Pediatric Emergency Medicine Reports

Practical, Evidence-Based Reviews in Pediatric Emergency Care

Volume 19, Number 5 / May 2014 www.ahcmedia.com

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Statement of Financial Disclosure

To reveal any potential bias in this publication, and in accordance with Accreditation Council for Continuing Medical Education guidelines, we disclose that Dr. Dietrich (editor), Dr. Skrainka (CME question reviewer), Dr. Staple (author), Dr. O'Connell (author), Dr. Taylor (peer reviewer), Ms. Coplin (executive editor), and Ms. Kimball (managing editor) report no relationships with companies related to the field of study covered by this CME activity.

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Pediatric Rapid Sequence Intubation: An In-depth Review

Pediatric advanced airway management is a critical intervention performed for ill or injured children in the emergency department (ED). Approximately 270,000 children require endotracheal intubation in the emergency department each year, comprising 0.2% of all ED visits.[1] Despite its infrequent occurrence, endotracheal intubation is a potentially lifesaving procedure for children with respiratory compromise and impending respiratory failure. Factors related to pediatric airway anatomy, provider education and training, and the availability of the appropriate equipment can significantly affect patient outcomes.

Safe emergent endotracheal intubation can be achieved through the process of rapid sequence intubation (RSI), using a sequential approach to preparation, sedation, and paralysis prior to intubation.[2] RSI must be differentiated from rapid sequence induction used by anesthesiologists to induce general anesthesia. RSI is the preferred method of intubation in the ED where most patients present with varying levels of consciousness and protective airway reflexes, and increased potential for pulmonary aspiration of gastric contents.[2,3,4] While there are no absolute contraindications to RSI, patients in cardiac arrest and those who are comatose without a gag reflex generally do not warrant RSI medications prior to intubation.[2] Decisions involving the RSI process are impacted not only by the individual case at hand, but also by a provider's stylistic approach. As with most things in medicine, practice variation exists and the choices of medications will differ depending on the clinical scenario. This chapter serves as a review of standard practice in the ED when caring for the pediatric trauma patient who requires intubation.

Decision to Intubate

The pediatric trauma patient who is awake, talking or crying, and able to maintain his or her own airway can be managed conservatively with supportive care (e.g., FiO_2 by facemask or nasal cannula). See Table 1 for recommendations for emergency endotracheal intubation in trauma patients.

When deciding on the safest and most appropriate technique, factors including the risk for secondary cord injury, pediatric specific anatomy, presence of traumatic injury, and the provider's expertise should be considered.[6]

Patient Preparation

It is necessary for ED clinicians to obtain a quick history prior to deciding which medications are appropriate for pediatric RSI. A simple mnemonic, AMPLE serves as a reminder for the hurried clinician: A = allergies & airway history, M = medications, P = past medical history, family history, and anesthetic history, L = last oral intake, and E = events leading up to the intubation[7,8] (*See Table 2*). Before preparing for intubation, a rapid but thorough assessment of the patient's head, neck, neurologic status, airway, and breathing should be performed.[9]

Executive Summary

- Preoxygenation allows oxygen to replace nitrogen in the lungs, permitting longer periods of apnea before hypoxemia occurs.
- Intubation has the potential to exacerbate an undiagnosed, underlying spinal cord injury. Attention should focus on maintaining cervical spine immobilization during intubation.
- Manual manipulation of the neck for the purpose of positioning prior to intubation (e.g., the "sniffing" position or hyperextension of the neck and "jaw thrust" and "chin lift" maneuvers) can be associated with increased risk for secondary cervical spine injury and should be avoided in pediatric trauma patients.
- The recent PALS updates recommend the use of cuffed endotracheal tubes, except in the newborn period.

Positioning

Airway management in the trauma patient is complicated by the potential for cervical spine injury. A large multicenter study involving 17 hospitals across the United States was conducted in children < 16 years of age to identify risk factors for cervical spine injury.[10] The study identified eight factors associated with cervical spine injury in children after blunt trauma: altered mental status, focal neurologic findings, neck pain, torticollis, substantial torso injury, conditions predisposing to cervical spine injury, diving, and high-risk motor vehicle crash. The authors concluded that having one or more risk factors was 98% sensitive and 26% specific for detecting cervical spine injury.

Cervical spine injury may be occult and present without radiographic abnormalities. SCIWORA syndrome (spinal cord injury without radiologic abnormality) refers to spinal injuries in the absence of identifiable bony or ligamentous injury on plain radiographs or computed tomography (CT), though often abnormalities may be detected on magnetic resonance imaging (MRI). SCIWORA occurs most often in the pediatric population and accounts for up to two-thirds of severe cervical spine injures in children younger than 8 years of age.[11] The elasticity and increased mobility of the pediatric spine increase the risk of cord injury from flexion, extension, and transverse forces. Children with spinal cord injuries will often present with immediate or transient loss of motor function in their arms and/or legs and variable sensory loss. It is important for the ED clinician to obtain a detailed injury history, including chief complaints and physical findings reported from the scene, when considering the risk of spinal cord injury. Procedures such as intubation have the potential to exacerbate an undiagnosed, underlying cord injury. Particular attention should focus on maintaining cervical spine immobilization and minimizing the risk of secondary injury during intubation of a pediatric trauma patient.

Providers intubating non-trauma pediatric patients are instructed to position the patient with the neck in mild extension, known as the "sniffing" position, to better align the oral and pharyngeal axes and allow maximal laryngeal visualization.[9] Ideally, the patient should be positioned with the external auditory meatus on the same plane as the sternal notch. Because young children have a prominent occiput, a towel roll placed underneath the shoulders will assist with achieving the desired position. The larger tongue-to-oropharynx ratio in children also may require a "jaw thrust" or "chin lift" maneuver to adequately open the airway. Hyperextension of the neck may occlude the child's airway and should be avoided.

Positioning the pediatric trauma patient is more challenging and efforts should focus on maintaining in-line cervical spine immobilization at all times. The "sniffing" position is preferred in non-trauma patients, but it extends the occiput at the atlas and should be avoided in patients with known or suspected C1/C2

Table 1. Emergency Endotracheal Intubation Recommendations for Trauma Patients

1. Trauma patients with the following clinical findings:[5]
   - Airway obstruction
   - Hypoventilation
   - Severe hypoxemia despite supplemental oxygen
   - Severe cognitive impairment (GCS < 8)
   - Cardiac arrest
   - Severe hemorrhagic shock

2. Smoke inhalation patients with the following conditions:[5]
   - Airway obstruction
   - Severe cognitive impairment (GCS < 8)
   - Major cutaneous burn (> 40% body surface area)
   - Prolonged transport time
   - Impending airway obstruction
     - Moderate-to-severe facial burn
     - Moderate-to-severe oropharyngeal burn
     - Moderate-to-severe airway injury seen on endoscopy

Table 2. History Prior to RSI

A:	Allergies and airway history
M:	Medications
P:	Past medical history, family history, and anesthetic history
L:	Last oral intake
E:	Events leading up to intubation

injuries.[12-14] The "jaw thrust" and "chin lift" maneuvers have also been shown to cause spine distraction in cases of lower cervical spine instability not mitigated by rigid collar use.[12-14] During intubation, the anterior portion of the cervical collar can be opened to allow for adequate jaw mobilization and laryngeal visualization. A second provider should use two hands to ensure cervical spine stability during the entire intubation process. Finally, the patient should be positioned as close to the head of the bed as possible and the bed should be elevated to above the waist level of the person intubating to facilitate correct visualization.

Preoxygenation

Preoxygenation is an essential preparation phase prior to pediatric RSI to achieve maximal pre-intubation oxygen saturation. Many children who require intubation are hypoxic or have impeding respiratory failure and very poor oxygen reserves. Children also have a higher oxygen consumption rate with a lower functional residual capacity and alveolar volume compared to adults, making them more susceptible to precipitous decline in oxygen saturation, particularly during intubation.[2,15]

The goals of preoxygenation are to achieve 100% oxygen saturation prior to intubating, to maximize oxygen stores in the lungs and bloodstream, as well as to denitrogenate the residual capacity of the lungs. The replacement of nitrogen in the lungs permits longer periods of apnea without consequential hypoxemia. Two minutes of administering 100% oxygen to a spontaneously breathing child will wash out approximately 95% of alveolar nitrogen.[2,9] Application of 100% oxygen at 15 L/minute via a nonrebreather mask for at least 3 minutes maximizes the oxygen reservoir in the alveoli and the rest of the body.[16] In the adult literature, high flow nasal cannula (HFNC) at 5-15 L/minute and basic nasal cannula at < 5 L/minute have also been used to facilitate preoxygenation during the apneic period prior to intubation. Some studies report success with HFNC preventing significant desaturations below 90% by offering a safety buffer during periods of apnea and hypoventilation.[16,17] Additional research is needed to adequately evaluate the efficacy of this intervention in critically ill pediatric patients.

Noninvasive positive pressure ventilation (e.g., bag-mask ventilation) is reserved for patients who cannot achieve acceptable oxygen saturation due to inadequate ventilation or advanced lower airspace disease.[2,8,16,18] Caution should be taken when administering positive pressure ventilation (PPV) via manual bag-mask ventilation as a means of preoxygenation because of gastric insufflation and the risk of emesis and aspiration. When bag-mask ventilation is necessary, steps should be taken to ensure adequate ventilation. First, clear the child's airway of blood, secretions, or debris. Significant mouth and facial trauma can inhibit a good mask-to-face seal and negatively affect adequate chest rise. Choose an appropriately sized mask that fits over the nose and extends down to the anterior bony aspect of the chin, completely encircling the mouth and nose. Oropharyngeal airways (OPA) can be used in a child without a gag/swallow reflex to help maintain a patent airway by positioning the tongue anteriorly and relieving posterior pharyngeal obstruction. The correct size OPA is measured from the middle of the patient's mouth to the angle of the jaw. An OPA that is too small can force the tongue back into the pharynx, causing airway obstruction and occlusion of the glottic opening. One that is too large may cause pharyngeal trauma and blood in the airway. The most accepted method for insertion in a trauma patient involves using a tongue depressor or manually holding the tongue forward while inserting the OPA right side up. The child- (500 mL) or adult- (1600 mL) sized self-inflating bags with an oxygen reservoir can be used to deliver adequate tidal volumes and close to 100% FiO_2 to all patients including infants. Most self-inflating bag systems are fitted with a pressure relief valve (also called a "pop-up valve") for the purpose of preventing accidental over-pressurization of the lungs. The typical pressure cutoff is 30-35 cm H_2O pressure, but a bypass clip can be used in cases where there is a need for higher pressures to maintain adequate ventilation.

Cricoid Pressure and External Laryngeal Manipulation

The use of cricoid pressure, often referred to as the Sellick maneuver, during intubation is controversial. Currently, there is insufficient evidence to recommend the use of routine cricoid pressure to prevent aspiration during endotracheal intubation in children.[2,7,9] Using the thumb and index or middle finger, pressure is applied posteriorly over the cricoid cartilage to compress the esophagus once the patient is unconscious. Manipulation of the trachea on the esophagus by this maneuver should be used with caution. When performed incorrectly, cricoid pressure may interfere with direct visualization of the larynx and in rare, severe cases, may result in esophageal rupture if applied in patients with active vomiting.[7]

External laryngeal manipulation (ELM) is another airway maneuver employed to facilitate laryngeal view during direct laryngoscopy.[19] A technique called the "BURP" maneuver is one method of ELM used to better visualize the glottis during difficult intubations. This acronym guides the intubator to move the larynx posteriorly toward the cervical vertebrae (**b**ackwards), superiorly (**u**pwards), and laterally to the right (**r**ightward **p**ressure) during laryngoscopy.[20,21] Pediatric and trauma-specific studies using ELM are lacking. One pediatric simulation study showed no difference in success rate using this technique.[21] Cricoid pressure and ELM should be used with caution after a thorough evaluation of the risks and benefits to the pediatric trauma patient.

