Learning Objectives

• Describe factors that must be considered to ensure appropriate timing of medical and mechanical skills during a rescue.
• Outline each phase of a rescue operation.
• Identify the appropriate personal protective equipment (PPE) for rescue operations.
Learning Objectives

• Describe important considerations for emergency medical services (EMS) crews in a surface water rescue.
• Discuss important considerations for EMS crews in rescues associated with hazardous atmospheres, including confined spaces and trench or cave-in situations.

Learning Objectives

• Describe hazards that may be present during an EMS rescue operation on a highway.
• Describe important considerations for EMS crews in a rescue involving hazardous terrain.
• Outline special considerations for prehospital assessment and management during a rescue operation.

Appropriate Training for Rescue Operations

• Rescue work requires training and expertise so that medical and mechanical skills are carefully balanced
  – Helps to ensure patients get effective treatment and timely extrication
  – Rescue effort must be driven by patient’s needs, both medical and physical
  – Success of any rescue depends on coordinated effort between medical care and specialized rescue efforts
Appropriate Training for Rescue Operations

• Coordinated effort allows
  – Patient access and assessment for treatment needs
  – Initiation of treatment at site
  – Release of patient from entrapment or imprisonment
  – Continuous medical care throughout incident

Role of the Paramedic in Rescue Operations

• Most rescues in U.S. are accomplished through systems operations approach
  – In this form of rescue management, extrication is performed by
    • Fire service personnel
    • Specialized units
    • Both
  – Patient care is duty of EMS personnel

Role of the Paramedic in Rescue Operations

• In another type of rescue system, rescue services are provided by
  – Fire
  – EMS
  – Law enforcement agencies that have cross-trained personnel
    • In this system, roles and responsibilities for rescue and patient care are shared
Role of the Paramedic in Rescue Operations

• Primary role of paramedic in rescue operations is to have proper training and appropriate PPE that allow for safe access to patient and treatment at site and throughout incident
  – Paramedics often are first responders to many scenes that require rescue

Role of the Paramedic in Rescue Operations

• Paramedics should
  – Understand hazards associated with various environments
  – Know when it is safe to gain access or attempt rescue
  – Have skills to perform rescue when it is safe and necessary
  – Understand rescue process and know when certain techniques are indicated or contraindicated
  – Be skilled in patient packaging techniques to allow safe extrication and medical care

What kind of emotions do you think you would see in a critical life-threatening rescue?
Safety

- Safety during any rescue operation is paramount because of potential for associated risks
  - Example: rescues may involve
    - Hazardous materials
    - Inclement weather
    - Temperature extremes
    - Fire
    - Electrical hazards
    - Toxic gases
    - Unstable structures
    - Heavy equipment
    - Road hazards
    - Sharp edges and fragments

Safety Essentials for every rescue operation
  - Initial scene assessment for hazards
  - Personal protective measures
  - Constant monitoring throughout operation is essential for every rescue response

Safety Priorities for safety in any rescue
  - Personal safety
  - Safety of crew
  - Safety of bystanders
  - Rescue of trapped and injured
Safety

• Reasons for this order of priority
  – When well-trained and properly equipped rescuers act safely, remaining vigilant for hazards
    • Minimize risk of personal injury
    • Avoid complicating scene by becoming another patient who requires care and possibly extrication

Safety

• Reasons for this order of priority
  – Crew is support team for rescuer
    • Crew safety is essential to ensure effective rescue and to provide mutual support for each team member
    • Operating with disregard for safety of fellow team members increases risk of injuries
    • Complicates operation

Safety

• Reasons for this order of priority
  – Uninvolved people must be evacuated and kept clear of hazards
    • Bystanders or untrained “helpers” only increase risk of additional injuries
    • Also complicate rescue operation
  – Rescue of trapped or injured is last priority
    • These people are already trapped or injured
    • Carrying out first three priorities safely maximizes chance for successful rescue
Phases of a Rescue Operation

- Rescue operation has seven phases
  1. Arrival and scene size-up
  2. Hazard control
  3. Gaining access to patient
  4. Medical treatment
  5. Disentanglement
  6. Patient packaging
  7. Transportation

Phases of a Rescue Operation

- Paramedics should not enter scene until it has been secured and made safe by trained personnel
  - Personal safety is always priority

Arrival and Scene Size-Up

- First phase of rescue is arrival and scene size-up
  - Requires paramedic to determine what is needed at specific emergency event
  - Involves quickly
    • Gathering facts about situation
    • Analyzing problems
    • Determining appropriate response
Arrival and Scene Size-Up

- During this phase, EMS crew must
  - Understand environment and risks
  - Establish command and conduct scene assessment
  - Determine number of patients and triage as necessary
  - Determine whether situation is search, rescue, or body recovery
  - Perform risk versus benefit analysis that considers personal safety before rescue is attempted
  - Request additional information
  - Make realistic time estimate in accessing and evaluating patients or other people at scene

Arrival and Scene Size-Up

- Scene size-up is ongoing evaluation of emergency scene
  - It begins when call is received and when information is obtained from dispatch center
  - Paramedic must constantly be alert to situations that may change needs of particular incident
  - If power lines are downed during extrication, electrical utility services may be needed that were not initially required
  - Three elements of assessment phase are response, other factors, and resources

Response

- During initial response to scene, information often is limited
  - En route, EMS crew and dispatcher should gather as much detail about situation as possible
  - Essential information includes
    - Exact location
    - Type of occupancy (manufacturing, mercantile, residence)
    - Number of victims
    - Type of situation
    - Hazards involved
Response

• Weather conditions (e.g., extreme heat or cold, rising water, rain, high winds) also can affect
  – Rescue attempts
  – Patient's status
  – Need to expedite operation

Response

• Standardized dispatch protocols guide initial emergency response
  – Predetermined system based on level of reported emergency
  – Example
    • If event is single-car crash, first-responder fire company and EMS unit may be dispatched
    • If event involves bus wreck with many patients, several fire companies and EMS units may respond

Response

• Standardized dispatch protocols guide initial emergency response
  – As dispatch center receives information about actual severity of event, dispatch protocol upgrades or downgrades response as needed
  • Center advises responding units of updated reports
Is there any disadvantage to routinely sending too much emergency equipment to a scene?

