Respiratory Care Emergency Preparedness For Mass Casualty Events

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This Presentation is Approved for 2 CRCE Credit Hours

Learning Objectives

- Identify infections capable of causing mass casualties & describe their etiologies, manifestations, diagnosis, management & prevention
- Describe strategies & devices to prevent communication of infections to caregivers, patients & the environment
- Identify chemical agents capable of causing mass casualties & describe their likely sources, effects, manifestations & management of chemically contaminated patients
- Identify the sources of mass casualty radiation events & describe the effects, manifestations & management of radiation injuries
- Identify sources of blast injuries & describe the types of injuries, their manifestations & their management

Learning Objectives

- Describe major types of natural disasters, their associated types of injuries, their manifestations & management
- Discuss problems associated with healthcare delivery in natural disasters, including those associated with transportation & destruction of physical facilities
- Distinguish among conventional, contingency, crisis modes within a healthcare facility with respect to space, staffing, equipment & supplies
- Describe preparations & response strategies for mass casualty situations with respect to respiratory care equipment & supplies, including oxygen & mechanical ventilators

Mass Casualty Events

Disaster

- Definition: a sudden calamitous event bringing great damage, loss, or destruction (Merriam-Webster)
- Types
  - Natural disasters, e.g. pandemics, hurricanes, earthquakes, etc.
  - Man-made
    - Accidental, e.g. industrial explosions
    - Terrorism, which intends to injure & to provoke maximum fear

Medicine in Mass Casualty Incidents

- Conventional medicine: do the greatest good for the individual patient
- Disaster medicine: do the greatest good for the greatest number of patients
  - Triage of victims
  - Economizing resources
  - Reliance on available assets
  - Mass evacuation

Possible Mass Casualty Scenarios

- Pandemic infections (febrile respiratory illnesses)
- Bioterrorism
- Chemical injuries
- Radiation injuries
- Natural disasters
- Explosions

Febrile Respiratory Illnesses (FRI) & Bioterrorism

Infections Capable of Mass Casualties

- Naturally-occurring
  - Influenza, e.g. swine influenza A (H1N1)
  - Severe acute respiratory syndrome (SARS) - coronavirus infection
  - Avian (bird) flu

Infections Capable of Mass Casualties

- Bioterrorist threats
  - Pulmonary anthrax
  - Smallpox
  - Plague
  - Tularemia
  - Viral hemorrhagic fever, e.g. Ebola, Marburg

Influenza

- Causative agent: viruses
- Communication routes
  - Airborne
  - Contact
- Manifestations
  - Fever
  - Headache
  - Muscle pain
  - Malaise
  - Pneumonia - may progress to ARDS

Influenza

- Diagnosis
  - Index of suspicion: clinical signs, multiple cases
  - Oral swab for viral ID
  - Clinical signs for mass victims
- Problem: many people may be exposed before diagnosis is made
  - Masks for patients in ER waiting rooms?

Influenza

- Management
  - Home care, if possible & safe
  - Supportive care, e.g. hydration
  - Oxygen
  - Ventilation with low TV
  - Antiviral agents
    - Amantidines
    - Neuramidinase inhibitors

Influenza

- Prevention
  - Vaccination
  - Antiviral agents
    - Amantidine
    - Neuramidinase inhibitors
  - Airborne isolation of patients

Influenza

- Prevention
  - Vaccination
  - Antiviral agents
    - Amantidine
    - Neuramidinase inhibitors
  - Airborne isolation of patients
  - Personal protection equipment (PPE)
    - N95 mask
    - Respirator for high-risk procedures
  - Minimize high-risk procedures

Pulmonary Anthrax

- Pulmonary form likely due to bioterrorism
- Causative agent: bacillus anthracis
  - Spore forming
  - Gram positive rod
- Communication route
  - Inhalation of spores
  - No person-to-person transfer

Pulmonary Anthrax

- Manifestations
  - 3-5 day incubation period
  - Fever, chills
  - Dyspnea, chest pain
  - Cough
  - Headache
  - Nausea & vomiting
  - Hypoxemia
  - Stridor
  - Widened mediastinum on radiograph

Pulmonary Anthrax

- Diagnosis
  - Index of suspicion: exposure risk
    - Occupation
    - Location
  - Pathognomonic (distinct signature)
    - Previously healthy adult
    - Overwhelming flu-like signs
    - Widened mediastinum