Equipment Preparation

When preparing for successful RSI, all necessary monitors, equipment, personnel, and medications

***Table 3.* Equipment Preparation**

S:	Suction with a Yankauer tip
O:	Oxygen
A:	Airway equipment
P:	Pharmacologic agents
ME:	Monitoring Equipment

***Table 4.* RSI Equipment Recommendations**

Age	Blade Type and Size	ETT Size
Newborn	Miller 0 or 1	2.5-3.5
3-9 months	Miller 1 or Wis-Hipple 1.5	3.5-4.0
1 year	Miller 1 or Wis-Hipple 1.5	4.0-4.5
2-3 years	Miller 1 or 2 or Wis-Hipple 1.5	4.0-4.5
4 years	Miller 2 or Macintosh 2	4.0-5.0
5-6 years	Miller 2 or Macintosh 2	4.5-5.0
7-8 years	Miller 2 or Macintosh 2	4.5-5.5
9-10 years	Miller 3 or Macintosh 3	6.0-7.0
11-12 years	Miller 3 or Macintosh 3	6.5-7.5
>13 years	Miller 3 or Macintosh 3	7.0-8.0

* Note: Either a Miller or Wis-Hipple (straight blades) or Macintosh (curved blade) may be used during intubation. The epiglottis is relatively long, narrow, anteriorly angled, and more flexible in younger children making it often helpful to gently lift the epiglottis out of the way with use of a straight blade. The curved blade is used by inserting the tip of the blade into the vallecula and applying traction on the stiffer, older child's hyoepiglottic ligament to retract the epiglottis providing better visualization of the larynx. While both straight and curved blades can be successfully used in children, the most important factor is the operator's comfort with the device.

Endotracheal Tube Size

- Uncuffed Endotracheal Tube Size
  - Tube size (mm in diameter) = 4 + (age in years/4)
  - Have estimated tube size available, as well as 0.5 mm smaller and 0.5 mm larger
- Cuffed Endotracheal Tube Size
  - Tube size (mm in diameter) = 3+ (age in years/4)
- Most reliable estimation based on a child's body length
- Length-based resuscitation tapes are helpful for children up to approximately 35 kg

should be assembled. A helpful mnemonic to aid with preparation is SOAPME: [S]uction with a Yankauer tip, [O]xygen, [A]irway equipment (uncuffed endotracheal tube [ETT] size = 4 + [age/4], use 0.5 smaller for a cuffed ETT, *See Table 3*, [P]harmacologic agents and [M]onitoring [E]quipment, including pulse oximetry and $ETCO_2$ monitoring.[2] Guidelines for sizing laryngoscope blade and ETTs are based on the patient's age (*See Table 4*).

Conventional teaching instructs clinicians to use uncuffed ETTs in children < 8 years of age; however, current research confirms the safe use of cuffed tubes in all infants and pediatric patients except in the newborn period.[22-24] In younger children and infants, the subglottic area is the narrowest part of the pediatric airway and creates an anatomical seal around the ETT at that level. Care should be taken to not place an uncuffed ETT that is too large, as it can cause mucosal injury from excessive pressure. Caution with using cuffed tubes in young children has focused on the potential for causing increased airway resistance, laryngeal mucosal injury, and subsequent development of subglottic stenosis. Current cuffed ETTs are equipped with low-pressure, high-volume cuffs that provide a safer tracheal seal by using lower inflation pressures, allow pressure adjustments in the seal to be made over time, and decrease the potential risk of gastric aspiration. Cuffed ETTs also facilitate more accurate control of positive pressure ventilation because of smaller air leaks. A prospective cohort study of 597 children younger than 5 years of age demonstrated no significant difference between cuffed and uncuffed ETT in the incidence of post-extubation subglottic edema.[22] Similarly, a randomized control trial of 2246 children younger than 5 years of age showed that cuffed ETTs did not increase the risk of post-extubation stridor.[23] Regardless of whether an uncuffed or cuffed ETT is used, it is important that clinicians use the correct sized ETT to avoid complications such as airway trauma and mucosal ulceration.[24]

Premedications — Adjuncts

Atropine. Infants and children can experience bradycardia during intubation secondary to hypoxia, vagal nerve stimulation, and effects of medications such as succinylcholine.[25,26] Atropine is a nonspecific antagonist of acetylcholine at the muscarinic receptor and prevents reflex bradycardia by inhibiting vagal stimulation of the sinoatrial node. In one retrospective cohort study, approximately 10% of emergency intubations were associated with bradycardia (indicated by a pulse of < 80 beats per minute for children younger than 2 years and < 60 beats per minute for children older than 2 years).[27] The efficacy of atropine in preventing bradycardia associated with intubation has been questioned in recent studies.[27,28] The use of atropine, however, as adjunctive therapy is encouraged for the following situations: 1) all patients <

1 year of age, 2) children < 5 years of age receiving succinylcholine, 3) adolescents receiving a second dose of succinylcholine, and 4) patients who are experiencing bradycardia prior to intubation.[25-29]

Potential adverse effects include sinus tachycardia, mydriasis, xerostomia, decreased micturition, and hyperthermia.[26] It is advised to do a pupillary exam, especially for the pediatric trauma patient, before giving atropine because mydriasis can persist for hours after a single dose of atropine.

When administered, atropine should be given 1-2 minutes prior to any sedative or paralytic agent. The recommended dose is 0.02 mg/kg (minimum 0.1 mg, maximum 0.5 mg child, 1 mg adolescent).[2] Doses < 0.1 mg have been associated with paradoxical bradycardia. Weight-based dosing in low-birth weight and premature newborns may be less than the recommended minimum dose of 0.1 mg per dose. Consultation with a neonatologist is recommended when using atropine in this population.

Lidocaine. Lidocaine is used as an adjunct to pediatric RSI for the purpose of attenuating the increase in intracranial pressure (ICP) associated with laryngoscopy and intubation. Its mechanism of action is thought to include cough reflex suppression, brain stem depression, and decreased cerebral metabolism.[4] Providers should be aware of lidocaine's potential for exacerbating hypotension and must be prepared to treat this complication early and appropriately, especially in trauma patients. Pediatric studies regarding the efficacy of the use of lidocaine are conflicting and its addition to the RSI algorithm should be examined on a case-by-case basis.[4,7,9,18,30,31]

The recommended lidocaine dose for pediatric RSI is 1.5 mg/kg IV administered 2-3 minutes prior to intubation.[2]

Sedatives and Analgesics

Several factors should be considered when selecting the appropriate sedative and analgesic agents to use for ED-initiated RSI. Practice variation in choices of sedative agents is to be expected. Hospital settings differ in medication availability and provider comfort and experience using the different agents. Minimal adverse side effects are tolerable as long as the medications are easy to administer, rapid in onset, and have a high therapeutic index with few drug interactions.

Etomidate. Etomidate has become a popular sedative in pediatric intubations in the ED because of its rapid onset of action (5-15 seconds), short duration of sedation (5-14 minutes), and minimal cardiovascular side effects.[31-35] The use of etomidate is favored for children with unstable cardiovascular status because of its minimal effects on mean arterial pressure. It is also commonly used in trauma patients who have sustained head or ocular injury because it induces a transient decrease in intracranial and intraocular pressures.

Several recent studies have evaluated the efficacy and safety of etomidate in pediatric RSI. One prospective observational study of 77 pediatric patients demonstrated successful first attempt intubations in 65.8% of patients using an etomidate dose of 0.3mg/kg IV.[34] Another study of 105 pediatric patients younger than 10 years reported minimal cardiovascular side effects with etomidate at 0.3 mg/kg dosing without the adverse effects of adrenal suppression, myoclonus, status epilepticus, or new-onset seizures.[33] More recent studies have questioned the safety profile of even a single dose of etomidate for RSI. A major consideration in the use of etomidate is the dose-dependent, reversible inhibition of adrenocortical activity leading to decreased cortisol production for up to 15 hours.[7,32] Etomidate blocks the enzyme 11-ß-hydroxylase, which is involved in adrenal steroid production. One randomized controlled study of etomidate use in adult trauma patients[36] and one systematic review of elective surgical patients[37] confirmed a significant difference in cortisol levels after etomidate administration. Data on patient specific outcomes remains conflicting. The above referenced systematic review of elective surgical patients[37] and another observational study involving adults with sepsis[38] showed no statistically significant increase in mortality or hospital length of stay associated with etomidate use. On the contrary, one adult trauma study[36] and another study involving non-cardiac surgical patients[39] reported significant increases in cardiovascular morbidity, number of ventilator days, lengths of ICU and hospital stay, and risk for 30-day mortality associated with etomidate use.

Additional potential adverse effects include myoclonic activity, such as coughing or hiccupping, and decreased seizure threshold in patients with known seizure disorders.[28]

The recommended RSI dose range for etomidate is 0.2 to 0.4 mg/kg IV with clinical recovery in 10 to 15 minutes.[29,40]

Ketamine. Ketamine is a dissociative sedative-analgesic derived from phencyclidine (PCP). Patients given ketamine characteristically exhibit a trance-like state with open eyes, a slow nystagmic gaze, and occasional mild respiratory depression despite preserved airway reflexes.[7] It is the favored agent for patients with respiratory failure secondary to severe bronchospasm and asthma because of its bronchodilatory effects on respiratory smooth muscles. An additional side effect of ketamine is the sympathomimetic stimulation of the cardiovascular system leading to transient increases in heart rate, blood pressure, and cardiac output.

While ketamine may help the cardiovascular status of patients with signs of shock, it is often avoided in patients with increased ICP, eye injuries, and uncontrolled hypertension because of the concern for exacerbating these conditions. The original recommendations for caution in these patients was based on early data from patients with non-traumatic intracranial lesions leading to cerebral spinal fluid (CSF) outflow obstruction and resultant increased ICP.[41] More recent evidence shows ICP to remain normal (i.e., < 10 mmHg), with associated increases in mean arterial pressure (MAP) and cerebral perfusion pressure (CPP) after ketamine use in healthy patients.[20,41,42,43] Additional research suggests that in acute head trauma, the compensatory mechanisms of CSF flow and venous circulation remain intact, and therefore increases in cerebral blood volume (CBV) associated with ketamine do not lead to increased ICP.[41,42] Further research comparing ketamine to alternate RSI induction agents is necessary to substantiate its use in patients with head trauma.

Additional relative contraindications to ketamine use include thyrotoxicosis and major depressive disorders because of an emergence phenomenon that can be associated with visual and auditory hallucinations.[7]

The recommended RSI dose for ketamine is 1.5-2 mg/kg IV with clinical recovery within 10-15 minutes.[2]

Propofol. Propofol is a lipophilic sedative-hypnotic that produces general anesthesia.[2] It has a very rapid onset (10 to 20 seconds) and short duration of action (10 to 15 minutes).[40,44] Propofol use is associated with vasodilation, decreases in MAP and ICP, and myocardial depression. Its use in RSI should be reserved for hemodynamically stable patients without evidence of hypotension.

Propofol use can be beneficial when intubating patients with refractory status epilepticus.[45,46] When given as a bolus dose, propofol suppresses seizure activity by acting as a gamma-aminobutyric acid (GABA) A-agonist.[45] At high doses, propofol functions as a general anesthetic agent, and physicians must be prepared to intubate patients with status epilepticus to protect their airway.

Propofol contains egg lecithin and soybean oil and therefore is unsafe to use in patients with allergies to eggs and/or soybeans. When given in high doses for a prolonged period of time, propofol may be associated with a condition known as propofol infusion syndrome (PIS).[47,48] This syndrome is characterized by severe lactic acidosis, rhabdomyolysis, acute renal failure, hyperlipidemia, recalcitrant myocardial failure, hypotension, bradycardia, and death.[47,48] Proposed risk factors for developing PIS include head injury, airway infection, young age (< 18 years of age), low carbohydrate intake/high fat intake, inborn errors of fatty acid oxidation, high doses of propofol for more than 48 hours, and combined use of catecholamine vasopressors and/or glucocorticoids.[47,48] Serum lactate and creatine phosphokinase levels should be monitored closely during propofol infusions.

The recommended RSI dose range for propofol is 1.5-3 mg/kg IV with clinical recovery in 10 minutes.[2] Higher doses, such as 3-5 mg/kg IV followed by 1-15 mg/kg/hr continuous infusion, may be required for cessation of refractory seizure activity.

Midazolam. Midazolam is a rapid-acting benzodiazepine with amnestic, anxiolytic, and anticonvulsant properties. Midazolam is the sedative agent of choice for hemodynamically stable patients presenting with status epilepticus because of its potent anticonvulsant effects.[2,30,40] Side effects of midazolam include respiratory depression with associated apnea, myocardial depression, and hypotension secondary to a dose-related decrease in systemic vascular resistance (SVR). Because of the potential for significant cardiovascular side effects, it should be avoided in hemodynamically unstable patients.

