consent
The proposal defines the therapeutic window. The investigator will attempt to contact the LAR, if feasible, during the therapeutic window and will document these efforts for the IRB
The IRB reviews and approves the consent procedures and documents to be used
Additional protections of community consultation and public disclosure of risks and expected benefits be made to the communities from which the subjects may be expected. Community consultation and public disclosure will be conducted prior to study enrollment, and disclosure of demographic information and results will be made to the community and other researchers following completion of the study
An independent data monitoring committee will be established to oversee risks and benefits
IRBs must ensure that the earliest feasible attempts are made to inform the subject or his or her LAR of the subjects inclusion in the investigation as well as the other information contained in the informed consent document
Protocols involving an exception to the informed consent requirement must be performed under a separate investigational new drug application or investigational device exemption that identifies them as including subjects who are unable to consent. The FDA must approve the application before the study may proceed
If an IRB determines it cannot approve a clinical investigation because it does not meet criteria or because of ethical concerns, the IRB must provide this information in writing to the investigator and the study sponsor. The study sponsor must disclose this information to the FDA and other investigators participating in an equivalent investigation as well as to other IRBs that have been asked to review this or an equivalent protocol

Source: Data from Food and Drug Administration, Department of Health and Human Services. Exception from Informed Consent Requirements for Emergency Research: Guidance for Institutional Review Boards and Clinical Investigators. Available at: www.fda.gov/oc/ohrt/irbs/except.html

Community consultation: discourse between investigators and a wide variety of community members and representatives. Addresses multiple issues, including an opportunity for input from the community, ensuring transparency in the research process, and engendering trust in the research process and the proposed study. Community consultation also provides a mechanism by which community members may opt out of enrollment. Community consultation must occur prior to the enrollment of any subjects. (Example: town hall meeting)

Public disclosure: a one-way transfer of information to the community. Must be prior to start of study and after it is complete. It generally includes a notice that the study is planned, describes the nature and purpose of the research including the fact that consent will not be prospectively obtained, and presents the possible risks and expected benefits that might result. This should include:

- The intent to conduct the research without prospective informed consent
- A description of the treatment under study as well as its risks and benefits
- A synopsis of the protocol and study design
- Information about how subjects will be identified
- A list of sites participating in the research
- Description of future attempts to contact each subject's legally authorized representative

Public disclosure to the community and to other researchers following completion of the study should include the aggregate demographics and results (Example: press releases)

46 Cardiac arrest-related research methodology, 415

OHCA median survival rate to hospital discharge for all patients with attempted resuscitation has slowly risen from about 5% to about 10%, with individual systems reporting rates between 3% and 16%

Cardiac arrest - simplest to include cases in which EMS provided chest compressions or a shock with a defibrillator.

Resuscitation Outcomes Consortium - clinical trial network supporting cardiac arrest research. Since accurate etiology difficult, ROC has chosen to track all cases without obvious trauma regardless of etiology. With the declining incidence of VF, the proportion of OHCAs that are of non-cardiac etiology appears to be increasing.

Utstein reporting - uniform method of reporting cardiac arrest introduced in 1991

Table 46.1 Possible exclusion criteria

Etiology independent	Etiology related
Rigor mortis	Traumatic cause
Decapitation	Drowning
Dependent lividity	Accidental hypothermia
Do not resuscitate order	Asphyxia
Age <18 years	Toxic ingestion or overdose
Prisoner	Electrocution
Pregnant	Sepsis

Consolidated Standards of Reporting Trials (CONSORT) - a standard approach for authors to report findings and describing patients who were included or excluded. For Utstein, this defines:

- Location
- Witness status
- Type of EMS system
- Population density

All results should be reported in terms of **intervals** (i.e. the difference between event times) in order to ameliorate any ambiguity regarding terminology. For example, the call receipt to- first-shock interval represents the difference between the time the 9-1-1 call was received and the time the first defibrillation was attempted. Time points such as call receipt, EMS dispatch, defibrillator application, and shock delivery are reliably recorded electronically.