See link below to view chest radiograph of pulmonary anthrax

Pulmonary Anthrax

- Diagnosis
  - Sputum exams are NOT useful
  - Standard blood culture - growth in 6-24 H

Pulmonary Anthrax

- Management
  - Supportive: ventilation, O_2
  - Antibiotics
    - Doxycycline
    - Ciproflaxin
    - Amoxicillin

Pulmonary Anthrax

- Prevention
  - Universal precautions for patient care - no special barriers
  - Antibiotics for suspected exposure (60 D)
  - Human live attenuated vaccine
    - Three injections, two weeks apart
    - Three injections at 6, 12, 18 months

Smallpox

- Causative agents
  - Variola minor virus (less virulent)
  - Variola major virus
- Communication route
  - Inhaled droplets, aerosols
  - Very contagious

Smallpox

- Manifestations
  - Incubation: 10-14 days
  - Pre-eruptive phase (lasts 2-4 D)
    - High fever
    - Severe headache
    - Malaise
  - Eruptive phase
    - Centrifugal rash, starting on face
    - Evolves to pustular rash

Smallpox Rash

Smallpox

- Manifestations
  - Toxemia
  - Encephalitis
  - Mortality (20-30%) - 5th or 6th day after onset of rash

Smallpox

- Diagnosis - one suspected case represents an international health emergency
  - Characteristic rash
    - Centrifugal distribution
    - Same stage of development at each location
    - Palmar & plantar location (rare with chickenpox)
    - Confirmed by laboratory analysis

Smallpox

- Management
  - Strict isolation for hospitalized patients
  - Home care recommended
  - Supportive care
  - Antibiotics for secondary bacterial infection
  - Antiviral agents
    - Currently, none are approved
    - Agents for HIV have potential

Smallpox

- Prevention - post-exposure control
  - All face-to-face contacts with victim
    - Vaccinated
    - Surveillance for fever, rash
  - Vaccination of healthcare workers, police, transit workers, etc.

Smallpox

- Prevention - hospital infection control
  - Rooms - negative pressure with HEPA
  - Vaccination of employees, patients
  - Laundry & waste - biohazards

Plague

- Causative agent
  - Yersinia pestis
  - Gram negative rod
- Communication route(s)
  - Bite from infected flea
  - Droplets, aerosol (bioterrorism)
  - Contact (person-to-person)

Plague

- Forms
  - Bubonic (flea bites)
  - Septicemic
  - Pneumonic (bioterrorist aerosols)

Plague (Pneumonic)

- Manifestations (pneumonic)
  - Incubation: hours to days
  - Malaise
  - High fever, chills
  - Hemoptysis
  - Leukocytemia
  - Rapidly progressive pneumonia
  - Hypoxemia
  - Mortality: 100% if untreated

Plague (Pneumonic)

- Diagnosis
  - Index of suspicion: sudden outbreak of severe pneumonia & sepsis
  - Gram stain: sputum or blood, gram negative bipolar rod

Yersinia pestis Gram Stain

Plague (Pneumonic)

- Management
  - Supportive: ventilation, oxygen
  - Antibiotics - initiate STAT
    - Streptomycin - drug of choice
    - Gentamycin
    - Doxycycline

Plague (Pneumonic)

- Prevention
  - Post-exposure antibiotics: seven days post-exposure
    - Doxycycline
    - Tetracycline
    - TMP-SMT (Bactrim™)

Plague (Pneumonic)

- Respiratory isolation
  - Patient for first 48 hours
  - Close contacts who refuse chemoprophylaxis
- Vaccine - no longer available
- Decontamination - usual measures

Tularemia

- Causative agent
  - Francisella tularensis
  - Gram negative bacterium
  - Zoonotic organism (rabbit fever)
- Communication route(s)
  - Contact with infected animals
  - Vectors, e.g. ticks, flies
  - Inhalation (bioterrorism)
  - No person-to-person transfer

Tularemia

- Manifestations (ulceroglandular form)
  - Cutaneous ulcer
  - Lymph gland enlargement
  - Fever, chills
  - Headache, malaise
  - May progress to pneumonia

See link below to view tularemia cutaneous ulcer (rabbit bite)

Tularemia

- Manifestations (bioterrorist forms)
  - Incubation: 2-10 days
  - Typhoidal form
    - Fever
    - Cough
    - Chest pain
    - Shortness of breath
    - Mortality: 35%