Other Factors

- Other factors in determining type of response needed are description of scene and time of day
  - An emergency in highly populated area may call for special vehicles and equipment for extrication and fire suppression
    - High-rise apartment
    - School
    - Shopping mall
  - In rural or wilderness setting may require helicopter rescue or other resources
  - If hazardous materials are present, special response and decontamination equipment may be needed for bystanders, patients, and rescue personnel

Other Factors

- Time of day may affect on-scene needs
  - Rush-hour traffic and crowd control may be a concern
  - Extra lighting may be needed for early morning, evening, or night rescue
- Factors determine personnel requirements and scene management operations
Resources

• Ability to assess emergency quickly and correctly requires preplanning
  – Requires development of systems approach to response
  – Available resources are critical part of any response
  – Responding crew may not have personnel, training, or expertise to handle event

Resources

• Resources that may be required
  – Additional emergency vehicles for a large number of patients
  – Area hospital availability and personnel
  – Aeromedical services
  – Law enforcement
  – Fire service for automobile extrication, fire suppression, or lighting

Resources

• Resources that may be required
  – Water rescue, teams with self-contained underwater breathing apparatus (SCUBA), and other specialized rescue units
  – Hazardous materials teams
  – Urban search and rescue teams
Hazard Control

• Phase of rescue in which on-scene dangers are quickly identified and managed by first-arriving crew
  – Minimize risks from uncontrollable hazards
  – Make sure scene is as safe as possible
  – Ensure all personnel are equipped with PPE appropriate for incident

Hazard Control

• Possible hazards at scene
  – Fire
  – Unstable structures
  – Confined spaces
  – Swift water
  – Poisonous substances
  – Dangerous animals
  – Unruly crowds

Hazard Control

• Phase of rescue in which on-scene dangers are quickly identified and managed by first-arriving crew
  – Minimize risks from uncontrollable hazards
  – Make sure scene is as safe as possible
  – Ensure all personnel are equipped with PPE appropriate for incident
Gaining Access to the Patient

• To safely gain access, paramedic must determine
  – Must determine best method of reaching patient
  – Deploy appropriate personnel to patient
  – Stabilize patient’s physical location

Gaining Access to the Patient

• Extrication tools and equipment can cause injuries
  – To reduce risk, use least amount of force needed
  – Clear area of unnecessary people
  – Extraneous noise should be kept to minimum
  – Safety officer should remain alert to stress of operation on rescuers
    • Should rotate personnel to prevent heat exposure disorders and injuries resulting from fatigue
  – Rescuers should wear approved protective clothing
  – Supply protective covering for patient
## Gaining Access to the Patient

- Paramedics may not directly take part in freeing patient
  - Chief responsibility for patient care
  - Serve key role as observers for potentially hazardous procedures
  - "Team concept" is most important element in any rescue system or operation
  - Teamwork maximizes safety, efficiency, and effectiveness
    - Basic element of prehospital care
    - Powerful implications for safety of responders

## Medical Treatment

- After team has gained access to patient, medical treatment can begin
  - Perform rapid primary survey to identify and manage any life-threatening situations
  - Care may be limited by circumstances and physical working area
  - May be able to initiate some stabilization procedures
    - Spinal immobilization
    - Airway management
    - Oxygen administration
    - IV fluid therapy

- If paramedic recognizes rapidly fatal or potentially fatal conditions, "load and go" approach must be taken
  - Rapid extrication and transport are indicated
Medical Treatment

- Physical examination should be performed after primary survey completed and life-threatening conditions have been managed
  - Another crew member may perform examination at same time of primary survey if it does not interrupt initial assessment and emergency care

Disentanglement

- Making pathway through wreckage of incident and removing wreckage from patients
- Main responsibilities of paramedic during disentanglement
  - Release patient from entrapment
  - Perform risk versus benefit analysis
    - Does risk outweigh benefit or vice versa?
    - Analysis should take personal safety into account

Disentanglement

- Phase of rescue is driven by needs of patient
  - May call for specialized rescue personnel and equipment
  - Be aware of available resources in the area
  - Know how to mobilize these resources
  - Disentanglement often is time-consuming
    - EMS crew should be prepared for extended scene time
What rescue teams are accessible to your community?

Patient Packaging

• Stabilizing patient physically and preparing person for transport
  – May call for special rescue capabilities
    • Moved over hazardous terrain
    • Lifted by hoist to a helicopter
  – Coordination of activities and sharing of patient care responsibilities among various agencies offers greatest chance of successful outcome

Patient Packaging

• Paramedic’s responsibilities
  – Ensure patient is ready to be removed from scene
  – Protect patient from additional injury during disentanglement and egress (exit pathway)
    • Cover patient with blankets or tarpaulins
    • Provide with ear and eye protection
    • Apply face mask with supplemental oxygen or air, protects patient from toxic fumes, if present
Patient Packaging

• For minimum packaging for transport
  – Airway and cervical spine must be stabilized
  – IV lines and oxygen tubing must be secured
  – Patient must be immobilized on long spine board

Patient Packaging

• When time allows
  – Extremity fractures should be immobilized
  – Open wounds covered with sterile dressings and secured with bandages
• Scene delay for patients who require rapid stabilization and transport may lessen patient’s chances of survival

Patient Packaging

• Use of other patient care equipment should be considered as patient is removed from area of entrapment
  – Communication and coordination with other rescuers must continue during this process
  – Exit pathway must be clear and secure
  – No additional danger for patient or rescuers should exist during removal phase
Patient Packaging

- During disentanglement and patient packaging, consider patient’s emotional needs
  - Patients often are anxious and frightened by rescue operations
  - When possible, maintain rapport with patient
    - Provide reassurance that patient is being well cared for
    - Prepare patient for unexpected movements or procedures that may cause discomfort
    - Explain all rescue maneuvers