Bystander accounts of collapse time and administration of CPR are important data points. Reliable information may be obtained through witness interview via the telephone after the event is over. Electronic capture of cardiac rhythm information is relatively easy. When captured electronically, ECG information is available for in-depth digital signal analysis. Ideally, the presenting rhythm should be ascertained through blinded review of rhythm strips. Electronic data capture also allows assessment of the quality of chest compressions and ventilations provided to the patient. Relevant outcome measures:

- Survival
- ROSC
- Neurological status

- Quality of life

The use of ROSC is controversial as a patient-centered outcome, but it is a less interesting outcome from the point of view of the patient compared to neurologically intact long-term survival.

Clinically significant short-term survival may be defined as survival to 4 hours after the initial call.

The Cerebral Performance Category (CPC) Score:

Table 46.3 Cerebral Performance Category Score

Cerebral performance	Overall performance
1. Good performance	Conscious. Alert, able to lead normal life. May have minor psychological or neurological deficits. May have mild functional disability from non-cerebral organ system
2. Moderate disability	Conscious. Sufficient cerebral function for part-time work in sheltered environment or ADLs. May have moderate cerebral disability alone or moderate disability from non-cerebral organ system. Performs ADLs
3. Severe disability	Conscious with at least limited congition. Dependent on others for daily support because of severe brain dysfunction. May have severe cerebral disability alone or from non-cerebral organ system
4. Coma, vegetative state	Not conscious. Unaware of surroundings. No interaction with surroundings
5. Death	Certified brain dead or dead by traditional criteria

ADLs, activities of daily living.

More objective scales such as the modified Rankin Scale are more sensitive but require contact with the patient.

Quality-of-life evaluation is an excellent patient-centered outcome.

Quality control regular audits should be performed to ensure that the data collected are accurate.

Data and safety monitoring boards (DSMBs) - monitor clinical trials involving interventions that entail potential risk to the participants. Periodically review and evaluate the accumulated study data for participant safety, study conduct and progress, and efficacy when appropriate, and make recommendations concerning the continuation, modification, or termination of the trial. If a profound benefit or detriment to patients is discovered, the DSMB decides whether or not to stop study.

47 Trauma-related research methodology, 420

NEMSIS -national compilation of EMS data, supplied by participating state EMS offices, and offers the broadest overview of EMS nationally.

Traumatic injuries accounted for 14.6% of EMS calls in 2012 (NEMSIS data)

Most frequent cause of death for Americans aged 1–44 yo

Fifth largest overall cause of death nationwide

- **Prospective randomized double-blind clinical trials** are the gold standard. Patients randomly assigned to one treatment arm or another and the outcomes of each treatment group are analyzed. Blinding minimizes bias that could change other ways in which the patients in the two study groups are treated.
- **Cohort/observational** studies provide clinical information despite the possibility of treatment and/or observational bias. no "active" treatment intervention. In a prospective cohort study, the study parameters, patient cohorts, and outcomes are defined before each group undergoes the treatment. In a retrospective observational study, the information being studied has already been collected but the study questions and outcomes of interest have not been established.
- **Case–control** studies compare two groups of patients whose outcomes differ. This research format is especially useful when the adverse outcome of interest is observed infrequently. The case group is matched to the control group only on a minimum number of variables, so that it is possible to examine which variables differ in the two patient outcome groups.
- **"Intention to treat"** design -all patients randomized to a therapy are analyzed as if they received that therapy, even if that therapy was not provided for some reason. allows for an adjustment in outcome that could occur due to bias in the delivery of the therapies in the clinical trial.

Other terms

- **Wash out period** - When studying new therapy, may wait until new therapy has been fully integrated into the EMS system of care. Time period is not studied, which helps to remove any inaccuracies that may influence the study outcome as a result of incomplete or inaccurate adoption of the treatment being studied as the system and providers become accustomed to it.
- **Informed consent** -*before* trial starts -allows the patient to make an informed decision about whether or not to participate. Obviously problematic for emergency research, especially prehospital, because urgency often makes obtaining consent from either the patient or representative difficult.
- **Trauma Score-Injury Severity Score (TRISS)** - method for predicting outcome in trauma includes age as a factor in its calculation. Survival of a patient treatment group can be estimated using the TRISS method, and this estimated survival compared to the survival of the treatment group that receives the intervention or

therapy under study.