The recommended RSI dose for midazolam is 0.1-0.2 mg/kg IV with clinical recovery in 30-60 minutes.[2]

Thiopental. Thiopental is a short-acting barbiturate sedative with a short onset of action (10-20 seconds) and duration of action (5-10 minutes). Thiopental does not have analgesic effects, so it should be used in conjunction with an analgesic. Associated side effects of thiopental include decreases in ICP and cerebral oxygen consumption, which make its use favorable in patients with head trauma or intracranial infections. Significant adverse effects include profound hypotension, myocardial depression, and bronchospasm from histamine release. Thiopental should be avoided in patients with cardiovascular instability and in those with asthma.

The recommended RSI dose for thiopental is 2-5 mg/kg IV.[2]

Narcotics. Narcotics, such as fentanyl and morphine, may be used as sedative agents for RSI. They provide both anesthesia and analgesia while decreasing sympathetic tone and therefore are good agents for patients exhibiting pain prior to intubation. Compared with morphine, fentanyl is more lipophilic, causing a faster onset (1-2 minutes) and shorter duration (approximately 30 minutes) of action. Fentanyl also causes less histamine release but can be associated with chest wall rigidity and ventilation difficulties when rapidly infused. Morphine has a longer onset of action (3-5 minutes) and longer duration of action (4-6 hours). Histamine release associated with morphine may cause significant pruritus. The large doses of both medications often required to achieve significant sedation and analgesia can lead to prolonged sedation, a decrease in SVR, and hypotension.[2,40]

The recommended RSI dose for fentanyl is 2-4 mcg/kg IV and morphine is 0.1-0.2 mg/kg IV.[29]

See Table 5 for a summary of RSI medications.

Neuromuscular Blocking (Paralytic) Agents

Neuromuscular blocking agents provide muscle paralysis to facilitate endotracheal intubation. They should be used in conjunction with a preceding sedative to achieve full RSI effect.

There are two main classes of neuromuscular blocking agents: depolarizing and non-depolarizing. Both induce motor paralysis by inhibiting acetylcholine stimulation of nicotinic receptors at the neuromuscular junction.

Depolarizing Agents

Succinylcholine. Succinylcholine is a commonly used paralytic agent in pediatric RSI. Its benefits include

Table 5. Summary of RSI Medications

Medication	Drug Class	Onset	Duration	IV Dose	Side effects
Atropine	Adjunct	30 min	Up to 4 hr	0.02 mg/kg (max 1 mg, min 0.1 mg)	↑ HR, Mydriasis
Lidocaine	Adjunct	3 min		1.5 mg/kg	↓ BP
Etomidate	Sedative-analgesic	5-15 sec	5-15 min	0.2-0.4 mg/kg	Adrenal suppression
Ketamine	Sedative-analgesic	< 2 min	10-15 min	1.5-2 mg/kg	Bronchodilation
Propofol	Sedative-analgesic	10-20 sec	10-15 min	1.5-3 mg/kg	Lactic acidosis
Midazolam	Sedative	1-5 min	30-60 min	0.1-0.2 mg/kg	Anticonvulsant, ↓ RR, ↓ BP
Thiopental	Sedative	10-20 sec	5-10 min	2-5 mg/kg	Bronchospasm, ↓ BP
Fentanyl	Analgesic	1-2 min	30 min	2-4 mcg/kg	Analgesia, ↓ BP
Morphine	Analgesic	3-5 min	4-6 hr	0.1-0.2 mg/kg	Analgesia, ↓ BP
Succinylcholine	Paralytic	< 1 min	4-6 min	1-2 mg/kg	Rhabdomyolysis, ↓ HR
Rocuronium	Paralytic	< 1 min	45 min	1 mg/kg	↑ HR, ↑ BP
Vecuronium	Paralytic	90-120 sec	20-60 min	0.15-0.3 mg/kg	anaphylaxis
Pancuronium	Paralytic	2-5 min	120-150 min	0.1-0.15 mg/kg	↑ HR, ↑ BP

an extremely fast onset (< 1 minute) and a short duration of action (4-6 minutes).[2,7,49] It is most often used in previously healthy children and in cases where brief, transient paralysis is preferred such as known or suspected difficult intubations.

There are potential significant adverse effects associated with succinylcholine use. Administration of this drug may cause bradycardia and, in extreme cases, asystole with repeat doses. For these reasons, atropine is typically recommended as an adjunct in pre-medicating children < 5 years of age or adolescents receiving a second dose of succinylcholine. Succinylcholine is absolutely contraindicated in children with underlying muscular dystrophy because it interacts with the unstable muscle membranes leading to severe, prolonged rhabdomyolysis and life-threatening hyperkalemia. Succinylcholine can also cause significant hyperkalemia and should be avoided in the setting of malignant hyperthermia, large body surface area burns, multisystem trauma, and traumatic spinal cord and other denervating injuries. Caution with succinylcholine use in multisystem injured patients stems from the proposed upregulation of skeletal muscle acetylcholine receptors that occurs approximately 2-3 days after injury.[2,50] In this situation, when depolarized, there is an even larger efflux of potassium leading to extremely elevated serum potassium levels and myocardial dysfunction.[2,50] Succinylcholine may also lead to an increase in ICP and intraocular pressure and should be used with caution in patients with intracranial injuries, brain tumors, and penetrating eye trauma.[2,44]

It is important to note that defasciculation and priming are no longer recommended when using succinylcholine due to increased medication errors associated with this practice.[2]

The recommended dose for RSI is 2 mg/kg IV in infants and younger children. In older children, the dose is 1 mg/kg IV, similar to adults. The age-related dosing difference stems from the fact that succinylcholine is distributed in the extracellular fluid, and younger children tend to have increased extracellular water compared to older children.[2]

Nondepolarizing Agents

Rocuronium. Rocuronium is a non-depolarizing neuromuscular blocking agent that induces muscle paralysis by competing with the nicotinic cholinergic receptor. It has a rapid onset of action (< 1 minute) and can last up to 45 minutes. It is recommended in patients with absolute contraindications to succinylcholine such as muscular dystrophy and/or malignant hyperthermia.

Rare adverse effects include tachycardia and hypertension.[32]

The recommended dose for pediatric RSI is 1 mg/kg IV.[2]

Vecuronium. Vecuronium is an alternative nondepolarizing agent that has a longer onset of action (90-120 seconds) and duration of action (20-60 minutes). Caution should be taken when using this agent in cases where endotracheal intubation may be difficult and prolonged paralysis contraindicated.

Rare adverse effects include hypersensitivity reactions, including anaphylaxis.[2]

The recommended dose for pediatric RSI is 0.15-0.3 mg/kg IV.[2]

Pancuronium. Pancuronium is a longer-acting nondepolarizing agent with a much slower onset (2-5 minutes) and long duration of action (120-150 minutes). It is primarily used for maintenance of paralysis after initial RSI. Significant side effects include a profound vagolytic effect leading to increased heart rate, blood pressure, and cardiac output.[2]

The recommended dose is 0.1 mg/kg IV for infants and 0.15 mg/kg IV for children.[2]

Confirmation of Endotracheal Intubation

Upon successful endotracheal intubation, the ETT should be secured and proper positioning confirmed. Appropriate ETT depth (cm from the upper lip) can be calculated by using the equation: ETT depth (cm) at the lips = 3 × ETT size (mm). Breath sounds should be auscultated at bilateral axillary areas and adequate, symmetric chest rise confirmed during bag insufflation. End-tidal CO_2 monitoring should be used post-intubation and measurable CO_2 return confirmed. This can be achieved as a one-time immediate confirmation using a colorimetric device or continuously with mainstream monitoring directly from the ETT, the preferred method. Lastly, a chest radiograph should be obtained to confirm proper ETT position. Documentation of vital signs, including temperature, heart rate, blood pressure, pulse oximetry, and end-tidal CO_2 level and airway reassessments are recommended every 5 minutes.

Complications of Endotracheal Intubation

Complications of pediatric intubations occur more frequently than in their adult counterparts[7] (*See Table 6*). The frequency of complications associated with endotracheal intubation in pediatric patients outside the operating room has been estimated to range between 15-38%.[28] A retrospective observational study using video review of pediatric intubations suggested that complications associated with pediatric RSI may be more prevalent than previously reported.[51] Sixty-one percent of their intubations (70/114) were associated with at least one adverse event. The most common complications were oxygen desaturation, right mainstem intubation, and esophageal intubation. Two intubations were associated with physiologic deterioration requiring cardiopulmonary resuscitation.

Anatomic characteristics of the pediatric head, neck and airway may pose challenges to the ED clinician caring for the pediatric patient and contribute to potential complications.[9,15,27] Children have proportionally larger heads and occipital prominences, causing passive anterior neck flexion and airway obstruction when lying supine. Their larger tongue to oropharynx ratio offers less visualization during intubation. The epiglottis in children is long, floppy, narrow, and more anteriorly located in the larynx, making visualization of the cords more difficult. The trachea in children is also shorter, narrower, and more anteriorly positioned, increasing the risk of right mainstem intubation. Complications during endotracheal intubation can be quite frightening even to the experienced clinician. Patient-related complications include oxygen desaturation, emesis, aspiration, laryngospasm, and trismus. Technical and intubator-related problems involve cuff leaks, equipment failure, medication dosage errors, dental and lip trauma, vocal cord avulsion, esophageal intubation, mainstem intubation, and tube dislodgement. Patients may develop dysrhythmias, hypotension, pneumothorax, bleeding and even cardiac arrest during endotracheal intubation. ED providers should anticipate potential complications and be prepared to manage them.[3,52,53]

Table 6. Complications with Endotracheal Intubation

Immediate problems
- Oxygen desaturation
- Emesis
- Aspiration
- Laryngospasm
- Oral trauma/bleeding
- Trismus
- Esophageal intubation
- Mainstem intubation
- Vocal cord injury/avulsion

Technical problems
- Cuff leak
- Medication dosage errors
- Equipment failure
- Tube dislodgement

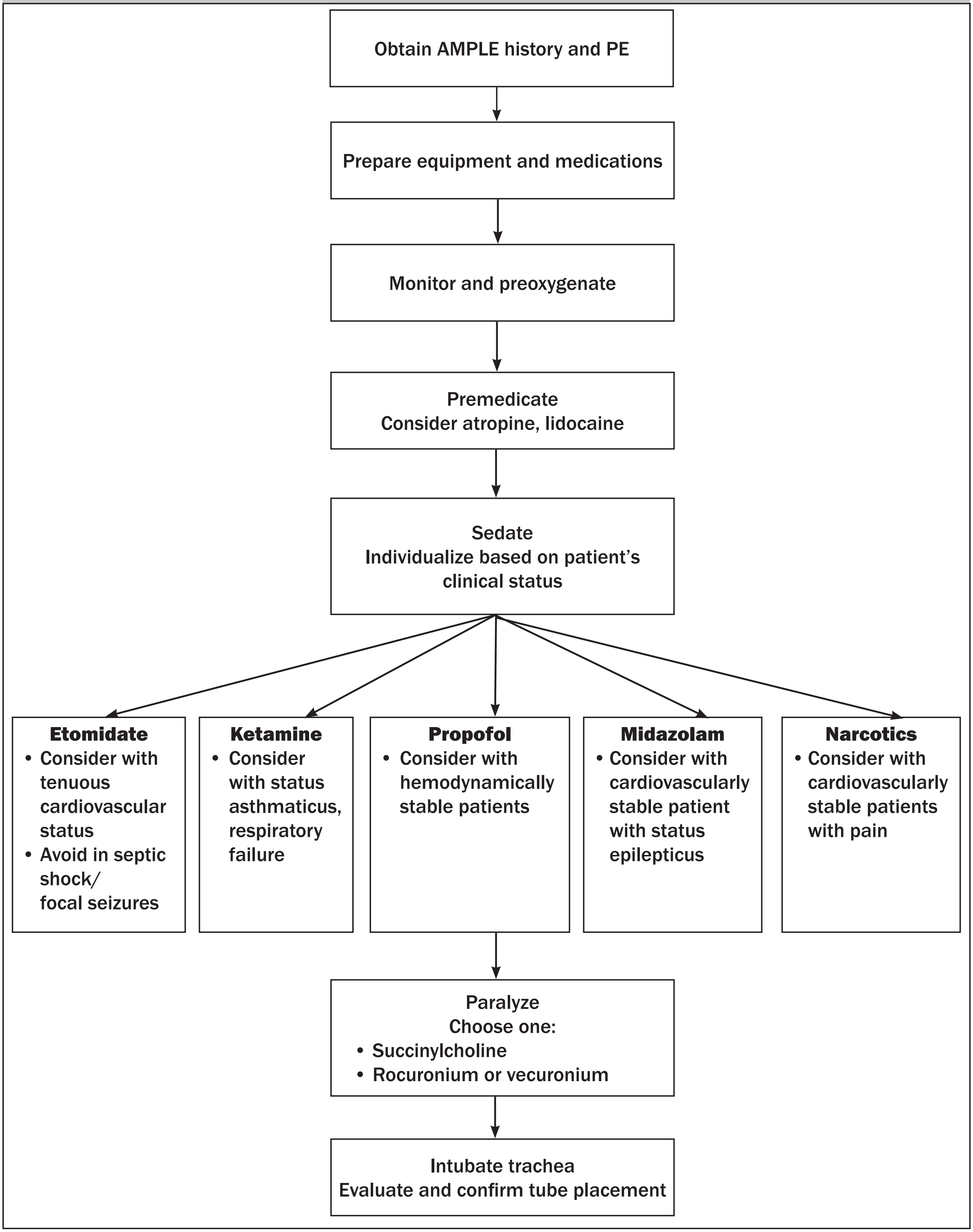
Other
- Dysrhythmias
- Hypotension
- Pneumothorax
- Cardiac arrest