Tularemia

- Manifestations (bioterrorist forms)
  - Pneumonic form: severe atypical pneumonia
    - ARDS → respiratory failure
    - Mortality unknown - no opportunity for study

Tularemia

- Diagnosis
  - May be missed on sputum exam
  - Histology: intracellular organisms
  - Serology
- Management
  - Support: ventilation, oxygen
  - Antibiotics
    - Streptomycin - drug of choice
    - Gentamycin, amikacin
    - Chloramphenicol (meningitis)

Tularemia

- Prevention
  - Antibiotics for suspected exposure
  - Universal precautions for victims

Viral Hemorrhagic Fevers

- Causative agents
  - Marburg virus (Angola, 2005)
  - Ebola virus (4 species)
- Communication routes
  - Contact with non-human primates
  - Droplet particles
    - Infected persons
    - Bioterrorism

FYI see link below to view trailer of "Outbreak" movie

Viral Hemorrhagic Fevers

- Manifestations
  - Incubation period: 4-5 days
  - Fever, chills, headache
  - Nausea, vomiting, diarrhea, abdominal pain

FYI see link below to download article on viral hemorrhagic fevers

Viral Hemorrhagic Fevers

- Manifestations (cont'd)
  - Prostration, stupor, shock
  - Bleeding: conjunctival, soft tissue, skin (rash), gastrointestinal, alveolar
  - Mortality
    - Marburg: about 25%
    - Ebola: 50-90% (depends on strain)

Viral Hemorrhagic Fevers

- Diagnosis
  - History of exposure
  - Clinical findings
- Management
  - Strict isolation
  - Supportive
    - Shock
    - Ventilatory failure (ARDS is likely)

Viral Hemorrhagic Fevers

- Prevention
  - Strict isolation of victims, exposures
  - Personal protective equipment, including airborne precautions

High-Risk Procedures

- Endotracheal intubation
- Noninvasive positive pressure ventilation
- Bag-mask ventilation
- Bronchoscopy

High-Risk Procedures

- Exhaled aerosols - all nebulizers
- Nonrebreathing mask without expiratory filter

See link below for video showing exhaled aerosols

Flow of Patient Care

- Patient presents with FRI
  - Placed in droplet or airborne isolation
  - Caregivers use personal protective equipment (PPE)
  - Diagnosis initiated

FYI see flowchart in: Sandrock CE. Severe febrile respiratory illnesses as a cause of mass critical care. Respir. Care 2008 Jan;53(1):40-53

Flow of Patient Care

- If the etiology is NOT an emergency critical care agent
  - Isolation removed or maintained, as indicated
  - PPE for high-risk procedures
  - Specific treatment undertaken

Flow of Patient Care

- If the etiology is an emergency critical care agent
  - Public health agencies notified
  - Isolation maintained, as indicated
  - PPE for high-risk procedures

Flow of Patient Care

- Presence of cases associated with ARDS
  - Low TV ventilation
  - Surge capacity plan activated with ventilator stockpile
  - Aggressive PPE for caregivers
  - Vaccination or antiviral therapy for caregivers

Personal Protective Equipment

- Level A: self-contained breathing apparatus & encapsulating chemical-protective (TECP) suit
- Level B: self-contained breathing apparatus or supplied-air respirator & nonencapsulated chemical-resistant garments, gloves, & boots

Personal Protection

- Level C: air-purifying respirator & non-encapsulated chemical-resistant clothing, gloves, & boots
- Level D: universal precautions

See link below for personal protective equipment requirements (you will need to scroll down the page)

Environmental Controls

- Mass infection with airborne agent will overwhelm conventional isolation capabilities
- Options
  - Cohorting patients
  - Industrial exhaust fans
  - High-capacity portable HEPA units
- Masks for infected patients

Summary & Review

- Types of disasters
- Medicine in mass casualty events
- Febrile respiratory illnesses
  - Pandemic influenza
  - Pulmonary anthrax
  - Smallpox
  - Plague
  - Tularemia
  - Viral hemorrhagic fever

Summary & Review

- High risk procedures
- Optimal flow of patient care
- Personal protective equipment
- Environmental controls

Chemical Injuries

Categories of Chemical Agents

- Lung damaging agents
- Blood agents
- Blistering agents
- Nerve agents

Categories of Chemical Agents

- Initial management for all agents
  - Rescuer personal protection
  - Removal of victim from source
  - Life support interventions
  - Decontamination