- **Revised Trauma Score** - assesses initial status based on the initial Glasgow Coma Scale score and vital signs.
- **Injury Severity Score (ISS)** based on assigning an Abbreviated Injury Scale (AIS) score for each of six body areas. The three highest AIS scores are then used to calculate the overall ISS. The ISS correlates well with subsequent morbidity, mortality, and other measures of patient severity. However, it cannot be calculated in the field or ED.
- **Joint Theater Trauma Registry (JTTR)**, was implemented during the Iraq war. Able to document a remarkable decrease in mortality and minimal morbidity with the widespread tourniquet use. Example: fielding VIIa to combat hospitals, showed an increased incidence of thromboembolic events.

Consider excluding patients unlikely to survive, because could bias the results towards showing no difference in outcome when one actually exists. Patients with these critical injuries include those with severe traumatic brain injury (Glasgow Coma Scale score less than 5), traumatic arrest with no recordable blood pressure, and other signs of likely demise.

Outcomes:

- 30-day survival - globally relevant
- Survival to the emergency department, operating room, or intensive care unit - incrementally important outcomes

Hanson recommendations regarding outcome measures:

- They should be directly tied to the specific aims and capable of measuring the outcomes of interest.
- They should be important to patients.
- Patient-reported outcomes should be considered.
    - **Patient-reported outcome measures** (PROMs)-patient completes questionnaire or survey after participation in a clinical trial to get his or her perspective on the outcome

The best way to overcome multi-agency challenges is to establish an oversight committee of co-investigators from each site. Each of those is responsible for maintaining that site.

48 Pediatric-related research methodology, 427

- Approximately 5–10% of EMS calls are for children.
- Decades of research focusing only on adults have left gaps in the epidemiology of EMS calls for children

and on critical treatment information for children.

- Ontario Prehospital Advanced Life Support (OPALS) study group found that pediatric cardiopulmonary arrest patients were more likely to have unwitnessed cardiac arrests and receive no bystander cardiopulmonary resuscitation (CPR). The most common arrest etiologies reported were trauma, sudden infant death syndrome, and respiratory disease.

- Institute of Medicine's (IOM) 2006 report Emergency Care for Children: Growing Pains focused on how pediatric emergency services are (and are not) integrated into the nation's health care system.

- National Commission on Children and Disasters found "death rates due to pediatric injury have dropped by 40 percent since the EMSC program was established.

- Consortiums are helpful for quality research:
    - PECARN, initially funded in 2001
    - NIH-funded Resuscitation Outcomes Consortium (ROC).

Challenges to pediatric research

- Defining a "pediatric" patient - The Federal Emergency Medical Services for Children (EMSC) program defines "children" as ages 0 through 21 years, in accord with the American Board of Pediatrics, which defines the field of pediatrics as encompassing patients 0 through 21 years of age.

- Limited numbers of pediatric patients seen by a typical EMS agency - pediatric patients account for approximately 10% of EMS call volumes, of whom only 10–20% actually have critical complaints

- Ethical standards to which pediatric research is held (Example: consent issues). Pediatric studies requiring consent are more complicated than adult studies because subject assent is necessary in addition to the consent of a participant's legal guardian.

- Research priorities include provider pediatric assessment and treatment skill maintenance, off-label medication use effectiveness, and management of respiratory disease.

49 Economic evaluation of EMS-related interventions, 433

All resources are finite and selecting the most cost-effective intervention is an important decision.