Transportation

- If patient is to be transported immediately to ambulance, following should be immediately available
  - Wheeled stretcher
  - Basket stretcher
  - Scoop stretcher
  - Long spine board

Transportation

- While patient is transported to emergency vehicle, terrain, equipment, personnel requirements for moving patient should be considered
  - Need for air evacuation
  - Specialized resources and extra personnel
Transportation

• Ambulance should be appropriately warmed or cooled, based on patient’s needs and rescue setting
• Rescue is considered complete once patient is en route to hospital
  – EMS crew continues emergency care
  – Medical direction is advised of patient’s status

Rescuer Personal Protective Equipment

• PPE for EMS personnel historically has been adapted from other fields (e.g., fire service)
  – Standards for protective clothing and PPE established by National Fire Protection Association and OSHA have been adopted by many fire and EMS agencies
  • Includes number of municipal and industrial fire services throughout U.S.

Rescuer Personal Protective Equipment

• At minimum, EMS providers involved in rescue and other rescue personnel should have access to following PPE
  – Impact-resistant protective helmet with ear protection and chin strap
  – Safety goggles with elastic strap and vents to prevent fogging
  – Lightweight, puncture-resistant turnout coat
  – Slip-resistant, waterproof gloves
  – Boots with steel insoles and steel toe protection
  – Self-contained breathing apparatus (SCBA)
Rescuer Personal Protective Equipment

- Same PPE is not appropriate in all situations
  - Adequate protection depends on level of rescuer involvement and nature of incident
  - Other PPE may be appropriate in some rescue events

Personal Protection from Blood-Borne Pathogens

- OSHA has established criteria for workplace protection from blood-borne and airborne diseases
  - Measures should be observed whenever potential exists for exposure to patient’s body fluids or to communicable diseases

Surface Water Rescue

- Rescue of patient who is afloat on surface of body of water
  - People are drawn to moving water for recreation
    - Many underestimate power and hazards of water
  - Hydraulics of moving water are affected by several variables
    - Include depth and velocity of water and any obstructions to flow
  - Water rescue is very dangerous and requires special training and skills
    - Should never be attempted by single rescuer or by untrained one
Obstructions to Flow

• Water that moves over uniform obstruction can create recirculating currents ("drowning machines")
  – Can trap victims and make escape difficult
  – Recirculating currents commonly are found in rivers and on low-head dams and often appear harmless
  – Height of dam is no indication of degree of hazard
  – Force of moving water is very deceptive and makes for hazardous rescue
  – Trapped victims often succumb to fatigue, hypothermia, drowning

Obstructions to Flow

• Strainers are obstructions that allow current to flow through but that can trap objects such as boats or people
  – Force of water against victim makes escape difficult
  – Rescue teams must approach strainers cautiously to avoid becoming entrapped themselves
Foot or Extremity Pin

- Generally considered unsafe to walk in fast-moving water that is over knee-high depth
  - Doing so may lead to entrapment of extremity in strainer
  - Victim can be dragged under water’s surface
  - With foot or extremity pin, crucial to remember that body part must be extricated in same way it went in

Flat Water

- About 3600 deaths occur each year in flat (static) water (lakes, ponds, and marsh) as a result of drowning
  - Factors
    - Alcohol or other drug use
    - Cool water temperature, which leads to hypothermia
  - Factors can quickly incapacitate victim and result in drowning

Flat Water

- Most people who drown never planned on being in water
  - Personal flotation devices (PFDs) worn routinely and fastened properly when person is on or around water can save lives by reducing likelihood of drowning
  - PFDs are required during water rescue operations
    - Type I or Type II PFDs are preferred for water rescue work
    - Type III, IV, and V PFDs are suitable for some rescue situations
Water Temperature

- Immersion in water with temperature below 98°F (37°C) can cause hypothermia
  - Person cannot maintain body heat when water temperature is below 92°F (33°C)
  - Water causes heat loss 25 times faster than exposure to air at same temperature
    - Colder the water, faster rate of heat loss
    - At water temperature of 35°F (1.7°C), person immersed for 15 to 20 minutes likely will die of hypothermia and drowning

Water Temperature

- Sudden immersion in cold water may trigger laryngospasm
  - Can lead to
    - Aspiration
    - Severe hypoxia
    - Unconsciousness

Water Temperature

- If hypothermia develops, victim often is unable to follow directions or help himself or herself to safety
  - PFDs lessen heat loss and energy required for flotation
  - In cases of sudden immersion, single victim should assume fetal position
    - Heat escape-lessening posture (HELP)
  - Multiple victims should huddle together to reduce heat loss
Cold Protective Response

- Cold protective response is mammalian diving reflex
  - Increases chance of victim’s survival in cold water
  - Response includes
    - Parasympathetic stimulation from immersion of face in cold water
      - Leads to bradycardia
    - Peripheral vasoconstriction that shunts blood to core
    - Hypotension

Cold Protective Response

- Cold protective response is mammalian diving reflex
  - Effectiveness of this protective response depends on
    - Victim’s age
    - Posture in water
    - Lung volume
    - Water temperature
Cold Protective Response

• Rapid development of hypothermia sometimes can improve brain viability in patients who suffer prolonged submersion
  – Hypothermic patients should be presumed salvageable
    • “A victim is never cold and dead, only warm and dead”
    • Patient must be rewarmed in hospital before accurate assessment can be made

Rescue versus Body Recovery

• Refers to chance to save human life (rescue) or body recovery without goal of saving human life
  – Factors affect outcome of patient who has been submerged in water
    • Length of time victim has been submerged
    • Known or possible trauma
    • Environmental conditions
    • Victim’s age and physical condition
    • Time until rescue or removal is achieved