Lung Damaging Agents

- Types of events
  - Chemical warfare
  - Terrorism
  - Industrial accidents - most likely scenario

FYI see links below for information on Montana chlorine spill & video on SC chlorine spill (3 min)

Lung Damaging Agents

- Agents
  - Chlorine: manufacture of paper, textiles
  - Ammonia: manufacture of fertilizer
  - Methyl isocyanate (MIC): manufacture of pesticides, e.g. Sevin (Bhopal)
  - Phosgene
    - WW I chemical warfare
    - Manufacturing: pesticides, dyes, pharmaceuticals

Lung Damaging Agents

- Effects
  - Copious secretions
  - Cough
  - Stridor
  - Laryngeal obstruction
  - Bronchospasm
  - Noncardiogenic pulmonary edema (ARDS)
  - Severe ocular burning (methyl isocyanate)

Lung Damaging Agents

- Treatment
  - Intubation, ventilation for severe exposure
  - Humidified air or O_2 (mild exposure)
  - Bronchodilators
  - Inhaled $NaHCO_3$ for chlorine
  - Removal of contact lenses

Blood Agents

- Agents
  - Hydrogen cyanide
  - Cyanogen chloride
- Sources
  - Manufacturing
  - Mining
  - Metalworking
  - Byproduct of combustion - fires
  - Chemical warfare

Blood Agents

- Pathophysiology: block cytochrome, inhibiting cellular O_2 uptake (histotoxic hypoxia)
- Effects
  - Bitter almond smell reported by victim
  - Bright red venous blood
  - Tachypnea
  - Metabolic acidemia

Blood Agents

- Treatment
  - Antidotes to displace & excrete cyanide
    - Amyl nitrite
    - Sodium nitrite
    - Sodium thiosulfate
  - Oxygen
  - Hyperventilation
  - $NaHCO_3$

Blister Agents

- Agents
  - Mustard
  - Lewisite
  - Phosgene oxime
- Sources
  - Chemical warfare
  - Hot dog overdose (mustard)

Up next: video on blistering agents

Blister Agents

- Effects (mustard has delayed effects)
  - Skin blisters
  - Burning eyes
  - Injury to all airways
    - Upper airway obstruction
    - Peripheral airway obstruction
  - Pulmonary edema
  - Gastrointestinal damage: vomiting, diarrhea

See link below for picture of blistering agent effects

Blister Agents

- Treatment
  - There are no antidotes
  - Supportive
    - Oxygen, intubation, ventilation
    - Bronchodilators
    - Medications for vomiting, diarrhea

Nerve Agents

- Agents: organophosphates
  - GA (Tabun): genocide
  - GB (Sarin): genocide (Japan, 1994)
  - GD (Soman): genocide
  - GF
  - VX

Nerve Agents

- Agents: organophosphates
  - Pesticides
    - Sevin
    - Diazinon
    - Malathione

Nerve Agents

- Action: inhibit cholinesterase, which causes accumulation of acetylcholine at nerve synapses
- Skeletal muscle (nicotinic) effects
  - Twitching
  - Weakness
  - Paralysis, including diaphragm
- Muscarinic effects - cholinergic crisis

Nerve Agents

- Cholinergic crisis (see neuro lesson)
  - Salivation
  - Lacrimation
  - Urination
  - Diaphoresis
  - GI distress (diarrhea, vomiting)
  - Emesis
  - Bronchospasm

See link below for video on nerve agents (1.5 min)

Nerve Agents

- Treatment
  - Rescuer & caregiver personal protection - caregivers in Japan sickened from Sarin
  - Decontamination of victims
    - Water
    - Calcium hypochlorite
    - Charcoal & absorptive resins (military)

Nerve Agents

- Treatment: antidotes
  - Atropine: blocks nicotinic & muscarinic effects of acetylcholine (massive dosages)
  - Pralidoxime (2-PAM-Cl): removes organophosphoryl molecule

Nerve Agents

- Supportive treatment
  - Endotracheal intubation
  - Ventilation
  - Bronchodilators: albuterol & ipratropium
  - Tracheal suctioning
  - Benzodiazipine for seizures

Chemical Agents

- Additional causes of surge of patients to institution will include frightened people who think they were exposed - it will be hard to sort them out