Video Laryngoscopy

Video laryngoscopy is becoming a popular tool to aid clinicians with RSI in both pre-hospital and hospital settings. Most video laryngoscopy units allow for both direct and indirect (projected on a video monitor) visualization of the glottis during intubation. Monitor viewing allows for shared situational awareness and enhances bedside teaching when the intubator is a trainee. Blade sizes and choices are similar to conventional laryngoscopy blades; however, there are some (e.g., angulated blade, anatomically shaped blade with guide channel) that are specific to videolaryngoscopy with which the intubator should become familiar. One video laryngoscopy specific blade, the angulated blade, must be placed in the middle of the oropharynx without tongue displacement to view the vallecula. Providers then insert the ETT around the device during intubation. Another video specific blade, the anatomically shaped blade with guide channel, functions similarly to the angulated blade, but the ETT is preloaded into the guide channel and providers look for the vocal cords in the posterior aspect of the epiglottis during intubation.

Studies evaluating video laryngoscopy in non-trauma pediatric, adult, and simulated patients have shown video laryngoscopy to improve visualization of the larynx, facilitate successful intubations, and provide rescue capabilities with difficult intubations.[54-59] Benefits of video laryngoscopy over direct laryngoscopy in trauma patients remain controversial and studies evaluating patient outcomes are rare. Two studies involving adult trauma patients reported

Figure 1. Algorithm



improved visualization of the tracheal entrance with reduced cervical spine movement using video laryngoscopy compared to direct laryngoscopy.[60,61] A recent randomized controlled trial involving 623 adult trauma patients showed videolaryngoscopy by GlideScope to be associated with longer intubation times, but no difference in survival to hospital discharge among all patients studied.[62] In a small cohort of patients with severe head injuries in the same study, however, GlideScope laryngoscopy was associated with a greater incidence of hypoxia to ≤ 80% and a higher mortality rate.[62] Pediatric studies in trauma patients requiring intubation are few and results to date are similar to findings in adult studies. One study of 23 pediatric patients undergoing elective surgical procedures compared GlideScope to direct laryngoscopy with manual cervical spine immobilization to mimic conditions similar to trauma intubations.[63] Laryngoscopy with GlideScope resulted in significantly decreased views to the glottis entrance as measured by glottic opening score and time to best view.[63] Further evaluation of the efficacy and safety of video laryngoscopy, whether GlideScope or other video modalities, is needed in pediatric trauma patients to help guide the practice of intubation in scenarios requiring cervical spine immobilization.

Since there are no paradigms in place to guide the use of video laryngoscopy, providers must decide on a case-by-case basis whether to employ these devices when intubating in the ED setting.

Summary

Numerous studies confirm the safety and efficacy of pediatric RSI in the ED for both medicine and trauma patients requiring intubation. According to recent literature, the RSI approach to emergency intubation is associated with fewer attempts at laryngoscopy and better success at achieving endotracheal intubation.[37,64] The Pediatric Emergency Medicine Committee of the American College of Emergency Physicians advocates for the use of RSI "in every emergency intubation involving a child with intact upper airway reflexes."[8,9,37] RSI remains the method of choice for managing an emergent airway in the ED, and when conducted with the appropriate planning, positioning, and medications, intubation can be achieved with minimal complications (*See Figure 1*).

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CME Questions

1. A 9-year-old boy presents to the ED with his mom in extreme respiratory distress. The mother reports that he was around a friend's dog over the weekend and has been having trouble breathing. She gave him repeated albuterol treatments at home before calling 911 to bring him to the ED. On exam, the patient is extremely tight with little to no air movement. You give him several albuterol treatments with atrovent, magnesium sulfate, and epinephrine with no improvement. His arterial blood gas indicates impending respiratory failure and you decide to intubate him. The best choice of sedative would be:
   a. etomidate.
   b. ketamine.
   c. morphine.
   d. midazolam.

2. Which of the following is an absolute contraindication to the use of succinylcholine?
   a. Burn victim
   b. Renal failure
   c. Muscular dystrophy
   d. Concussion

3. A 10-year-old girl presents to the ED via EMS in status epilepticus. She continues to seize for 25 minutes, and you prepare to intubate her. The best choice of sedative would be:
   a. morphine.
   b. midazolam.
   c. etomidate.
   d. fentanyl.

4. You are preparing to intubate a 4-year-old girl with presumed septic shock. Which sedative should you avoid in this scenario?
   a. Midazolam
   b. Ketamine
   c. Fentanyl
   d. Etomidate

5. For the same 4-year-old mentioned above, what size uncuffed endotracheal tube would you need?
   a. 3.0
   b. 4.0
   c. 5.0
   d. 6.0

6. Which of the following statements is true?
   a. The adult occiput is proportionally larger than that of children.
   b. The larynx is more posterior in children.
   c. The trachea is shorter in children.
   d. The airway is narrower in adults.

7. Which of the following medications is considered a depolarizing muscle relaxant?
   a. Rocuronium
   b. Vecuronium
   c. Midazolam
   d. Succinylcholine

8. Which of the following medications should be used with caution in patients with egg and soybean allergies?
   a. Propofol
   b. Ketamine
   c. Fentanyl
   d. Etomidate

9. A 6-year-old girl presents to the ED after falling off her new bicycle. She was with the babysitter at the time who forgot to remind her to wear her helmet. She has a GCS of 9, and her pupils are unequal. You decide to intubate her to protect her airway. The best choice of sedative would be:
   a. ketamine.
   b. etomidate.
   c. morphine.
   d. midazolam.

10. In which of the following patient scenarios would atropine be recommended as an adjunct to the RSI regimen?
    a. 10-year-old child receiving ketamine and succinylcholine
    b. 8-year-old child receiving etomidate and rocuronium
    c. 3-year-old child receiving etomidate and succinylcholine
    d. 2-year-old child receiving ketamine and rocuronium

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Editorial Director: Lee Landenberger
Executive Editor: Leslie Coplin
Managing Editor: Neill Kimball

GST Registration No.: R128870672
Periodicals Postage Paid at Atlanta, GA 30304 and at additional mailing offices.

POSTMASTER: Send address changes to *Pediatric Emergency Medicine Reports*, P.O. Box 550669, Atlanta, GA 30355.

Back issues: $65. Missing issues will be fulfilled by customer service free of charge when contacted within one month of the missing issue's date.

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Pediatric Rapid Sequence Intubation: An In-depth Review

Emergency Endotracheal Intubation Recommendations for Trauma Patients

1. Trauma patients with the following clinical findings:[5]
   - Airway obstruction
   - Hypoventilation
   - Severe hypoxemia despite supplemental oxygen
   - Severe cognitive impairment (GCS < 8)
   - Cardiac arrest
   - Severe hemorrhagic shock
2. Smoke inhalation patients with the following conditions:[5]
   - Airway obstruction
   - Severe cognitive impairment (GCS < 8)
   - Major cutaneous burn (> 40% body surface area)
   - Prolonged transport time
   - Impending airway obstruction
     - Moderate-to-severe facial burn
     - Moderate-to-severe oropharyngeal burn
     - Moderate-to-severe airway injury seen on endoscopy

History Prior to RSI

A: Allergies and airway history
M: Medications
P: Past medical history, family history, and anesthetic history
L: Last oral intake
E: Events leading up to intubation

Equipment Preparation

S: Suction with a Yankauer tip
O: Oxygen
A: Airway equipment
P: Pharmacologic agents
ME: Monitoring Equipment

RSI Equipment Recommendations

Age	Blade Type and Size	ETT Size
Newborn	Miller 0 or 1	2.5-3.5
3-9 months	Miller 1 or Wis-Hipple 1.5	3.5-4.0
1 year	Miller 1 or Wis-Hipple 1.5	4.0-4.5
2-3 years	Miller 1 or 2 or Wis-Hipple 1.5	4.0-4.5
4 years	Miller 2 or Macintosh 2	4.0-5.0
5-6 years	Miller 2 or Macintosh 2	4.5-5.0
7-8 years	Miller 2 or Macintosh 2	4.5-5.5
9-10 years	Miller 3 or Macintosh 3	6.0-7.0
11-12 years	Miller 3 or Macintosh 3	6.5-7.5
>13 years	Miller 3 or Macintosh 3	7.0-8.0

* Note: Either a Miller or Wis-Hipple (straight blades) or Macintosh (curved blade) may be used during intubation. The epiglottis is relatively long, narrow, anteriorly angled, and more flexible in younger children making it often helpful to gently lift the epiglottis out of the way with use of a straight blade. The curved blade is used by inserting the tip of the blade into the vallecula and applying traction on the stiffer, older child's hyoepiglottic ligament to retract the epiglottis providing better visualization of the larynx. While both straight and curved blades can be successfully used in children, the most important factor is the operator's comfort with the device.

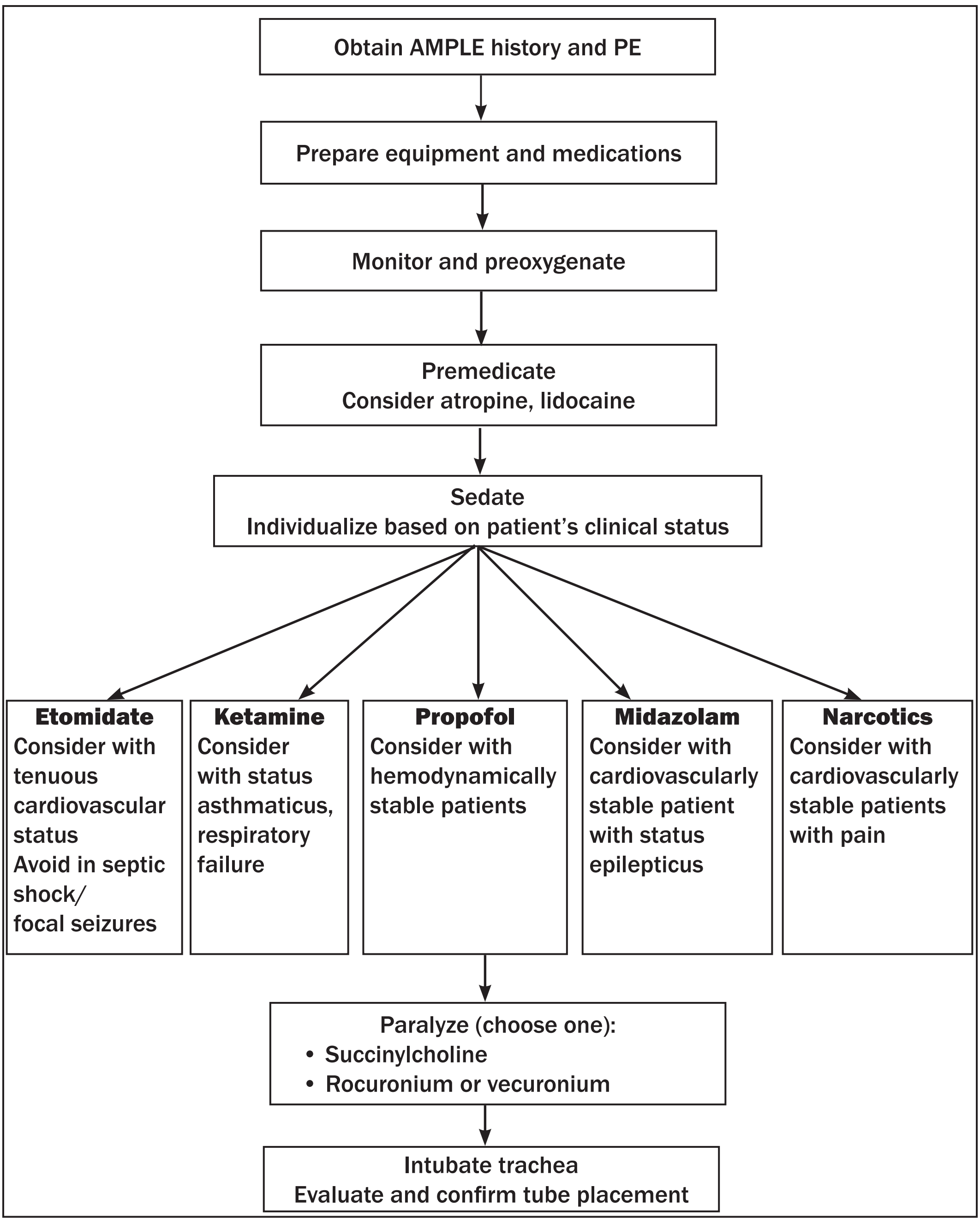
Endotracheal Tube Size

- Uncuffed Endotracheal Tube Size
  - Tube size (mm in diameter) = 4 + (age in years/4)
  - Have estimated tube size available, as well as 0.5 mm smaller and 0.5 mm larger
- Cuffed Endotracheal Tube Size
  - Tube size (mm in diameter) = 3 + (age in years/4)
- Most reliable estimation based on a child's body length
- Length-based resuscitation tapes are helpful for children up to approximately 35 kg