Rescue versus Body Recovery

• Successful resuscitation with full recovery has occurred in victims of prolonged submersion in extremely cold water
  – Resuscitation should be initiated by rescuers at scene unless physical evidence of death is obvious
    • Putrefaction
    • Dependent lividity
    • Rigor mortis
In-Water Spinal Immobilization

- In-water spinal immobilization requires special training
  - Only rescuers trained in water rescue should enter water
- Steps required for in-water spinal immobilization
  - Turn patient to supine position by rotating entire upper half of body as single unit
  - Using spinal precautions, begin artificial ventilation (if needed)
    - Do not attempt to clear airway of water

In-Water Spinal Immobilization

- Steps required for in-water spinal immobilization
  - Float long spine board under patient's body
  - Apply rigid cervical collar
  - Secure patient to spine board with straps, cravats, or other devices
  - Float patient to edge of water and remove
    - Remove patient from water and completely stabilize
    - Cover patient to prevent hypothermia
    - Begin CPR if indicated

Overview of Rescue Techniques

- Rescuers should never underestimate power of moving water
  - Never attempt water rescue without highly specialized training
Overview of Rescue Techniques

• Recommended water rescue model is reach-throw-row-go
  – Reach
    • If victim is close to shore, paramedic should try to reach out to person
    • An oar, large branch, pole, or some other rescue device should be used
    • Before rescue attempt, paramedics should don PFD
    • Make sure footing is secure so not pulled into water by victim

  – Throw
    • While paramedic remains on shore, flotation device (e.g., a water throw bag attached to polypropylene rope) should be thrown to victim
    • Victim can be pulled to shore

  – Row
    • If reach and throw methods are unsuccessful or if victim is unconscious, trained rescuers should row out to victim in boat if one is available

  – Go
    • If boat is unavailable and reach and throw methods are not viable options, trained rescuers should go to patient by wading or swimming
Overview of Rescue Techniques

• Shore-based rescue attempt by first responder is method of choice
  – Coach victim in self-rescue
  – Reaching or throwing

• Boat-based or “go” techniques require specialized training

Self-Rescue Techniques

• If paramedics inadvertently enter dangerous water, use self-rescue techniques as follows
  – Cover your mouth and nose during entry
  – Protect your head and keep your face out of water
  – If in flat water, assume HELP position
  – If in moving water, do not attempt to stand up
  – Float on your back with your feet downstream and your head pointed toward nearest shore at a 45-degree angle

Hazardous Atmospheres

• Hazardous atmospheres are oxygen-deficient environments that may occur in confined spaces
  – Confined spaces have limited access or egress and are not designed for human occupancy or habitation
  – According to the National Institute of Occupational Safety and Health (NIOSH), nearly 60 percent of deaths associated with confined spaces are people attempting rescue of victim
Hazardous Atmospheres

- Confined spaces examples
  - Grain bins and silos
  - Wells and cisterns
  - Storage tanks
  - Manholes and pumping stations
  - Drainage culverts
  - Underground vaults
  - Trenches and cave-ins

Hazardous Atmospheres

- According to OSHA, six major hazards are associated with confined spaces
  - Oxygen-deficient atmospheres
  - Chemical/toxic exposure or explosion
  - Engulfment
  - Machinery entrapment
  - Electricity
  - Structural concerns

Oxygen-Deficient Atmospheres

- Not visible hazard
  - Rescuers often presume atmosphere is safe
  - Oxygen in confined spaces must be tested
  - Use atmospheric monitoring meter at top, middle, bottom of confined space before entry
  - Any confined space that has oxygen concentration less than 19.5 percent must be considered an atmospheric hazard
  - Oxygen level that is too high (over 22 percent) in confined space may produce rapid combustion
  - Serious safety hazard
Chemical/Toxic Exposure or Explosion

- Oxygen can be removed from atmosphere by certain chemical reactions
- Reactions that occur during formation of rust on steel structures and while pouring concrete
- Natural decaying processes that displace oxygen by producing dangerous gases (e.g., methane)
- Presence of some chemicals and gases can lead to toxic exposure

Chemical/Toxic Exposure or Explosion

- May pose high risk of explosion
  - Some dusts and particulate materials found in grain bins, silos, and storage tanks can be highly explosive when mixed with air
  - Many gases are heavier than air
    - Found in higher concentrations at bottom of storage vessels
  - Trained personnel should monitor for toxic or explosive gases in confined spaces using appropriate testing device

Why can workers easily become disabled in situations that may involve exposure to toxic gases?
Engulfment

- Mechanical entrapment
  - Can occur when earth, grain, coal, or any other dry material that can flow engulfs person in a confined space
  - Engulfment can produce oxygen-deficient atmosphere and subsequent suffocation
  - Those trapped by engulfment may be victims of physical (crushing) injury
  - Also are at increased risk from explosive hazards

Machinery Entrapment

- Some structures, such as grain bins and silos, often have augers, screws, conveyors, and other machinery to move material stored in them
  - Can entrap person requiring extrication
  - Before rescue is attempted, trained and experienced personnel should identify and secure all such devices

Electricity

- Electrical hazards from power supply of motors and materials-management equipment may be present in some situations
  - All electrical devices must be identified and secured by experienced personnel
    - Helps to ensure safety of rescuer
Electricity

• Electrical hazards from power supply of motors and materials-management equipment may be present in some situations
  – Lock-out process must prevent any unauthorized person from entering area or gaining access to controls that have been shut off
  • Motors and other electrical devices can “store” power that can lead to entrapment or injury
  • Chemical, steam, and water lines also must be secured or blocked by trained personnel during all rescues

Structural Concerns

• Supporting structures of confined space must be identified before entry to aid in safe rescue and extrication
  – Examples
    • Most cylindrical structures are supported by central I beams
    • These beams make for relatively easy maneuvering
    • Noncylindrical structures may have L-, T-, and X-shaped spaces
    • Can affect entry and rescue procedures
    • Can complicate extrication pathway

Crush Compartment Syndromes Secondary to Entrapment

• Compartment syndrome can be caused by crushing mechanisms, which lead to
  – Ischemic muscle damage
  – Tissue necrosis
  – Crush syndrome
Crush Compartment Syndromes Secondary to Entrapment