Summary & Review

- Chemical injuries are likely due to industrial accidents
- Lung damaging agents, e.g. chlorine
- Blood agents, e.g. cyanide
- Blistering agents, e.g. mustard
- Nerve agents, e.g. Sarin

Radiation Injuries

Radiation Injuries

- Causes (mass casualties)
  - Accidents, e.g. nuclear reactor meltdown
    - Three Mile Island (Pa.)?
    - Chernobyl (Ukraine, 1986)
  - Nuclear warfare

FYI see links below to view nuclear explosion (1.5 min) & video about Chernobyl (3 min)

Radiation Injuries

- Causes
  - Terrorism
    - Radiation dispersion device, AKA "dirty bomb"
    - Non-explosive radiation dispersal, e.g. radioactive material left in public place

Injuries With Nuclear Explosion

- Blast injuries: multiple types of trauma
- Thermal injuries
  - Flash burns
  - Flame burns
- Ionizing radiation injury

Ionizing Radiation Types

- Alpha particles: stopped by sheet of paper
- Beta particles: stopped by clothing
- Gamma rays: stopped by inches of concrete or inch of lead
- X-rays: concrete or inch of lead
- Neutrons: concrete or inch of lead
- Cell phones: nothing stops their annoying effects

Ionizing Radiation Types

- External radiation: exposure to source
- Contamination
  - External (skin, hair): exposure to radioactive debris (fallout), which can be transmitted to rescuers & caregivers

Ionizing Radiation Exposure

- External radiation: exposure to source
- Contamination
  - External (skin, hair): exposure to radioactive debris (fallout), which can be transmitted to rescuers & caregivers
  - Internal: entry of fallout via
    - Inhalation
    - Ingestion
    - Open wounds → decreased survival

Radiation Injuries

- Severe radiation → cell death
- Less severe radiation → cell injury
  - Repaired → scarring
  - Altered genetic information
    - Carcinoma
    - Teratogenesis (birth defects)

FYI see link below to view Chernobyl birth defect

Radiation Injuries

- Severity of injury depends on dose received, which is function of
  - Exposure time
  - Radiation dosage

Radiation Sickness

- High dose manifestations
  - Nausea
  - Vomiting
  - Diarrhea
  - Fatigue
  - Mental status changes
  - Fever
  - Respiratory distress

Radiation Sickness

- Delayed manifestations
  - Decreased WBC, platelet production
  - Severe gastrointestinal damage
  - Severe CNS damage
  - Teratogenesis - birth defects
  - Carcinoma

Treatment

- Wound closure
- Medical treatment may not be indicated for first few hours
- Supportive treatment
- Potassium iodide (SSKI): protects only the thyroid from radioactive iodine

Summary & Review

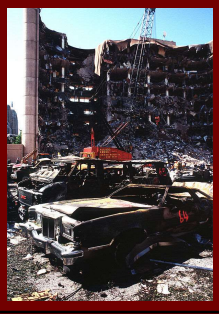
- Causes of mass casualty radiation injuries, e.g. meltdowns, terrorism
- Nuclear explosion injury types, e.g. radiation injury
- Radiation exposures: external, contamination
- Manifestations of radiation sickness
- Radiation sickness treatment

Explosions
Blast Injuries

Sources of Blast Injuries

- Industrial accidents
- Natural disasters, e.g. earthquakes & natural gas lines
- Warfare
- Terrorism: blast injuries are the most common result
  - Mumbai, India, 2006
  - London, 2005
  - New York City, 2001
  - Oklahoma City, 1995

Oklahoma City
Murrah Building, 1995



Categories of Blast Injuries

- Primary blast injuries
- Secondary blast injuries
- Tertiary blast injuries
- Quaternary blast injuries

Primary Blast Injuries

- Caused by high-energy explosions that produce a pressure wave
- Pressure wave can cause severe damage without overt signs of trauma
- Pressure wave primarily affects gasfilled structures
  - Abdominal hemorrhage, perforation
  - Cerebral concussion
  - Blast lung: bilateral lung contusion
  - Tympanic membrane: red flag

FYI see link below for article on blast injuries

Secondary Blast Injuries

- Caused by flying debris
- Penetrating & blunt force injuries to any body parts, e.g. open pneumothorax

See links below to view blast injuries

Tertiary Blast Injuries

- Caused by victims being propelled by wind from explosion
- Most common injuries
  - Fractures & traumatic amputations
  - Brain injury: open & closed