Summary of RSI Medications

Medication	Drug Class	Onset	Duration	IV Dose	Side effects
Atropine	Adjunct	30 min	Up to 4 hr	0.02 mg/kg (max 1 mg, min 0.1 mg)	↑ HR, Mydriasis
Lidocaine	Adjunct	3 min		1.5 mg/kg	↓ BP
Etomidate	Sedative-analgesic	5-15 sec	5-15 min	0.2-0.4 mg/kg	Adrenal suppression
Ketamine	Sedative-analgesic	< 2 min	10-15 min	1.5-2 mg/kg	Bronchodilation
Propofol	Sedative-analgesic	10-20 sec	10-15 min	1.5-3 mg/kg	Lactic acidosis
Midazolam	Sedative	1-5 min	30-60 min	0.1-0.2 mg/kg	Anticonvulsant, ↓ RR, ↓BP
Thiopental	Sedative	10-20 sec	5-10 min	2-5 mg/kg	Bronchospasm, ↓ BP
Fentanyl	Analgesic	1-2 min	30 min	2-4 mcg/kg	Analgesia, ↓ BP
Morphine	Analgesic	3-5 min	4-6 hr	0.1-0.2 mg/kg	Analgesia, ↓ BP
Succinylcholine	Paralytic	< 1 min	4-6 min	1-2 mg/kg	Rhabdomyolysis, ↓ HR
Rocuronium	Paralytic	< 1 min	45 min	1 mg/kg	↑ HR, ↑ BP
Vecuronium	Paralytic	90-120 sec	20-60 min	0.15-0.3 mg/kg	anaphylaxis
Pancuronium	Paralytic	2-5 min	120-150 min	0.1-0.15 mg/kg	↑ HR, ↑ BP

Algorithm



Supplement to *Pediatric Emergency Medicine Reports*, May 2014: "Pediatric Rapid Sequence Intubation: An In-depth Review." *Authors:* **Lauren E. Staple, MD,** Assistant Professor of Clinical Pediatrics, Perelman School of Medicine at the University of Pennsylvania, Philadelphia; and **Karen J. O'Connell, MD, Med, FAAP**, Assistant Professor of Pediatrics, The George Washington School of Medicine and Health Sciences; Director of Patient Safety, Pediatric Emergency Medicine, Children's National Health System, Washington, DC. *Pediatric Emergency Medicine Reports' "Rapid Access Guidelines."* Copyright © 2014 AHC Media LLC, Atlanta, GA. **Editorial Director:** Lee Landenberger. **Editor-in-Chief:** Ann Dietrich, MD, FAAP, FACEP. **Executive Editor:** Leslie Coplin. **Managing Editor:** Neill Kimball. For customer service, call: **1-800-688-2421**. This is an educational publication designed to present scientific information and opinion to health care professionals. It does not provide advice regarding medical diagnosis or treatment for any individual case. Not intended for use by the layman.

Pediatric Emergency Medicine Reports

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In an effort to learn more about the professionals who read *Pediatric Emergency Medicine Reports* (PEMR), we are conducting this reader survey. The results will be used to enhance the content and format of *PEMR*.

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O A. Always
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6. Agitated pediatric patients (Sept. 2013)	O A	O B	O C	O D
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10. Kawasaki disease (Jan. 2014)	O A	O B	O C	O D
11. Pediatric UTIs (Feb. 2014)	O A	O B	O C	O D
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14. Pediatric rapid sequence intubation (May 2014)	O A	O B	O C	O D

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Trauma Reports

PRACTICAL, EVIDENCE-BASED REVIEWS IN TRAUMA CARE

Volume 15, Number 3 **May/June 2014**

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AHC Media

Fractures in Older Adults

As the population ages and continues to retain an increasingly high level of function, including driving and recreational activities, a unique pattern of injuries is emerging in older patients. The authors review risk factors for fractures, impact of comorbidities, and unique aspects for management strategies.

— Ann M. Dietrich, MD, Editor

Introduction

Older adults, adults 65 years and older, have both an increased rate of trauma and an increased predisposition to injury from even minimal force. This makes older adults a high-risk population for traumatic fracture from high- or low-impact mechanisms. High-impact fractures occur from falls from a height, motor vehicle collisions (MVCs), and sporting injuries. The number of high-impact fractures seen in older adults will continue to increase over the next 15 years as the U.S. population ages. For example, by 2030, motor vehicle crashes involving drivers older than 65 years are projected to increase 178%, and older adults will account for 25% of total driver fatalities.[1] High-impact fractures have high mortality rates, and even those who survive to discharge have increased mortality over the following year.[2] Surprisingly, MVCs are not the most common or the deadliest causes of fractures in older adults. Low-impact fractures, commonly called fragility fractures, have even higher mortality. Older patients with injuries from a fall have five times the mortality that their same age colleagues have from injuries from MVCs.[3] Five-year survival after an osteoporotic hip fracture is similar to that of patients with breast or other cancer.[4] Almost one in 13 (7.5%) of those with fragility fractures will die within 90 days of fracture.[5] Low-impact fractures from falls at standing height or lower are commonly associated with decreased bone mineral density (BMD). Falls resulted in 13.5% of older adult emergency department (ED) visits in 2010, and a fracture was the most common injury noted.[6,7] In total, U.S. older adults suffered from 2.5 million fractures in 2009-2010.[8]

A fracture can be a devastating blow to an older adult's health and independence, decreasing functional status and quality of life permanently.[9] While some may recover their independence, half of older adults will require home health care in the 6 months following a fracture, and many will have long-term functional decline.[10] Spine, hip, or upper leg fractures decrease long-term quality of life just as much as chronic diseases such as diabetes or chronic lung disease.[11] Acutely, the pain and shock of an injury may precipitate delirium, complicating diagnosis and treatment, increasing the need for further medication, and increasing the rate of long-term cognitive deficits. In addition to the morbidity related to the initial fracture, the risk of further falls and subsequent fractures is also greatly increased. Almost a quarter of older adults will have a second fracture within the next 5 years, and the risk of hip fracture is 17-fold higher in the first month after a fragility fracture.[12-14] Understanding the risk factors for fractures, the effects of common comorbidities, the differences in the type of fractures seen in older adults, and the different management strategies is important to optimize the care of this high-risk population.

Executive Summary

- Five-year survival after an osteoporotic hip fracture is similar to that of patients with breast or other cancer. Almost one in 13 (7.5%) of those with fragility fractures will die within 90 days of fracture.
- Each standard deviation decrease in BMD increases the relative risk of fracture by 1.5. Nearly all 80-year-old women have low BMD, with 27% being osteopenic and 70% osteoporotic.
- Thoracic and lumbar vertebral fractures are common from low-impact or high-impact trauma, and are estimated at 27% of fragility fractures.
- Patients diagnosed with a fracture in the ED should be considered high risk for future fractures and referred for preventative care, such as BMD testing, initiation of low BMD treatment, geriatric assessment, or home safety assessment.

Fracture Risk Factors in Older Adults

Due to the physiologic changes of aging as well as common comorbidities, older adults are at high risk for fractures. Difficulties with gait, vision, and proprioception (due to neuropathy or medications) contribute to falls. Household hazards such as throw rugs and lintels can contribute to falls. The utility of different fall risk interventions was assessed in a recent Cochrane Review.[15]

While interventions to prevent falls have had only moderate success, treatment of low bone mineral density (BMD) has been shown to significantly reduce fracture rates. Low BMD is classified as osteoporosis (< 2.5 standard deviations below normal) or osteopenia (between 1 and 2.5 standard deviations below normal) based on hip or vertebral DXA scan. Osteoporosis affects more than 10 million Americans, in addition to the numbers of untested older adults or those with only osteopenia. Each standard deviation decrease in BMD increases the relative risk of fracture by 1.5.[16] Nearly all 80-year old-women have low BMD, with 27% being osteopenic and 70% osteoporotic.[17] Men especially may not know that they have low BMD, as the screening rate in the United States for older men is as low as 11%.[18] Despite the lack of screening, men account for more than 25% of osteoporosis-related fractures.[19] As BMD testing currently is not feasible in the ED setting, any adult with a fracture (high or low impact) should be referred for outpatient testing. In older adults without osteoporosis, fracture risk factors include falls in the prior 12 months, any prior fractures, and any decrease in BMD.[20] Risk stratifying patients by BMD alone or even by FRAX guidelines (World Health Organization screening guidelines) may not be sufficient to identify patients at high risk for fracture.[21] Therefore, all older adults should be considered to be high risk for fracture, and imaging should be ordered liberally.

Multiple medical conditions also increase the risk of fracture. Any condition requiring chronic glucocorticoid use, such as inflammatory bowel disease, celiac disease, chronic obstructive pulmonary disease, and rheumatoid arthritis, decreases BMD.[22] Neurologic, endocrine, renal, and other problems also predispose older adults to fracture. (*See Table 1.*) Patients on dialysis have an increased risk of fracture that is most often seen in older Caucasian females.[23] An episode of acute kidney injury that requires dialysis, even if only temporarily, increases the risk of fracture.[24]

Other risk factors include changes in body mass index (BMI), socioeconomic factors, and prior fracture history. Low BMI is a risk factor for hip and osteoporotic fractures, but is a protective factor for lower leg fracture. High BMI is a risk factor for upper arm (humerus and elbow) and ankle fractures.[25,26] Socioeconomic factors also may play a role in patient health and are especially important in the older adult population. Poverty itself is a risk factor for low BMD and fragility fractures, and the risk may begin with low socioeconomic status in childhood.[27,28] The best predictor of future fracture, however, is prior fracture.[22] Prior wrist fracture doubles the risk of any future fracture.[29] Men with a prior non-hip, non-vertebral fracture have a 41% chance of having a second fracture within 5 years of the initial fracture.[30] Further fractures decrease an older adult's life expectancy significantly.[31] Patients diagnosed with a fracture in the ED should be considered high risk for future fractures and referred for preventative care, such as BMD testing, initiation of low BMD treatment, geriatric assessment, or home safety assessment.

Medications that Contribute to Fracture Risk and Complications

In addition to chronic glucocorticoid use, many other medications have been implicated in increasing the fracture risk in the elderly. Antipsychotic use in skilled nursing facility patients increases the risk of hip fracture in the first year after initiation,[32] and changes in any psychotropic medication including selective serotonin reuptake inhibitors (SSRIs) are associated with increased fall and fracture risk.[33] Long-term warfarin use increases the risk of osteoporotic fractures in elderly men with atrial fibrillation (versus those with atrial fibrillation not on warfarin), but a similar effect was not noticed in women.[34] Similarly, chronic levothyroxine use increases the risk of hip fracture in men but not in women.[35] This gender disparity may be due to the already elevated risk in women compared to men so that the effect of medications is less apparent in women.