• Injuries can be severe
  – Associated with
    • Rupture of internal organs
    • Major fractures
    • Hemorrhagic shock

• Degree of injury produced by crushing force depends on three elements
  – Amount of pressure applied to body
  – Length of time pressure is exerted on body
  – Specific body region where injury occurs
• Massive crush injury to vital organs may cause immediate death

• Patients with crush syndrome are victims of compressive forces that crush tissue
  – Causes prolonged hypoxia
  – Patient may appear stable for hours or days, as long as compressive forces remain in place
  – When patient is released from entrapment, reperfusion of trapped body part may lead to detrimental processes
    • Volume loss into tissue
    • Release of myoglobin, lactic acid, and other toxins into circulation
Crush Compartment Syndromes Secondary to Entrapment

• These events occur simultaneously and may ultimately lead to death
  – If patient’s condition or mechanism of injury is suspicious for compartment syndrome or crush injury, consult with medical direction
  – Management of crush syndrome is controversial
    • Prehospital care must be supervised through medical direction physician familiar with this pathological process

Emergencies in Confined Spaces

• OSHA requires permit before workers may enter confined space
  – Standard has forced industrial, municipal, and government response teams to be better prepared to manage confined-space incidents
  – Requirements for obtaining permit
    • Area must be made safe or workers must wear PPE
    • Fall-arresting and retrieval devices must be in place
    • Environmental monitoring must be available at site before entry

Emergencies in Confined Spaces

• Sites without permits, with no atmospheric monitoring are likely locations for emergencies
  – At these sites, rescuers often may encounter oxygen-deficient atmospheres
  – Other types of emergencies that can occur in confined spaces (in both permitted and nonpermitted locations)
    • Falls
    • Medical emergencies
    • Explosion
    • Entrapment
    • Exposure to toxic gases and chemicals
Safe Entry for Rescuers

- Safe entry for rescuers in confined-space operation requires specialized training
  - No rescuer should enter space until rescue team has made area safe

Safe Entry for Rescuers

- Safe entry cannot be made without
  - Proper and thorough training in confined-space rescue
  - Atmospheric monitoring to determine
    - Oxygen concentration
    - Hydrogen sulfide level
    - Carbon monoxide level
    - Explosive limits
    - Flammable atmosphere
    - Toxic air contaminants

Safe Entry for Rescuers

- Safe entry cannot be made without
  - Proper ventilation
  - Secured electrical systems (lock-out/tag-out of all power)
  - Dissipation of stored energy
  - Disconnection of all pipes (blinding/blanking) to prevent flow into the site
  - Appropriate respiratory protection
Supplied-Air Breathing Apparatus

- Close quarters make access and extrication difficult in confined-space rescue
  - Use of typical “bottle on back” SCBA is usually dangerous
    - Provides limited air supply
    - Can cause entrapment
    - May have to be removed in order to reach victim
  - Supplied-air breathing apparatus (airline SABA) is preferred in confined-space operations
    - Lightweight devices provide nearly unlimited supply of air from device located outside confined space

Supplied-Air Breathing Apparatus

- Potential complications of SABA
  - Equipment malfunction
  - Damaged or entangled air lines
  - Limitations imposed by length of air hose
- Trained rescuers carry small, personal reserve air supply (escape bottle) that can be used for short time if needed
Arriving at the Scene

• EMS crew that arrives at scene of confined-space emergency should proceed as follows
  – Perform scene size-up and determine nature of emergency by obtaining copy of OSHA permit for site
    from permit/entry supervisor
    • Determine number of workers (victims) in confined space
  – Request specialized rescue teams
  – Establish safe perimeter away from incident
    • Allow only rescue team members to enter space
  – Assist workers at site with any remote retrieval devices they may be using

Arriving at the Scene

• Scene safety is of prime importance for all involved in rescue
  – Only specialized rescue personnel should directly perform rescue activities
  – EMS personnel who are not trained in specialized rescue should assist rescue team only if they can
    do so safely without entering space
Rescue from Trenches and Cave-Ins

- Most trench collapses occur in trenches less than 12 feet deep and 6 feet wide
  - Federal law requires either shoring or trench box for evacuations that are 5 feet or deeper
  - Often collapses occur when contractors forsake safety measures because of increased cost of providing them

Rescue from Trenches and Cave-Ins

- Factors that contribute to collapse
  - Cave-in of lips on one or both sides of trench
  - Walls that shear away and cave in
  - Piling of excavated dirt too close to edge, causing collapse
  - Presence of intersecting trenches
  - Ground vibrations
  - Water seepage

Arrival at the Scene

- On arrival at scene of collapse that has resulted in burial, keep in mind that second collapse is likely; do not approach lip
- EMS personnel should not attempt rescue unless trench is less than waist deep
Arrival at the Scene

- Scene management for trenches and cave-ins
  - Secure scene, establish command, and secure safe perimeter
  - Shut down nonessential equipment that can cause vibrations
  - Request specialized rescue teams
  - Prevent entry into trench or cave-in area

Arrival at the Scene

- Access to patient should be attempted by trained personnel only after proper shoring is in place
  - Process of shoring and excavating can be labor and time intensive
  - Scene safety is necessary for successful recovery

Consider an EMS and rescue team that, for safety reasons, will be unable to go in after a person who is buried in a trench collapse. How do you think they will feel?
Highway Operations

- Traffic flow is major hazard in EMS highway operations
  - Factors associated with highway hazards
    - Emergency responses to limited and unlimited access highways
    - Emergency vehicle crashes
    - Backup of traffic that impedes flow to and from scene
  - EMS personnel must work closely with law enforcement to help ensure safe response

Highway Operations

- Paramedics can take following steps to reduce traffic hazards
  - Position apparatus (pumper, rescue, or other emergency vehicle) across traffic way in fend-off position
    - Protects scene from traffic hazards
  - Stage unnecessary apparatus off highway
    - Essential on limited-access highways
    - Establish staging area away from scene
  - Position apparatus to reduce traffic flow and provide for safe ambulance loading area