Quarternary Blast Injuries

- Injuries not caused by the explosion
  - Burns
  - Crush injuries from structure collapse
  - Exacerbations of asthma & COPD from inhalation of dust
  - Angina, MI

FYI see link below to download 1 hour course - scroll down to Bombings: Injury Patterns & Care Class Material

Respiratory Care

- Supplemental O_2
- Airway management - difficult airways are likely
- Ventilation for
  - Pulmonary contusions
  - Bronchopulmonary fistulae
  - Massive trauma: acute lung injury
  - Brain & spinal cord injuries

Summary & Review

- Sources of blast injuries: accidents, natural disasters, terrorism
- Categories of injuries
  - Primary
  - Secondary
  - Tertiary
  - Quaternary
- Management
  - Airway management
  - Ventilation

Natural Disasters

Types of Natural Disasters

- Floods: most common
- Hurricanes: wind, flooding, fires
- Tornadoes: wind
- Wild fires
- Avalanches, landslides, mudslides

FYI see link below for information on disaster death tolls

Types of Natural Disasters

- Heat waves
- Blizzards, extreme cold
- Earthquakes: collapses, explosions
- Tsunamis
- Volcanic eruptions

FYI see links below to view a natural disaster risk map & video of earthquakes

Injuries From Natural Disasters

- Near drowning: flooding
- Suffocation: structural collapse
- Crush injuries: structural collapse
- Blunt trauma: structural collapse, winds
- Penetrating trauma: structural collapse, winds
- Thermal injuries: wildfires, blizzards
- Inhalation injuries: fires, collapses
- Psychological trauma: all disasters

Additional Problems

- Services lost, impaired &/or overwhelmed
  - Water
  - Electricity
  - Sewer
  - Communications
  - Fire, EMS, police agencies

Additional Problems

- Transportation problems
  - Impassable roads
  - Loss of vehicles
  - Death, injury, or illness of transport personnel
- Destruction of healthcare facilities
- Impaired sanitation: increased risk for infectious diseases
- Criminal activities, e.g. looting

Mass Casualty Critical Care Demands

Surge Capacity

- Definition: Health Care system's ability to expand quickly to meet an increased demand for medical care in the event of a large scale public health emergency (AHRQ definition)
- The same event can produce different stresses on different institutions, e.g. influx of trauma patients to non-trauma ER

Surge Considerations

- Critical care capabilities are essential to limiting mortality in a mass casualty event
- Facilities may not be able to divert or evacuate casualties
- Assistance from other agencies will take time

Components of Surge Capacity

- System
- Space
- Staff
- Stuff

System

- Command: incident command system (ICS) for overall management
- Control: control of facility infrastructure, e.g. building access
- Communication: internal & external communications
- Coordination: coordination of facility response with other facilities & public agencies

Space Considerations

- Critical care beds are premium
- Facility must identify & plan for using alternate spaces to accommodate surge patients
- Facility should train personnel for alternate space utilization

Facility Space Categories

- Conventional space: available for daily operations
- Contingency space: areas in facility that can be used temporarily for patient services
- Crisis space: do not meet usual standards of care, but sufficient for disaster situation

Space Response

- Conventional space
  - Economize on critical care beds, moving patients to step-down units, general care floors
  - Cancel elective procedures
  - Discharge patients, as possible
  - Add beds to patient rooms - eliminate private rooms

Space Response

- Contingency spaces that can be used for patient care
  - Recovery rooms
  - Surgical waiting areas
  - Procedural areas, e.g. dialysis units

Space Response

- Crisis spaces that can be equipped for patient care
  - Hallways
  - Lobbies
  - Adjacent medical offices
  - Temporary structures, e.g. tents

Staff Considerations

- Personnel may be unable to travel to facility, because of roads, etc.
- Personnel may be unwilling to report, due to
  - Illness or injury from event (victims)
  - Fear of contracting illness
  - Concerns over care for family, pets
- Critical care personnel need to be enabled to focus on their primary patient care responsibilities

Staff Considerations

- Facility must have plan to mobilize its personnel in response to emergency
- Facility must have plan to use ad hoc staff effectively
- Facility must have mechanism for emergency credentials & privileges for ad hoc staff

Staffing Categories

- Conventional: staff within the facility who are credentialed & privileged at facility
- Contingency: staff within the facility who can assume additional duties or staff imported from other facilities
- Crisis: non-clinical staff assigned to basic patient care