- **Full economic evaluation** - costs and the consequences of two or more interventions are compared
- **Cost-benefit** analysis measures the outcome or the effect of an intervention, in dollars. (Example: annual cost for EMS system was $8.3 million, and outcome from providing EMS care was $44.3 million in socioeconomic cost savings to the community)
- **Cost-effectiveness** analysis measures a common effect (Example: lives saved). Result in terms of effect per unit of cost. Effect is measured in natural units such as the amount of disability or health care resources consumed. A common example is the reporting of cost per life saved (Example: police AED estimated the cost per life saved ranged from $23,542 to $70,342 and the cost per year of life saved ranged from $1,582 to $16,060).
- **Cost-utility analysis** - effect measured in quality-adjusted life-years. (Example: mean incremental cost per quality-adjusted life-year for lay responder defibrillation was $46,700 - per QALY). Published standards consider $200,000 per additional good outcome and $50,000 per QALY to be the limit at which benefits are worth the related costs.
- **Cost-minimization** analysis compares two equivalent treatments and determines which has the lowest cost.
- **EMS Cost Analysis Project (EMSCAP)**, sponsored by the National Highway Traffic Safety Administration (NHTSA) made standardized guideline for calculating the cost of EMS from the community's perspective.
- **Costs -** actual resources consumed to produce a good or service. Should be used when calculating from societal perspective.
- **Charge** includes the cost as well as taxes and any profit gained from providing the good or service. The charge is frequently more than the cost.
- **Societal perspective** aka community's perspective - broadest and most comprehensive view of the cost of patient's treatment = cost for EMS agency response, the first responder agency response, communications infrastructure including dispatch, administration of the EMS system, medical oversight, training, on call and direct patient care, and "downstream" costs of the patient's hospital care, rehabilitative care, lost wages, prevention, mutual aid, special events (requested by planners, not community, so community-requested/ appropriate support should be included).

Table 49.1 *Continued*

Category	Description
Medical oversight	A physician may be employed by the EMS agency, in which case the cost may be accounted for in human resources; otherwise, estimate cost, not simply charges; also consider that administrative overhead may be borne by other entities but should be accounted for (e.g. malpractice insurance, travel, communication equipment). Include the cost of all of the following: Quality assurance/quality improvement of out-of-hospital emergency care Direct medical oversight Indirect medical oversight
Physical plant	Any buildings necessary to train, provide, maintain, or administer the EMS system. This should include the cost of: Acquisition Operation Maintenance Replacement
Training	Any training provided including: Initial training (e.g. instructor, location, durable and consumable equipment) Continuing education (e.g. instructor, location, durable and consumable equipment)
Vehicles	Any vehicle used to train, provide, maintain, or administer the EMS system including those that travel by ground, air, or water. This should include the cost of: Acquisition Operation Maintenance Replacement

Source: Lerner 2007 [26]. Reproduced with permission of Elsevier.

- **Excluded costs** when calculating cost of EMS system include taxes (charge rather than a true cost), sunk costs, costs for billing.
- **"Sunk" costs** - costs to the society regardless of whether EMS is provided.
- Medical errors and adverse event costs should be included in the downstream costs rather than the EMS system costs, but the costs for liability coverage and legal costs should be included because they are direct costs for running the EMS system.
- **"Joint production" problem** - Cost of maintaining idle ready agency that plays multiple roles in a community, such as a fire department or police agency --difficult to determine how to attribute the cost; no consensus.

Consider proportion of calls that are EMS-related, the proportion of time engaged in responses that are related to EMS, or not attributing the cost of readiness from that agency at all. There is no single solution that could fit every agency and system type.

50 Data handling and statistics essentials, 439

- **Null hypothesis** = no difference between two or more groups, with respect to the measured quantity of interest.
- **P value** = calculated probability of obtaining the results observed, or results more inconsistent with the null hypothesis, assuming the null hypothesis is true.
- **"Treatment effect"** aka "effect size" = difference between the two groups defined by the alternative hypothesis
- **α** if $p<\alpha$ (usually 0.05) we are willing to accept a 5% probability (α) of falsely concluding that there is a difference (Example: between dispatch systems), when in reality there is no difference.
- **Type I error** saying there is a difference between the systems when there really is not --"false positive."
- **Type II error** when a difference does exist between the two groups that is as large as, or larger than that defined by the alternative hypothesis, yet a non-significant *p* value is obtained. This is a "false negative" because the *p* value is greater than α, when in reality there is a difference. Common cause is an inadequate sample size. β (1 − power)
- **"Power"** = chance of detecting true treatment effect, if one truly exists. Usually 0.80, 0.90, or 0.95. β (1 − power) is the chance of missing a true treatment effect (i.e. the risk of committing a type II error) if a true difference equal to the effect size actually exists. Four parameters influence the power of a study: the sample size, the effect size defined by the alternative hypothesis, the variability of the results from patient to patient, and α. Always calculate before the study.
- **Numerical variables** (or quantitative) = the size of differences between numbers has meaning. Includes continuous or discrete. Summarized with mean and median.
- **Continuous variable** = examples include age, height, weight, time.
- **Discrete variable =** taking on only specific values (Example: number of paramedic calls per shift).
- **Categorical variables** = qualitative or nominal scale, no inherent order (Example:. race, sex, hospital name). Dichotomous = binary. Polychotomous = more than two. It is not advised to categorize continuous variables (Example: systolic blood pressure ≤ 90 mmHg or age by decades) as it reduces available info, frequently requires arbitrary cut-off, may reduce study power, and leave room for residual confounding.
- **Ordinal variable** = inherent order (Example: GCS, Apgar).