Highway Operations

- Steps to reduce traffic hazards
  - Use only essential warning lights so drivers are not distracted or confused
    - Consider use of amber scene lighting
    - Turn off headlights that might blind nearby motorists
  - Use traffic cones and flares to redirect traffic away from workers and to create safe zone
    - Use flares safely in proximity to scene
    - Do not extinguish them once they have been ignited
  - Make sure all rescuers wear high-visibility clothing
    - Orange highway vests
    - Reflective trim
Highway Operations

- Other scene hazards associated with highway operations
  - Fuel and fire hazards
  - Electrical power
  - Unstable vehicles
  - Airbags and supplemental restraint systems (SRS)
  - Hazardous cargoes

Fuel and Fire Hazards

- Gasoline spills from crashes are common fire hazard encountered by EMS providers
  - Chances that flammable liquids will ignite can be reduced by
    - Turning off vehicle ignition switch
    - Forbidding smoking
    - Avoiding use of flares near spill
  - EMS personnel should approach scene with fire extinguishers and should keep extinguishers ready throughout extrication
  - Ideally, fire apparatus with charged hose line should be at scene

Fuel and Fire Hazards

- Vehicle should be put in park and engine turned off immediately after gaining access
  - Battery of crashed car generally should be left connected so that power electric door locks, windows, seat mechanisms, and trunks can be operated
  - If battery is to be disabled, ground cable should be disconnected first to reduce chance of sparking
    - May ignite spilled fuel or leaking battery gases
Fuel and Fire Hazards

- Battery cable can be cut with wire cutters or disconnected with battery pliers
  - Disconnected cable should be folded back onto itself
  - Should be securely taped to insulate it from any bare metal contact that might reestablish electrical ground to system
  - Both cables should be disconnected and secured

Fuel and Fire Hazards

- Vehicle fires associated with crashes usually are caused by ruptured fuel tanks and fuel lines ignited during crash
  - Catalytic converters are capable of igniting spilled fuel
  - Do not try to fight fully involved vehicle fires unless trained and properly equipped
  - If fire service has not arrived and victims are in burning vehicle, EMS crew should quickly determine whether victims can be safely removed
    - If victims are trapped and vehicle is not fully engulfed by flames, attempt should be made to stop fire from spreading
    - Done using fire extinguishers

Fuel and Fire Hazards

- Burning vehicles present very serious potential hazards
  - May explode with deadly force at any time
  - All actions must be directed toward rescuer safety and protection
  - When paramedics must approach burning vehicle, crouch low and approach from side, staying clear of bumpers that may fly off during explosions
  - PPE also should be worn to guard against dangerous and caustic smoke
Alternate Fuel Systems

- Some automobiles operate with alternate fuel systems
  - Powered by natural gas
  - High-voltage electrical storage cells
  - Hybrid vehicles that use combination of fuel sources

Alternate Fuel Systems

- Alternate fuel sources are capable of producing fire hazards and injury from explosion of high-pressure cylinders and storage cells
  - Electric vehicles also carry enough voltage to cause serious burns, electric shock, and death
  - Hybrid vehicles often can be identified by hybrid label and presence of orange sleeves that cover components under hood, in rear, and under car
  - Each automobile manufacturer has specific guidelines for emergency personnel to follow when working at crash scene

Alternate Fuel Systems

- General guidelines for rescue
  - Remain safe distance from vehicle if on fire
  - Always power down windows, open locks and latches, and move electric seats before disabling any vehicle
    - Put vehicle in park
    - Chock wheels as soon as possible in case car in "sleep mode" has its gas pedal depressed inadvertently by driver
Alternate Fuel Systems

• General guidelines for rescue
  – Verify that vehicle is absolutely not under any power
  – Always assume vehicle is powered up despite no engine noises
  – Shutting vehicle off shuts down hybrid system, shuts down fuel pump, stops electrical flow to airbags, and isolates high-voltage current from battery pack
  – Many conventional and hybrid vehicles use keyless entry/start ignition/start system
  – High-voltage capacitors can store voltage current for up to 10 minutes, even after vehicle is shut down
  – During this “drain time,” vehicle should be considered unsafe

Alternate Fuel Systems

• General guidelines for rescue
  – Never touch, cut, or open any orange cable or components protected by orange sleeves
  • Always consider high-voltage cable to be live or hot

Electrical Power

• Downed electrical wires are dangerous
  – Modern transformers are programmed to retest broken circuits at certain time intervals
  – Dead lines can suddenly surge with lethal current
Electrical Power

• Downed electrical wires are dangerous
  – Rescuers must be familiar with power system in their area
    • Check with local power company for information and availability of training sessions for response team
    • Only utility workers and trained rescuers using proper equipment should secure downed electrical wires

Electrical Power

• Rescuers should never approach patient until scene is safe
  – Rescuers who experience tingling sensations in soles of feet, legs, or thorax as they enter area should not proceed
    • Retreat from area
  – Victims inside vehicle in contact with downed wires should be advised to remain inside unless at additional risk of injury (e.g., explosion, fire)
  – Leaving vehicle is dangerous and poses significant risk of electrical injury

Electrical Power

• When absolutely necessary to touch patient who is in contact with source of electricity, trained personnel may use nonconductive equipment such as
  – Leather gauntlets
  – Wooden poles
  – Polypropylene rope
  – Other specially designed equipment
    • None of these provides absolute safety from electrical injury
Unstable Vehicles

- Unstable vehicles are common hazard in rescue events
  - Must be stabilized before access is gained
  - When assessing stability of vehicles, consider
    - Mechanism of crash
    - Position and number of vehicles
    - Environment of scene

Unstable Vehicles

- Some vehicles are obviously unstable
  - Even car on its wheels that appears to be stable may be unstable from possible movement of tires and swaying of vehicle’s suspension system
  - All wrecked vehicles should be approached cautiously