Staffing Response

- Conventional
  - Departmental managers assume patient care
  - Surgeons assess, treat ER trauma patients

Staffing Response

- Contingency
  - Staff within the facility assume additional duties, under supervision
  - Staff imported from other facilities
  - Provider extenders, e.g. Project XTREME to cross train
    - Physicians, physician assistants
    - Nurses
    - Physical therapists

FYI see link below for information on Project XTREME

Staffing Response

- Crisis: staff likely to perform beyond their usual scope of practice
  - Non-critical care physicians assisting in critical care areas
  - Lay personnel assisting with patient hygiene & monitoring
  - Housekeeping providing bag-valve ventilation

FYI see link below for information the national stockpile

Stuff Considerations

- Hospitals & suppliers avoid surplus of materials
- Medications & supplies stockpiled by CDC for delivery
- Transportation of supplies to facility may be crippled

Stuff Considerations

- Mass casualties will overwhelm critical care equipment & supplies on-hand
  - Mechanical ventilators
  - Mechanical ventilation supplies
  - Oxygen
  - Oxygen administration supplies
  - Monitors, e.g. pulse oximeters

Options for Short-Supply Situation

- Prepare (stockpile) before the event
- Substitute equivalent items
- Adapt, using items that are sufficient, though not ideal
- Conserve resources, e.g. oxygen
- Reuse items after disinfection
- Reallocate items or therapy to patient with greater benefit

Stuff

- Conventional supply: maximum supplies for usual facility operations
  - Critical care equipment & supplies should NEVER be in short-supply
  - Example: minimal inventory of ventilator circuits → trouble!
  - The inventory should ALWAYS include an excess of personal protective equipment

Stuff

- Contingency supply: conventional inventory exhausted; response examples
  - Adapt: pulse oximeters to monitor heart rate
  - Substitute: transport or anesthesia ventilators for ICU ventilators
  - Reuse: manual resuscitators

Stuff

- Crisis supply: overwhelming number of critical care patients
  - Bag-valve ventilation
  - Accept lower limits, e.g. SpO_2 to conserve oxygen
  - Reallocate therapeutics → ethical decisions

Respiratory Care Stuff

Oxygen

- Potential sources
  - Bulk liquid oxygen system
  - Cylinders
  - Oxygen concentrators
  - Mobile liquid oxygen systems

Bulk Liquid Oxygen System

- Failure possibilities
  - Structural damage: container, pipe system
  - Impaired delivery of oxygen, e.g. roads, lack of personnel or vehicles
  - Damage to gas separation plants
  - Overwhelming demand for oxygen

Oxygen Cylinders

- Mass casualty applications
  - Small cylinders
    - Transports
    - Temporary therapy
    - Built-in regulator most desirable
  - Large cylinders
    - Individual long-term therapy
    - Back-pressure feed units
    - Manifolds can create multiple-patient capabilities

See link below to view emergency oxygen manifold

Oxygen Cylinders

- Limitations
  - Facility storage capacity
  - Transport difficulties
- Infectious events demand disinfection of cylinders before transport

Oxygen Concentrators

- Mass casualty applications: large oxygen generators
  - Refill cylinders
  - Back pressure feed units for capability of 93% O_2 at 50 PSIG

See link below to view Medical Oxygen Generator Skid™

Oxygen Concentrators

- Mass casualty applications: large oxygen generators
  - Refill cylinders
  - Back pressure feed units for capability of 93% O_2 at 50 PSIG
- Limitations
  - Size: storage space
  - Require electricity
  - Expense

See link below for information on Oxair oxygen generator

Mobile Liquid Oxygen Systems

- Primarily used to refill aircraft oxygen systems
- Requires less space than cylinders
- Mass casualty application: refill mobile multiple-patient system

See link below to view multiple-patient LOX systems

Oxygen Conservation Methods

- Repair all leaking outlets - this should be an ongoing effort
- Turn flowmeters off when not in use
- Use minimum FiO_2 & liter flows necessary
- Use reservoir cannulae
- Use gas-sparing ventilators
- Use HMEs for humidification
- Target lower SpO_2

Endotracheal Intubation

- Caregivers are at risk for contagions & some chemical injuries
- Emergency intubations should be avoided
- Preparation for intubation is essential
- Patient must be sedated
- Performed in negative-pressure room
- All caregivers wear PPE