- **Parametric** tests = used to analyze numerical data. Requires normal distribution of data and that the variance of data from each group is equal. T-test if two groups. ANOVA if more than 2.

- **Non-parametric** tests do not require these assumptions (or can't be assumed). Considering the low power of available tests used to detect deviations from the normal distribution, it is prudent to use nonparametric methods of analysis when there is any doubt as to the underlying distribution of the data. The trade-off for not requiring data to be normally distributed is a slight loss of power for detecting a true difference between groups (i.e. greater chance of type II error). This difference in power is usually of little practical significance but may require a slightly larger sample size to achieve the same desired power (Example: an additional 10% more subjects).

Table 50.2 Common statistical tests and their assumptions

Statistical test	Description
Parametric tests	
Student's t test	Used to test whether the means of a continuous variable from two groups are equal, assuming that the data are normally distributed and that the data from both groups have equal standard deviation or variance. A less common form of the t test can be used to analyze data from matched pairs (e.g. before and after measurements on each patient)
One-way analysis of variance (ANOVA)	Used to test the null hypothesis that three or more sets of continuous data have equal means, assuming the data are normally distributed and that the data from all groups have equal standard deviations or variances. The one-way ANOVA may be thought of as a t test for three or more groups
Non-parametric tests	
Wilcoxon rank sum test (Mann-Whitney U test)	Used to test whether two sets of continuous data have the same median. These tests are similar in use to the t test but do not assume the data are normally distributed
Wilcoxon signed rank test	Used to examine data from matched pairs, similar to the matched pairs t test, but when differences in each pair are not normally distributed
Kruskal-Wallis	This is a test analogous to the one-way ANOVA, but no assumption is required regarding normality of the data. The Kruskal-Wallis test may be thought of as a Wilcoxon rank sum test for three or more groups or as a one-way ANOVA for non-normally distributed data
Chi-square test	Used with categorical variables (e.g. two or more discrete treatments or groups with two or more discrete outcomes) to test the null hypothesis that there is no association between treatment and outcome. The chi-square test assumes at least five expected observations of each combination of treatment and outcome, under the null hypothesis
Fisher's exact test	Used in an analogous manner to the chi-square test, Fisher's exact test may be used even when less than five observations are expected in one or more categories of treatment and outcome

- **Confidence interval** - estimate a range of values between which the true treatment difference will lie with some degree of certainty (e.g. 95%). If an interval excludes zero, it is equivalent to $p < 0.05$. A larger sample size will decrease the width of the confidence interval, allowing greater certainty of either no clinically important difference or determination of a difference that was not uncovered by an analysis of the smaller sample size.

- **The *p* value -** answers the question: "Is there a statistically significant difference between the two treatments?" The *p* value does not tell us the magnitude of the treatment difference, whether the difference is clinically important, nor how precisely our trial was able to estimate the true treatment difference.

- **Point estimate** (Example: one min decrease in response time) and its confidence interval answer the questions, "What is the size of the treatment difference?" and "How precisely did this study determine the

true treatment difference?"

- **Bonferroni correction** reduces the overall type I error risk (the study wise risk) by reducing the maximum *p* value considered statistically significant (α) for each of the individual tests (the testwise risk). The overall risk of a type I error that is desired (usually 0.05) is divided by the number of statistical tests to be performed, and this value is used as the maximum significant *p* value for each individual test. Controls the overall (study wise) risk of a type I error, at the expense of an increased risk of a type II error, since there is an increased risk that each test will miss a difference as big as that defined by its associated alternative hypothesis (by yielding a *p* value that is non-significant using the new criteria for *p)*. The overall or "studywise" risk of at least one type I error is roughly equal to the maximum significant *p* value used for each individual test multiplied by the total number of tests performed. If p=0.05, there is a 5% chance of false positive (type 1). This rough equality is the basis for the Bonferroni correction.