Unstable Vehicles

- Some vehicles are obviously unstable
  - Standard methods of stabilizing vehicles
    - Supporting vehicle with wooden cribbing, wheel chocks, and airbags
    - Securing vehicle with ropes, cables, and chains to poles, trees, and other vehicles and structures
  - Specialized training is required for paramedics involved in this aspect of rescue management
Airbags and Supplemental Restraint Systems

- Airbags as supplemental restraint system (SRS) are required safety features in all cars manufactured in U.S.
  - Three main types of airbags
    - Frontal impact
    - Side impact
    - Head protection bags
  - Airbags generally are considered effective safety device in crashes
    - Children and small adults in passenger seat have been fatally injured after airbag deployment

- Once deployed, airbags are not dangerous
- Produce residue that can cause minor skin or eye irritation
  - Irritation is temporary
  - Can be avoided by
    - Wearing gloves and eye protection
    - Keeping residue away from patient’s eyes and wounds
    - Thoroughly washing after exposure
Airbags and Supplemental Restraint Systems

- Emergency personnel should be trained in detection and scene management of SRS equipment
  - Rescue guidelines for airbag-equipped cars have been provided by NHTSA and automobile and airbag manufacturers
    - Have been coordinated with U.S. Fire Administration

Hazardous Cargoes

- Most hazardous substances transported in U.S. travel by road
  - Paramedics should be suspicious of crashes that involve commercial vehicles

Automobile Anatomy

- Construction, roof, support posts
  - Most vehicles are of unibody rather than frame construction
  - Support posts (A, B, C, D posts), floor fire wall, trunk are integral to integrity of unibody construction
    - Cutting support posts can threaten stability
Automobile Anatomy

• Fire wall and engine compartment
  – Fire wall separates engine and occupant compartments
  • Often collapses onto occupant’s legs during high-speed, head-on collisions
  – Car battery is usually located in engine compartment

Automobile Anatomy

• Glass
  – Safety glass is composed of glass-plastic and laminate glass and is usually found in windshield
  • Designed to stay intact when glass is broken or shattered (fractures into long strands)
  – Tempered glass has high tensile strength and may not stay intact when shattered or broken (fractures into small pieces)

Automobile Anatomy

• Doors
  – Most car doors contain reinforcing bar
  • Designed to provide structural integrity to vehicle and protection to occupants during front- and side-impact collisions
  – Have case-hardened steel “Nader” pin or latch designed to prevent car door from opening during impact
  • If engaged, may be difficult to pry open door; must be disengaged first
Rescue Strategies

- Rescue strategies should begin during initial scene size-up
  - Can be based on details provided by dispatching center before arrival
  - On arriving at scene, EMS crew should
    - Begin hazard control
    - Establish command
    - Call for appropriate backup

Rescue Strategies

- Important elements of scene size-up
  - Scene safety (including protecting scene from traffic hazards)
  - Location of crash
  - Vehicle stability
  - Electrical hazards
  - Fire hazards
  - Hazardous materials
  - Special rescue needs
  - Number and location of patients
Rescue Strategies

- After initial scene size-up and ensuring scene safety, responding crew should assess degree of entrapment and fastest means of extrication
  - Try to gain access to trapped victims by first trying to open all car doors
  - When door cannot be opened by patient or rescuer, check side windows
    - Glass windows can be shattered by striking glass in lower corner or by using spring-loaded center punch

Rescue Strategies

- Initial care can then be provided until patient has been extricated
  - Trained rescue personnel with extrication tools can gain access to patient by
    - Door removal
    - Roof removal
    - Front or rear windshield openings
    - Dash roll-up maneuver
Rescue Strategies

• Paramedics involved in rescue or who are near the site should wear PPE that provide adequate hand, eye, body protection
  – Persons trapped in vehicle should also be protected during extrication
  – Clothing with reflective striping improves safety during day and night operations

Hazardous Terrain

• Hazardous terrain can pose major difficulties during rescue operations
  – Car crash that occurs on embankment
  – Rescues for sport enthusiasts such as rock climbers, snow skiers, mountain bikers
• Three common classifications of hazardous terrain
  – Low-angle
  – High-angle
  – Flat terrain with obstructions

Hazardous Terrain

• Low angle (steep slope)
  – Terrain that can be walked on without use of hands
  – Secure footing may be difficult on steep slopes
    • Hazardous to carry litter even with several rescuers
    • Low-angle rescue used to prevent falls and tumbles through use of ropes to counteract gravity during litter carrying
Hazardous Terrain

• High angle (vertical)
  – Terrain (cliffs, sides of buildings) that is so steep hands must be used to maintain balance (slopes greater than 40 degrees)
  – Rescuers are completely dependent on rope or aerial apparatus for litter movement
  – Requires rappelling (controlled descent by rope) by trained personnel to retrieve victims
  – Falls are likely to result in serious injury or death
What factors in the environment can increase the danger of steep-slope rescue?

Hazardous Terrain

- Flat terrain
  - May include various obstructions that can make rescue difficult
    - Level land with large rocks, loose soil (scree), and waterbeds or creek
  - Extra personnel and resources may be needed to extricate victim safely and ensure safe litter movement
Basket stretcher is standard for rough-terrain evacuation

- Rigid frame offers protection for victim
- Relatively easy to carry with adequate personnel
- Patients are immobilized on long backboard, and secured in basket
- Alternative spinal immobilization devices (e.g., vest-type devices) also can be used in conjunction
- Using basket stretcher itself as spinal immobilization device should be considered last resort
- Older “military style” devices do not provide adequate spinal immobilization

Basket stretchers have two basic designs: wire mesh (Stokes) and plastic

- Wire mesh generally is stronger
  - Relatively inexpensive
  - Design allows for air and water to flow through device
  - Ideal in water rescue when used with supplemental flotation