Anticoagulation use is also common and complicates fracture management. The use of oral anticoagulants may be associated with decreased BMD and increased fracture risk.[36] The evaluation of a patient on anticoagulation with a closed fracture should include an assessment for compartment syndrome due to expanding hematomas. Open fractures in any extremity may require anticoagulation reversal and transfusion. Perioperative bleeding is especially a concern in pelvic, acetabular, femur, and tibial fractures, and these injuries frequently require transfusions.[37] Patients on clopidogrel may have worse immediate outcomes with emergent surgery for hip fracture, but delaying surgery seven days to regain normal platelet function is associated with increased one-year mortality.[38,39] In fact, a delay to surgery of more than 24 hours for any reason is associated with increased mortality in patients with hip fractures.[40] Reversing anticoagulation reduces hospital length of stay and complications in hip fracture patients.[41] Vitamin K reversal for orthopedic trauma patients on warfarin is both effective and cost effective.[42]

Treatment of underlying predisposing factors such as reversal of anticoagulation (if indicated) and abnormal bone mineral density treatment can decrease morbidity and mortality. Treatment with calcium and vitamin D reduces overall three-year mortality from a hip fracture in men by 43% and in women (with the addition of antiosteoporotic medications) by 36%.[43] The addition of calcium and vitamin D in the first six weeks after a proximal humerus fracture has been shown to increase callus formation and BMD.[44] Oral vitamin supplementation of 700-800 IU must be given to achieve this effect, which is greater than the typical 400 IU in multivitamins.[45,46] The effect of osteoporosis treatment on morbidity and mortality for other types of fragility fractures is not as well characterized. Given the benign side-effect profile of vitamin D supplementation, we recommend all older adults with fractures be discharged on vitamin D supplementation with follow up by their primary

Table 1. Common Comorbidities that Increase the Risk of Fracture in Older Adults[9,98,16,17]

Gastrointestinal	Inflammatory bowel disease, celiac disease
Neurologic	Multiple sclerosis, Parkinson's disease
Pulmonary	COPD, pulmonary fibrosis with steroid use
Endocrine	Type 1 diabetes, Addison's disease
Hematologic	Hemophilia A, hemophilia B
Renal	End stage renal disease and possibly long-term renal insufficiency
Rheumatologic	Rheumatoid arthritis
Oncologic	Cancer with bony metastases

Table 2. Incidence of Fractures in Older Adult Men and Women[30,53,54,70,73,83,99-101]

Fracture	Incidence (per 10,000 patient years)	
	Women	Men
Lower vertebral- clinical and incidental‡	680	700
Hip‡	50-76	33-36
C-spine**	18-85	18-85
Non hip, non vertebral, low trauma‡	154	78
Distal Radius†	75	19
Ankle*	58	24
Proximal Humerus††	42	15
Rib	40©	35*
Overall	2 million /year	

‡ Incidence in ages ≥ 60, low energy trauma fractures only
** Incidence from Norway increases from 18/10,000 in 60-75 year olds up to 85/10000 in the oldest old, genders combined
† Incidence from Norway, ages ≥ 50, high and low energy trauma fractures
†† Incidence from US, ages ≥ 70, high and low energy trauma fractures
© Incidence in ages ≥ 60 in hospitalized patients only, low energy trauma fractures only
* Incidence from US, ages ≥ 65, high and low energy trauma fractures

Figure 1. **Multiple Thoracic Spine Fractures**

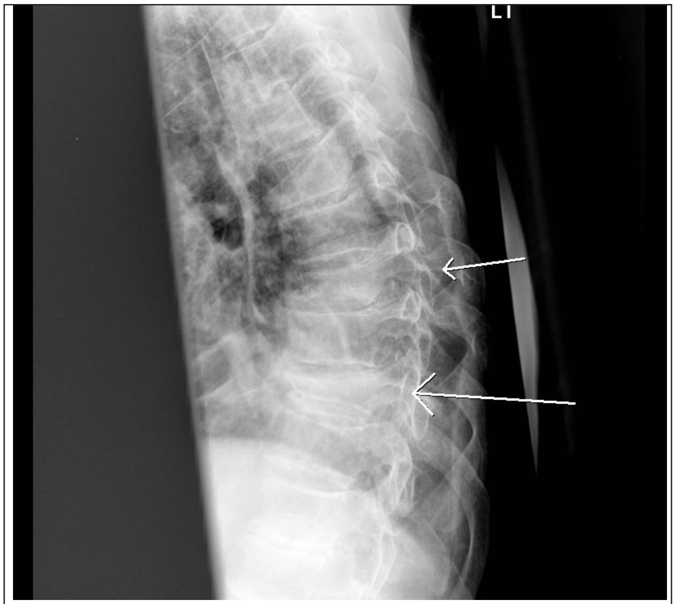


Image courtesy of Ademola Adewale, MD

Figure 2. **L1 Compression Fracture**

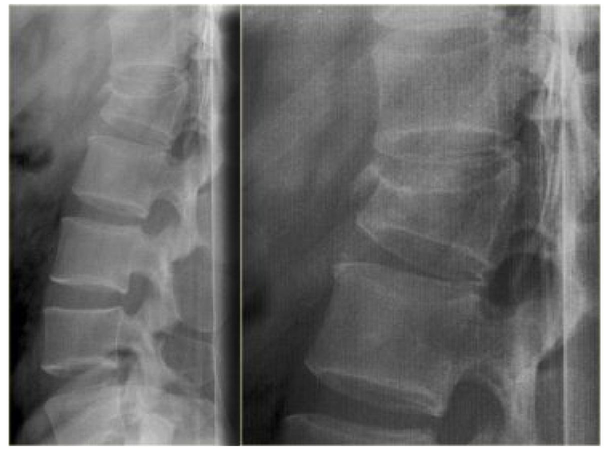


Image courtesy of Ademola Adewale, MD

care physician. Overall, older adults with fractures would benefit from a full medication review with attention to risks for immediate fracture treatment, as well as subsequent fracture prevention.

Overview of Common Fractures

Older adults are prone to different fractures and fracture mechanisms than a younger cohort. The fracture incidences tend to change after age 50, when post-menopausal changes to BMD start. The most common fractures in older adults are vertebral fracture from compression or trauma, followed by hip and distal radius fractures. (*See Table 2.*) One in two women and one in five men will suffer from an osteoporotic fragility fracture, which is defined as any low-energy trauma fracture. The most common fragility fractures are proximal humerus, hip, distal radius, and spinal fractures.

Thoracic and Lumbar Vertebral Fractures

Thoracic (*see Figure 1*) and lumbar vertebral fractures (*see Figure 2*) are common from low-impact or high-impact trauma, and are estimated at 27% of fragility fractures.[19] Degenerative changes in the more mobile thoracolumbar junction and lumbar spine place older adults at higher risk for injuries to this area in high-impact traumas such as MVCs. Trauma registries demonstrate that the oldest old (80+ years) tend to have more upper thoracic and T-L junction injuries, while the younger old (60-79 years) may have more lumbar spinal fractures. Younger adults tend to have flexion-distraction fractures, while older adults suffer the higher mortality extension fractures.[47] Stable compression fractures or mild burst fractures seen on X-ray and without neurologic symptoms may not need further imaging, but it is important to recognize that significant soft-tissue injuries can be missed with these injuries, and CT or MRI may better clarify the extent of the injury. Helical spine CT is 99% accurate in identifying spinal fractures, as compared to 87% accuracy of 2-view thoracolumbar X-rays (which may be even less accurate with low BMD). CT also aids in the assessment of fracture age and acuity.[48] Acute vertebral fractures have a three-year survival rate of 40-60% depending on the type of treatment. Acute fractures can be treated with analgesics only, or treated surgically with balloon kyphoplasty or vertebroplasty, which is best done in the first two months after an acute fracture.[49] Surgical treatment decreases mortality and chronic pain and increases quality of life compared to medical management.[50,51]

Thoracic and lumbar compression fractures from low BMD or low-impact trauma are a significant health problem. The prevalence is around 20% in both women and men 70 years and older, and most are between T6 and L1.[52] Asymptomatic compression fractures are often noted on routine chest X-rays. In one study of women with one or more risk factors for compression fractures, 31% had an undiagnosed moderate or severe vertebral fracture, and of these women, 75% did not have osteoporosis on DXA scan.[53] Additionally, 18% may develop a new compression fracture in the year following diagnosis of the initial compression fracture.[51] Therefore, prevention is very important, even if these fractures are asymptomatic. ED referral or discussion with the patient about treatment options is also important, as most compression fractures will be treated on an outpatient basis unless there is uncontrollable pain or concern for cord injury.

Hip Fractures

Hip fractures (fractures of the proximal femur, including subcapital neck, intertrochanteric, subtrochanteric, and others) are some of the most common types of fragility fractures and are associated with the highest mortality. The incidence of hip fractures worldwide may be decreasing slightly due to implementation of national screening guidelines and preventative treatment .[54] (*See Table 2.*) Women more commonly suffer hip fractures at a rate of 4.5:1, but this difference is minimized after age 70.[55] Other risk factors may include low vitamin K and vitamin D levels.[56]

The clinical presentation of hip fracture classically occurs after a fall in an older individual, but can present after any type of traumatic injury. In most instances, a hip fracture can be diagnosed from the history and physical exam. Patients are usually unable to bear weight on the affected side, have tenderness to palpation over the greater trochanter, and pain with external rotation, abduction, or axial loading of the hip. More obvious fractures will present with the leg in external rotation and shortened. The diagnostic imaging modality of choice is plain film X-rays of hip (*see Figure 3*), but CT or MRI may help characterize more subtle fractures, as X-rays are only 90-98% sensitive.[57] Occult, or X-ray-negative hip fractures, make up 3-9% of hip fractures. Currently, MRI is the gold standard for the detection of occult fractures and should be considered in any at-risk patient unable to bear weight after a traumatic event.[57]

Treatment strategies include various surgical options. It is important to optimize pre-operative health, but delays in surgery have been shown to increase mortality.[38-40] Older adult patients commonly experience peri-operative complications such as hypoxia, delirium, anemia requiring transfusion, congestive heart failure, acute renal injury, and myocardial infarction.[58] The most common

***Figure 3.* Hip Fracture**

post-operative complications are pneumonia, acute renal injury, and pressure ulcers.[59] The risk of mortality is much higher in those who suffer one or more complications. Those at highest risk of mortality and complications include patients on dialysis, those presenting in shock, patients with obesity, history of cardiopulmonary disease, diabetes, or a delay to surgery of more than 48 hours.[59] In high-impact trauma patients, such as MVCs or motorcycle collisions, patients with any type of femur fracture (hip or distal) are more likely to have a perioperative MI; however, overall their mortality is similar to other older adult trauma patients without a femur fracture.[60] Despite definitive surgical management, hip fractures in the elderly have a high mortality rate of 8.1% at 30 days and 21.6% at one year,[58] and a similar five-year survival rate as breast cancer patients.[4] For those who survive, many do not regain their previous level of functioning and require skilled nursing care or home health assistance. The emergency physician can decrease morbidity and mortality by having a low threshold to proceed to CT or MRI to rule out occult fracture, facilitating pre-operative clearance (decreasing time to surgery), and discussing delirium and pressure ulcer prevention with family and staff. Depending on the anesthesia and hospitalist staff, pre-operative clearance usually involves a pulmonary exam and chest X-ray, a cardiac exam with EKG and possibly echocardiogram if the patient has a history of heart failure or valve disorders, and a medication review. Pre-operative labs such as a type and cross, coagulation parameters (PT and PTT), and basic blood counts and chemistries are also required. Many of these tests can be obtained quickly in the ED.