- **Interim analyses** - conducted before the full sample size has been reached, to see if a final conclusion may be drawn from the data and the trial terminated early. Plan in advance to avoid increasing the type I error rate because this is a type of multiple comparison.

- Subgroups analysis problems
    - It is a type of multiple statistical comparisons, increasing the chance of a type I error.
    - Since fraction of sample, may have low statistical power, increasing the chance of a type II error.
    - **"Proper" subgroup** - defined by signs, symptoms, or other characteristics available at the initial presentation (e.g. on the arrival of EMS personnel) that are not modified by the interventions being compared. Therefore many retrospective studies inappropriately compare improper subgroups of patients (treated).

- **Intention to treat** -must properly account for patients for whom a procedure is initiated/ordered but cannot be completed.

- **Multivariable analysis** -goal is to quantify the separate effect of each multiple predictor (or "independent") variable on the outcome of interest (the "dependent" variable). mathematical modeling and stratified analysis.

- **Multivariable modeling** provides a mechanism for integrating several variables into the same analysis to account for the variety of factors that may influence a given outcome and to increase comparability between patient groups.

- **Stratification** - separating sample into two (or more) groups, based on a given variable (frequently a confounder), and analyzing these groups in parallel.

- **Multivariable logistic regression** - form of mathematical modeling used with a categorical outcome and multiple predictor or confounding variables. The outcome is generally dichotomous or binary (e.g. survival versus death). The predictor variables can be numerical or categorical. allows an investigator to assess how

a single predictor affects the outcome of interest. a measure of association (odds ratio) is calculated for each predictor variable, along with the confidence interval and *p* value for the null hypothesis that the odds ratio is 1 (i.e. no independent association).

- **"Clustering"** = tendency of subjects who have some features in common in correlated data (e.g. the EMS agency that responds to their 9-1-1 calls) to have other characteristics in common as well (e.g. hospital disposition or receiving certain types of hospital care). may exhibit similarity in patient characteristics, EMS care (e.g. a certain EMS agency or crew may have more or less experience with certain procedures than other crews), or hospital care (e.g. treatments and outcomes at certain hospitals may be better or worse than other hospitals). failing to account for these correlations can result in inappropriately narrow confidence intervals and artificially low *p* values (i.e. increased type I error rates).

- **Missing data** - Unavoidable. But can introduce substantial bias in study results, decrease the precision of estimates, and reduce study power, potentially leading to invalid conclusions. One solution is to use observed values to predict plausible values for missing data, while appropriately accounting for the uncertainty (i.e. variance) inherent in this process.

Table 50.1 Definitions of terms commonly used in classical statistical testing

Term	Definition
α	The maximum p value to be considered statistically significant; the risk of committing a type I error
α error	A type I error
Alternative hypothesis	The hypothesis that is considered as an alternative to the null hypothesis; the hypothesis that there is an effect of the studied treatment, of a given size, on the measured variable of interest; the hypothesis that there is a difference between two or more groups of a given size, on the measured variable of interest; sometimes called the test hypothesis
β	The risk of committing a type II error
β error	A type II error
Null hypothesis	The hypothesis that there is no effect of the studied treatment on the measured variable of interest; the hypothesis that two or more groups are the same with respect to the measured variable of interest
Power	The probability of detecting the treatment effect defined by the alternative hypothesis (i.e. obtaining a p value $<\alpha$), given α, and the sample size of the clinical trial; power $= 1 - \beta$
p value	The probability of obtaining results similar to those actually obtained, or results more inconsistent with the null hypothesis, assuming the null hypothesis is true
Type I error	Obtaining a statistically significant p value when, in fact, there is no effect of the studied treatment on the measured variable of interest or that the groups being compared are not different; a false positive
Type II error	Not obtaining a statistically significant p value when, in fact, there is an effect of the treatment on the measured variable of interest that is as large or larger than the effect the trial was designed to detect, or that there is a difference between the groups that is as large or larger than the treatment effect tested; a false negative

Afterword

Though countless hours have gone into compiling this compact review guide, the editors recognize it is imperfect. Please forward any corrections or comments to ryan.coughlin@yale.edu.

Thank you and good luck!