Basket stretchers have two basic designs: wire mesh (Stokes) and plastic

- Plastic basket stretchers generally are weaker than steel mesh
  - Provide better protection for patient
  - Most are equipped with adequate restraints
- All require additional strapping or lacing (e.g., harness, leg stirrups) to prevent movement, as well as padding for rough-terrain evacuation or extraction
  - Plastic helmet or litter shield should be available to protect patient

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Patient Movement

- Methods of moving patient over rough terrain may include evacuation and litter-carrying over flat terrain
  - Special rescue equipment may be required for low-angle and high-angle evacuation
    - Load-lifting straps
    - Anchors
    - Rope-lowering and rope-hauling systems
    - Aerial apparatus (e.g., tower-ladder or bucket trucks, aerial ladders)
  - Moving a patient during low-angle and high-angle evacuations requires specialized knowledge and skills

Litter-Carrying Procedures

- Carrying litter across rough, flat terrain requires minimum of six rescuers
  - Four to carry litter
  - Two to observe or "scout" for potential hazards (e.g., loose rocks, holes, tree branches)
  - Team members should be matched in height
    - Ensures equal weight is shared and litter remains level
  - Load-lifting straps sometimes are used to spread weight of load over other parts of rescuer's body
  - Proper lifting techniques should be used to protect and support rescuer's back
Helicopter Use in Hazardous-Terrain Rescue

- Helicopters can be used for transport and rescues
  - When used for rescue, helicopter team (civilian and military) is geared toward performing rescue rather than providing medical care and transport
  - Rescue helicopter team has specialized knowledge and skills
    - Required to hover or land in tight places and to transport people and equipment

- Special rescue techniques helicopters use may include
  - Cable hoisting to extract people from ground
  - Short-haul (sling load) operations that allow personnel and equipment to be carried beneath helicopter as external load
  - Rescue helicopters have same safety concerns and limitations as those used for medical transport
  - All personnel at scene should be familiar with elements of scene safety, hazards, and restrictions for helicopter use

Assessment Procedures During Rescue

- Patient assessment during rescue operations often is complicated by factors
  - Weather and temperature extremes
  - Available access
  - Equipment limitations
  - Patient entrapment
  - Cumbersome PPE that affects rescuer mobility
Assessment Procedures During Rescue

- Other factors that can affect paramedic’s ability to perform thorough assessment and can result in compromised physical examination
  - Difficulty completely exposing patient
  - Restrictive clothing and PPE required for personal safety
  - Working in cramped space
  - Limited lighting
  - Difficulty transporting medical equipment to patient

Specific Assessment and Management Considerations

- During rescues, paramedics may need to downsize medical equipment
  - May not be able to carry normal bags and “street packaging”
  - Ideally, paramedics should be able to carry equipment hands free

Exposure of Patients

- Patients who need to be rescued may be at high risk for developing hypothermia
  - Should be covered to ensure thermal protection
  - Should be protected with shields (e.g., backboards or blankets) to prevent injury from equipment and debris during extrication
Advanced Life Support Measures

- Advanced life support (ALS) measures should be provided only if necessary
  - Good basic life support (BLS) techniques are mandatory
  - ALS equipment such as IV lines, endotracheal (ET) tubes, and ECG leads will complicate extrication process
    - Advanced airway support and volume replacement may be essential
    - Airway control with administration of supplemental oxygen must always be priority during rescue

Patient Monitoring

- Monitoring of patient’s vital signs and level of consciousness is necessary throughout rescue
  - In high-noise and tight spaces, BP may need to be measured by palpation
  - May be necessary to use compact devices such as pulse oximeter
  - Create and continue rapport with patient when possible
  - Explain procedures performed and why necessary
  - Providing emotional support during rescue is crucial

Improvisation

- Because of space and equipment limitations, some patient care may have to be improvised during rescue
  - Examples
    - Upper extremity fracture can be temporarily stabilized by tying it to patient’s torso
    - Lower extremity fracture can be tied to patient’s uninjured leg (buddy splinting)
    - Formable splints can be very useful for securing extremity fractures or dislocations
Pain Control

• Pain control for patients who require rescue may include drug therapy (narcotics, analgesics) and other methods
  – Nondrug therapy to manage pain
    • Splinting and positioning
    • Distraction (talking to patient and asking questions)
    • Sensory stimuli (e.g., mildly scratching patient) when painful procedure or maneuver is performed
  – Pain medication can mask serious injury and alter patient’s level of consciousness
    • Follow established protocol regarding use of drug therapy in these situations

Summary

• Rescue is a patient-driven event; it calls for specialized medical and mechanical skills
  – Right amount of each must be applied at right time
  – Main role of paramedic in rescues is to have proper training and appropriate PPE
    • Allow safe access to patient and provision of treatment at site and throughout incident

Summary

• Seven phases of a rescue operation are arrival and scene size-up, hazard control, gaining access to patient, medical treatment, disentanglement, patient packaging, and transportation
• Standards for protective clothing and PPE established by National Fire Protection Association and OSHA have been adopted by many fire and EMS agencies
  – Appropriate PPE depends on level of rescuer involvement and nature of incident
Summary

• Water rescue should never be attempted by a single rescuer or by one who is untrained
• Water hazards include obstructions to flow and foot or extremity pins that can trap victims and drag them under water
  – Some factors that contribute to flat water drowning are alcohol or other drug use
  – Cool water temperatures contribute to such drownings

Summary

• Hazardous atmospheres are environments with low oxygen
  – These environments can occur in confined spaces
  – Six major hazards associated with confined spaces are oxygen‐deficient atmospheres, chemical/toxic exposure and explosion, engulfment, machinery entrapment, electricity, and structural concerns

Summary

• Traffic flow is biggest hazard in EMS highway operations
  – Other scene hazards associated with highway operations include fuel or fire hazards, electrical power, unstable vehicles, airbags and supplemental restraint systems, and hazardous cargoes
• Hazardous terrain can create major difficulties during rescue events
  – Three common classifications of hazardous terrain are low‐angle, high‐angle, and flat terrain with obstructions
Questions?