Cervical Spine Fracture

Cervical spine (c-spine) injury (*see Figures 4 and 5*) is a significant cause of morbidity and mortality in the geriatric trauma patient. Older adults account for 19% of c-spine injuries,[61] but the likelihood of a c-spine injury is twice as high as that for a younger trauma patient,[62] with many requiring surgical intervention. Rollover motor vehicle accidents and

Figure 4. **Cervical Spine Fracture**

Image courtesy of Howard Werman, MD

Figure 5. **Cervical Spine Fracture**

Image courtesy of Howard Werman, MD

Figure 6. **C1 Fracture**

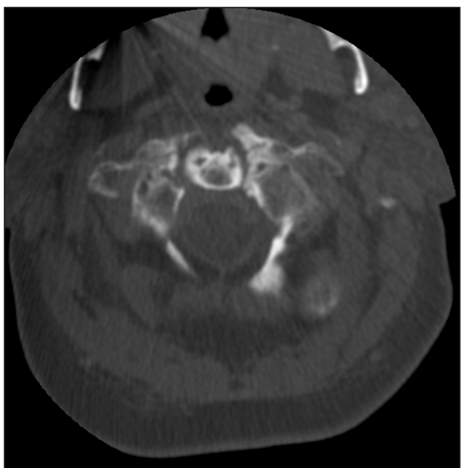


Image courtesy of Howard Werman, MD

Figure 7. **C2 Fracture**

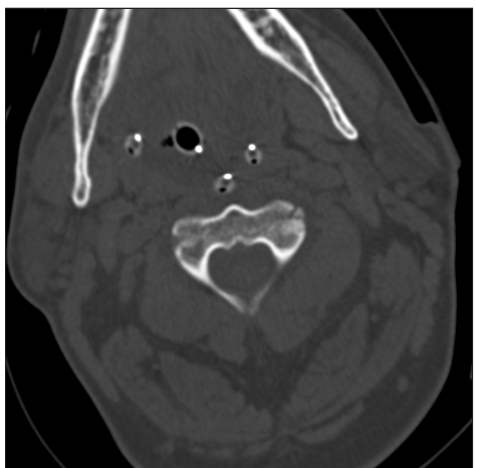


Image courtesy of Howard Werman, MD

older age increase the risk of c-spine fracture.[63] Low-impact mechanisms, however, cause more than 50% of c-spine fractures.[61] The injury pattern in older patients with cervical injury is also different than in younger patients. Due to the decreased range of motion of the cervical spine, elderly patients are more likely to sustain higher level c-spine fractures (*see Figures 6 and 7*), while younger patients are more likely to sustain lower c-spine injury. Elderly patients are also more likely to have additional intracranial injuries compared to younger patients.

The diagnosis of c-spine fractures in the elderly can be elusive. The NEXUS study provides practitioners with a set of clinical criteria that, if met, put the patient in a very low risk category for c-spine injury.[64] This landmark study did include a sufficient number of geriatric patients, and a geriatric subgroup analysis shows 100% sensitivity for clinically significant injuries.[62] However, many are reluctant to apply this clinical decision rule in the geriatric population due to the number of older adults with fractures from minimal trauma with minimal symptoms.[65,66] Various retrospective studies describe limitations,[63,67] but no clear prospective evidence has shown these criteria to be inferior in the geriatric population. The Canadian C-spine Criteria uses age 65 and greater as a high-risk feature that requires imaging, but fewer clinicians use these criteria, as it is a more complicated algorithm to implement.[65] The clinical exam is difficult in geriatric patients, as they commonly have decreased range of motion at baseline, baseline pathology that can make plain films difficult to interpret, and may have clinically significant spinal injuries with minimal symptoms. Therefore, CT (*see Figure 8*) should be the first imaging used to evaluate for c-spine injury in older patients.

Treatment options include nonoperative immobilization with cervical collar or surgery for internal fixation. Type II dens fractures are the most common type of cervical fracture in the elderly, and, thus, the best studied to determine the benefits from surgery. Some findings show protective effects with surgery in younger populations of geriatric patients.[68] Other non-randomized studies have shown a functional and mortality benefit with surgical intervention in those patients healthy enough to undergo surgery.[69] The only available studies to guide treatment options are limited to retrospective, uncontrolled studies. The decision to operate on cervical spine fractures in older adults depends on previous functional status and comorbidities in addition to the clinical judgment of the neurosurgical team. Despite intervention, mortality with c-spine injury is high; one-year mortality from dens fractures comparable to hip fractures at 37.5%.[70]

Distal Forearm Fractures

Distal forearm fractures account for 19% of osteoporosis-related fractures[19] and are almost always caused by a fall on an outstretched hand or an MVC. (*See Figures 9 and 10.*) Theoretically, as balance and motor coordination decrease with age, older women are more likely to fall onto their hip than an

Figure 8. **C4 Fracture**

Image courtesy of Howard Werman, MD

Figure 9. **Distal Forearm Fracture**

Figure 10. **Distal Forearm Fracture**

outstretched hand. However, the incidence of distal radius fracture still increases with age, with an increase from 34 per 10,000 patient years in women ages 50-54 to 101 in those 85 years and older.[71] This is more than double the incidence in men. Women are four times more likely to have a distal radius fracture overall, but men are five times more likely than women to have a high-impact fracture.[71] Older adults with distal radius fractures have a tendency toward better health than their peers with proximal humerus or hip fractures, and distal forearm fractures do not appear to increase mortality.[72] However, there is still an increased risk for further fractures.[12] Emergency department management includes a high index of suspicion in any older adult with wrist pain, and splinting or orthopedic consultation, as indicated, based on the severity and displacement of the fracture. While the patient population with distal forearm fractures tend to be high functioning, their ability to compensate for the immobilization of one hand may be decreased, especially if they normally walk with an assistive device. A home safety and functional assessment is indicated prior to discharge, with admission for rehabilitation placement if needed.

Ankle and Other Lower Extremity Fractures

Ankle, knee, and foot fractures are often seen after falls. Older adults suffer 20-30% of foot and ankle fractures, with an incidence of 42/10,000.[73,74] In addition to the risk factors for any fracture, an elevated BMI is associated with a higher risk for ankle fractures.[75] X-rays are usually sufficient to diagnose fractures. Surgical intervention is needed frequently for trimalleolar fractures (74%), but less frequently for isolated malleolar fractures (11-22%).[74] Surgical repair in patients with increasing age, diabetes, or smoking history have a complication rate greater than 20%, but surgery may provide improved long-term function.[76] A comparison of adults older than 70 years of age with ankle fractures treated conservatively (reduction and casting) versus operatively found that more than 25% of the conservative group had failure and required surgery at a later stage. Additionally, 72% of those treated operatively returned to their prior weight-bearing levels of activity, as opposed to only 42% in the conservative group.[77] Operative ankle fractures should be treated aggressively without prolonged delay to reduce the rate of wound and other complications.[78,79] Patella fractures usually occur from direct fall onto the knee. Depending on extensor tendon disruption and comminution, these may be treated operatively or conservatively. Both treatment courses result in 82% of patients returning to their prior functional status.[80]

Knee, foot, and ankle fractures may not be associated with low BMD as frequently as distal radius or vertebral fractures.[81] However, these patients should still be referred for testing for low BMD to ensure appropriate treatment. Treatment of any older adult with a lower extremity fracture should also include a safety assessment with assistive devices, as many of these patients may not be able to appropriately use crutches or a walker with a cast or splint on a lower extremity.

Figure 11. **Proximal Humerus Fracture**

Proximal Humerus Fractures

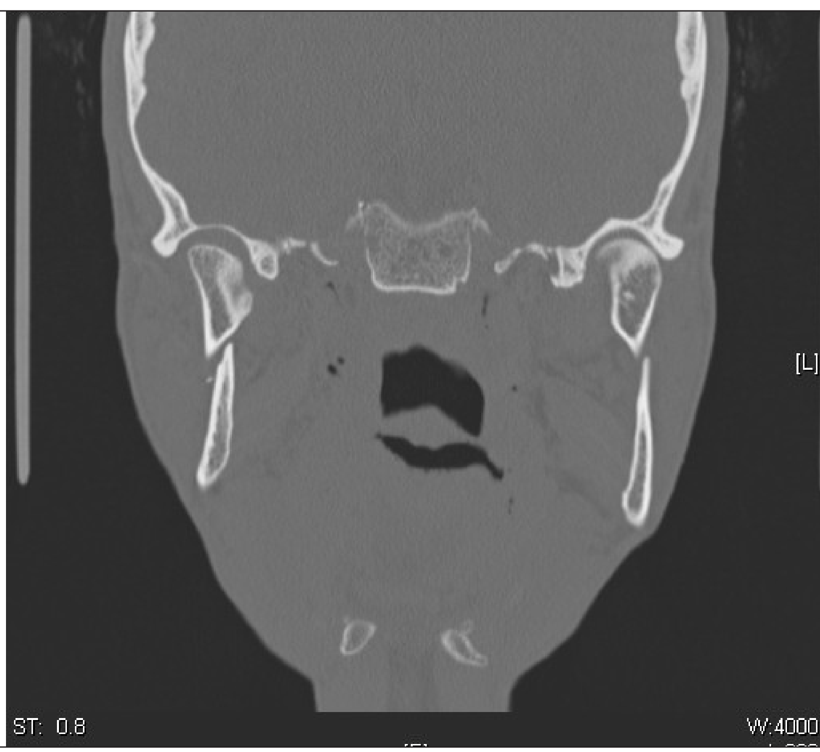
Men and women share similar risk factors for proximal humerus fractures, most notably decreased BMD.[82] In addition to low BMD and falls risk factors, antiepileptic use, diabetes mellitus, obesity, and left-handedness all increase the risk of proximal humerus fracture.[83] The risk increases with age, starting around 45 years old and peaking around 85 years old.[84] Older adults with proximal humerus fractures tend to be less physically and mentally impaired than age-matched colleagues with hip fractures, but they still have increased mortality in the initial year after fracture.[72] Women account for two-thirds of proximal humerus fractures in older adults, while men make up a greater proportion in younger adults. (*See Figure 11.*) Additionally, these fractures are more likely to be complicated by comminution or displacement in older adults.[85] In non-displaced fractures, there is insufficient evidence to recommend surgery versus immobilization, and, therefore, most non-displaced proximal humerus fractures are treated with a shoulder immobilizer and early physical therapy.[86] Despite treatment, proximal humerus fractures can decrease quality of life and independence chronically. If patients have not recovered good range of motion and strength within a year, they will continue to have chronic difficulties.[87] Additionally, this fracture may decrease a patient's ability to use adaptive equipment such as a walker, cane, or grab bars; a home healthcare needs and safety assessment should be done prior to discharging a patient who may not be able to maintain independence with this injury.

Facial Fractures

The most common mechanisms resulting in facial fractures include falls (50%) and motor vehicle crashes (20%).[88,89] These fractures are associated with significant morbidity and mortality, with up to 11% in-hospital mortality.[88,89] The most

Figure 12. **Bilateral Mandibular Fracture**

Figure 13. **Bilateral Mandibular Fracture**



common facial bone injured is the mandible (18%) (*see Figures 12 and 13*) and then the orbital floor (15%) (*see Figure 14*) and zygoma (15%) (*see Figure 15*). Providers should be aware that facial fractures along with upper extremity injuries are the most common presentations of elder abuse. Particular care should be taken to explore possible abuse in high-risk situations, such as when there is a culture of violence in the family or a vulnerable patient with dementia or social isolation.[90] If there is any concern for safety, the patient should be admitted until a full social work evaluation can be done.

Patients with any trauma and concerning bruising or tenderness of the face should undergo maxillofacial CT imaging. Patients with facial fractures may also sustain other injuries, including brain, extremity fractures, cervical spine fracture, and spinal cord injuries. Additional imaging, such as non-contrast CT of the brain or CT angiography, may be indicated to evaluate for intracranial pathology or blunt carotid injury. The majority of facial fractures in older adults are managed non-operatively.[88,89] In one clinical series, 30% of patients died before any operative intervention, 65.9% had non-operative management, and only 5% required internal fixation.