Ventilator Sources

- Conventional
  - ❖ On-hand intensive care ventilators
  - ❖ Rental ventilators - availability?
- Contingency situation
  - ❖ Transport ventilators
  - ❖ Borrowed - availability?
  - ❖ NPPV devices - NOT for mass casualties
  - ❖ Anesthesia ventilators
  - ❖ Negative pressure ventilators - no intubation required

Ventilator Sources

- Crisis situation
  - ❖ Pressure-cycled ventilators?
  - ❖ Single patient use ventilators?
  - ❖ Bag-valve ventilators
  - ❖ National stockpile ventilator kits
    - Impact Eagle Uni-Vent
    - Puritan-Bennett LP-10 (discontinued)
    - Carefusion LTV 1200

Mass Casualty Ventilator Requirements

- Approved for adult & pediatric patients
- Capability to operate without 50 PSIG source
- Battery life ≥ 4 hours
- Constant volume delivery
- CMV mode included
- Adjustable PEEP capability (5-15 cm H_2O)

Mass Casualty Ventilator Requirements

- Separate controls for rate & TV
- Monitors for airway pressure & TV
- Alarms
  - Circuit disconnect
  - High & low airway pressure
  - Loss of electrical power
  - Loss of high pressure gas source
- Ease of use

FYI see link below for article on mass casualty ventilation

Ventilators

- Intensive care ventilators
- Noninvasive positive pressure ventilators
- Transport ventilators
- Anesthesia ventilators
- Negative pressure cuirass ventilators
- Pressure-cycled, single use
- Bag-valve ventilators
- National stockpile ventilator kits

Ventilators

- Intensive care ventilators
  - May be too expensive to stock for surge requirements
  - Requires respiratory therapist to manage
  - Reserve for sickest patients, e.g. ARDS
  - Cradle-to-grave devices also may be applied to neonates & small infants

Ventilators

- Non-invasive positive pressure ventilators
  - Unsuitable for contagious conditions
  - Unsuitable for ARDS
  - Requires inordinate staff time

Ventilators

- Transport ventilators
  - Some have ICU ventilator capabilities
  - Less expensive than ICU ventilators
  - Some are oxygen & electrical power economical
  - Likely choice as ventilator to stock for surge

Ventilators

- Anesthesia ventilators
  - Some will be needed for emergency surgical procedures
  - Managed by
    - Anesthesia personnel - availability of time?
    - Respiratory therapists - require orientation to devices

Ventilators

- Negative pressure cuirass ventilators
  - No intubation required - less risk of infection for caregivers
  - Some casualties require airways
  - United Hayek MRTX™ has been tested as an option for application to patients by physicians at the scene
  - Not available in U.S.A.

FYI see link below for information Hayek MRTX

Ventilators

- Pressure-cycled, single-use ventilators
  - Non-constant volume delivery
  - No alarms
  - Not for unattended patients
  - Require 50 PSIG source
  - Use large amounts of gas

Ventilators

- Bag-valve ventilators
  - Short-term support
  - Effective ventilation without electrical power
  - Ventilation can be provided by ancillary staff, volunteers

FYI see link below for article on healthcare & Katrina

Ventilators

- National stockpile ventilator kits
  - Kit includes ventilators, ventilator supplies, instructional media
  - Airway management materials contained in 12 hour push packages
  - Takes hours to days for delivery

Organizational Preparation

- Maintain stocks of devices & supplies
- Plan for mass casualty events
- Rehearse mass casualty scenarios
- Prepare & train ALL personnel for mass casualty events

Individual Preparation

- Gain & maintain familiarity with hospital mass casualty plan
- Familiarize with likely surge equipment & supplies
  - SNS ventilators
  - Others acquired for mass casualty events
- Participate in planning, rehearsals & debriefings

Individual Preparation

- Personal preparations
  - ❖ Plan for disposition of family, pets, etc.
  - ❖ Assemble & store personal kit
    - • Clothes, underwear
    - • Toiletries
    - • Medications
    - • Eyeglasses, contact lenses

Summary & Review

- Surge capacity components
  - ❖ System
  - ❖ Space
  - ❖ Staff
  - ❖ Stuff
- Conventional, contingency, crisis modes

Summary & Review

- Respiratory care stuff
  - ❖ Oxygen resources
  - ❖ Ventilator resources
- Organizational preparations
- Individual preparation

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