Mandible and LeFort fractures are the most likely to require operative intervention. Functional and cosmetic outcomes that affect quality of life determine the need for intervention. Fractures that interfere with mastication and jaw function are likely to be more problematic for long-term quality of life if left untreated.[91] In another reported series, open reduction was used in 28.8% of patients, 26.9% were treated with closed reduction, and 44.2% did not undergo any treatment.[92] The variation in treatment for similar fractures again may be dependent upon the baseline characteristics of the patient, including comorbidities and functional status. Emergency department management includes a low suspicion for facial

Figure 14. **Orbital Floor Fracture**

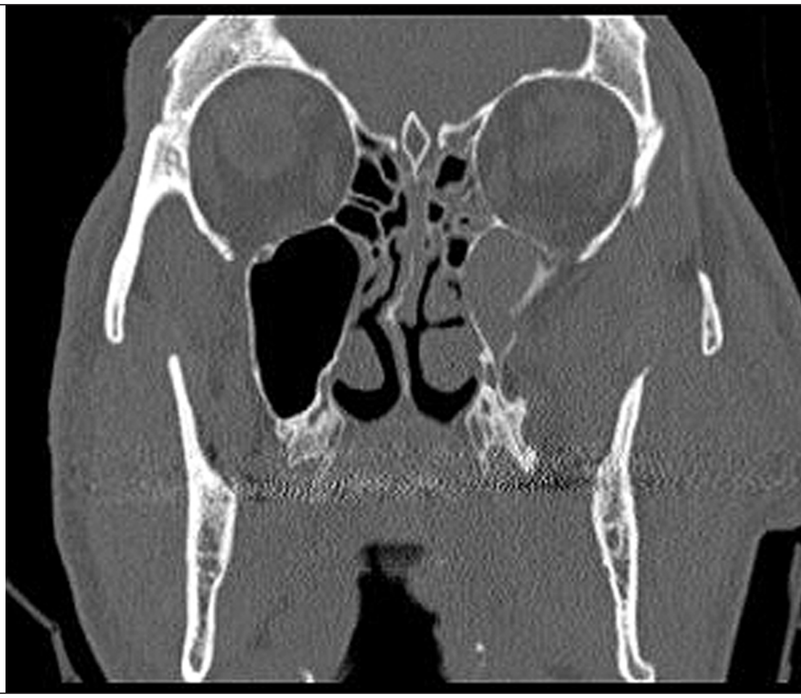


Figure 15. **Zygoma Fracture**

imaging, adequate pain control, and a thorough evaluation of function, including neurologic status, extraocular movements, and ability to masticate and swallow, in addition to specialist consultation as needed.

Rib Fractures

Ribs are commonly fractured in high-impact mechanisms. In trauma registries, rib fractures are found in 38% of admitted older adults.[93] Diagnosing rib fractures can be difficult, as plain films have low sensitivity, missing 50% of rib fractures. CT imaging of the chest, however, is highly sensitive. In clinical practice, rib fractures missed on plain films do not seem to impact clinical outcomes. One retrospective study found that any rib fracture or pulmonary contusion identified on plain films (*see Figure 16*) increased the incidence of pulmonary morbidity and mortality, whereas fractures identified only by CT did not increase mortality rates.[94]

Compared to the younger patient, older adults with rib fractures have greater incidence of morbidity (days on ventilator, pneumonia, etc.), along with an increased mortality. In one series, elderly patients with rib fractures suffered a mortality rate of 22%, compared to 10% for younger patients.[93,95] Also, the number of rib fractures correlates with increased morbidity and mortality. Geriatric patients had significantly increased mortality rates if they suffered three or more rib fractures. The incidence of complications of pneumonia or ARDS was also linearly associated with the number of rib fractures. A recent meta-analysis showed that age greater than 65, three or more rib fractures, pre-existing conditions, and pneumonia were strong predictors of mortality in patients with blunt traumatic chest wall injury.[96] In addition to increasing morbidity and mortality, a rib fracture in a post-menopausal woman (≥ 45 years old) increases the risk of further rib fracture by fivefold and the risk of any other fractures by more than double. Despite their association with MVC and high-energy trauma, rib fractures in post-menopausal women and older adults are associated with osteoporosis, and these patients should be referred for testing and treatment.[97]

Treatment of isolated rib fractures is largely supportive and often

Figure 16. Rib Fractures with Hemothorax

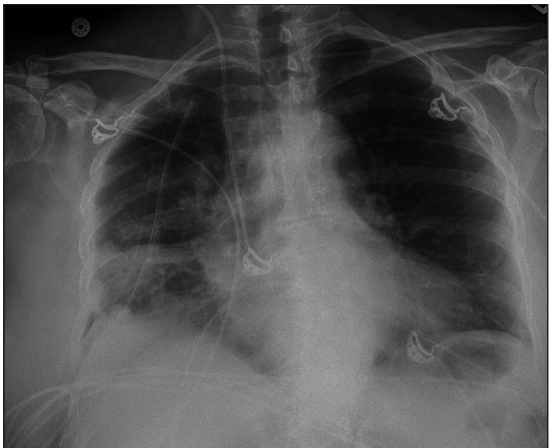


Image courtesy of Ademola Adewale, MD

done as an outpatient. Analgesia is important, as pain from rib fractures generates shallow breathing, leading to atelectasis and susceptibility to pneumonia. Some authors support the use of perioperative epidural anesthesia, which has been shown in limited studies to decrease morbidity and mortality.[95] This may limit the need for narcotic analgesia, which is associated with falls, over-sedation, and constipation in older patients. However, there have been no randomized trials to evaluate the potential benefits of epidurals. Surgical intervention may be warranted to improve ventilation when there are significant rib fractures or flail chest that is limiting the mechanical pull of the chest wall.[98] Incentive spirometers should be prescribed and instructions given to continue ambulation and deep breathing. If there are multiple comorbidities, concerns about the side effects of analgesics, or concerns about patient understanding, admission for initial pain control and pulmonary toilet is warranted.

Conclusions

Older adults have high rates of fractures, which are associated with higher morbidity, higher mortality, and more frequent social and home health care complications than in younger patients. Any fracture in an older adult may be complicated by low BMD, and all should be referred for testing and treatment. Starting vitamin D supplementation and referring for outpatient BMD testing can be done from the emergency department in order to improve healing and prevent subsequent fractures. Physicians must also give increased attention to a patient's social situation and ability to care for the injury at home. Physicians should be aware of occult fractures, or X-ray-negative fractures, especially when a patient has persistent pain or inability to ambulate. Once identified, older adults with fractures should be treated swiftly and aggressively. When surgical repair is indicated, it should not be delayed due to the patient's age, as delays more than 24 hours are associated with higher complication risks. Overall, this is a high-risk population prone to repeat injury that should be treated cautiously, with extra attention given to comorbidities, home safety, and future fracture prevention.

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CNE/CME Questions

1. After identifying a fragility fracture, the appropriate management includes which of the following?
   A. Assess patient's ongoing fall risk and intervene as needed.
   B. Prescribe calcium and vitamin D supplementation.
   C. Refer the patient to appropriate orthopedic specialists.
   D. all of the above

2. Which patient is at the highest risk of fragility fracture?
   A. 35-year-old obese woman on lisinopril

B. 65-year-old man with a prior fragility fracture
C. 60-year-old woman with known osteopenia
D. 68-year-old woman with normal BMD on DEXA

3. An elderly man presents to the ED after a fall at his nursing home. The only intervention done by EMS was to start an IV. The patient is able to talk and is complaining of hip pain. What should be done first in management of this patient?
A. Fully undress the patient.
B. Obtain a CT scan of the hip.
C. Evaluate cervical spine and stabilize if needed.
D. Obtain an MRI of the hip.

4. A 72-year-old female with a history of atrial fibrillation on Coumadin presents after a fall with a left intertrochlear hip fracture. According to the current literature, which of the following is true?
A. Patients with open fractures should not have anticoagulation reversed prior to surgery.
B. Surgical delay for full reversal is associated with increased mortality.
C. Patients on warfarin are at lower baseline risk for fragility fracture.
D. Reversing anticoagulation increases hospital length of stay.

5. A 78-year-old male presents after a rollover MVC. The initial chest X-ray shows four left-sided, minimally displaced rib fractures. In the trauma patient, which of the following is true?
A. Clinically significant rib fractures can be reliably seen on plain films.
B. Mortality and morbidity increase with the number of rib fractures.
C. Pneumonia and ARDS are possible complications from rib fractures.
D. All of the above are true.

6. A 62-year-old male on warfarin and hemodialysis presents for a syncopal episode. He was placed in cervical spine precautions en route, and on initial evaluation complained of midline cervical tenderness. An X-ray demonstrates non-displaced fracture of the C2 dens. When discussing the case with the junior neurosurgical resident, he proposes the possibility that this could be an old injury because he has never seen a dens fracture from the described mechanism. What additional information will help guide further management?
A. Elderly patients are more likely to suffer cervical spine injury from minor trauma.
B. The patient had decreased neck mobility at baseline.
C. Warfarin and dialysis are not associated with decreased BMD.
D. The patient has no neurological deficits.

7. A 68-year-old male with osteoporosis presents with a mid-shaft ulnar fracture. Three weeks ago he was seen for a fracture of the zygoma (a facial bone), which was managed conservatively. The patient appears disheveled and somewhat malnourished. After full trauma evaluation and splinting the arm with orthopedic referral, the next step in management should include which of the following?
A. discharge to home with adequate analgesic medication
B. additional history with social work consult
C. CT of the brain
D. referral to neurology for dementia

8. Patients with increased risk of fragility fracture include:
A. patients with COPD
B. patients with type 1 diabetes
C. patients requiring dialysis
D. all of the above

9. A 68-year-old woman slips on an icy sidewalk getting her mail and suffers a proximal humerus fracture. She is discharged with a shoulder immobilizer, a narcotic pain medication, and a referral for orthopedic follow-up. She is at risk for which of the following?
A. further falls
B. chronic decreased mobility in the shoulder joint
C. difficulty with activities of daily living at home due to arm immobilization
D. all of the above

10. A 71-year-old man presents to the ED with back pain of 2 days duration. No trauma was involved, and no neurologic deficits are noted on exam. X-rays demonstrate a compression fracture at T10, but cannot assess if this is new or old, and you have no prior imaging for comparison. Which of the following is *incorrect*?
A. Spinal CT or MRI may further delineate acute vs chronic fracture.
B. He has almost a 1 in 5 chance of a second vertebral compression fracture within a year of the first.
C. He should be referred for BMD testing and started on vitamin D supplementation.
D. This is probably incidental and can be ignored.

11. Which of the following is true regarding the use of oral anticoagulants and an older patient with a fracture?
A. Use of oral anticoagulants may be associated with decreased BMD.
B. Use of oral anticoagulants may be associated with increased fracture risk.
C. Evaluation of the patient should include a careful evaluation for compartment syndrome.
D. all of the above

12. Treatment of underlying predisposing factors such as bone mineral density treatment may decrease morbidity and mortality in patients with hip fractures.

CNE/CME Objectives

Upon completing this program, the participants will be able to:
• discuss conditions that should increase suspicion for traumatic injuries;
• describe the various modalities used to identify different traumatic conditions;
• cite methods of quickly stabilizing and managing patients; and
• identify possible complications that may occur with traumatic injuries.

CNE/CME Instructions

HERE ARE THE STEPS YOU NEED TO TAKE TO EARN CREDIT FOR THIS ACTIVITY:

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A. true
B. false

13. Which of the following is true regarding distal forearm fractures?
    A. The incidence of distal radius fracture decreases with age.
    B. Older adults with distal radius fractures have worse health in general than those with hip fractures.
    C. A home safety and functional assessment is indicated prior to discharge.
    D. There is no increased risk of future fractures.

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AHC Media is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center's Commission on Accreditation.

This activity has been approved for 1.5 nursing contact hours using a 60-minute contact hour.

Provider approved by the California Board of Registered Nursing, Provider # 14749, for 1.5 Contact Hours.

This is an educational publication designed to present scientific information and opinion to health professionals, to stimulate thought, and further investigation. It does not provide advice regarding medical diagnosis or treatment for any individual case. It is not intended for use by the layman. Opinions expressed are not necessarily those of this publication. Mention of products or services does not constitute endorsement. Clinical, legal, tax, and other comments are offered for general guidance only; professional counsel should be sought for specific situations.

This CME/CNE activity is intended for emergency, family, osteopathic, trauma, surgical, and general practice physicians and nurses who have contact with trauma patients.

It is in effect for 36 months from the date of publication.

AHC Media

Dear *Trauma Reports* Subscriber:

This issue of your newsletter marks the start of a new continuing education semester and provides us with an opportunity to remind you about **the procedures for earning credit and delivery of your credit lette**r.

Trauma Reports, sponsored by AHC Media, provides you with evidence-based information and best practices that help you make informed decisions concerning treatment options. Our intent is the same as yours — the best possible patient care.

Upon completion of this educational activity, participants should be able to:

- discuss conditions that should increase suspicion for traumatic injuries;
- describe the various modalities used to identify different traumatic conditions;
- cite methods of quickly stabilizing and managing patients; and
- identify possible complications that may occur with traumatic injuries.

HERE ARE THE STEPS YOU NEED TO TAKE TO EARN CREDIT FOR THIS ACTIVITY:

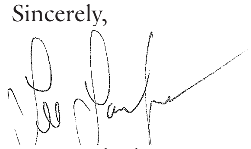
1. Read and study the activity, using the provided references for further research.
2. Log on to **www.cmecity.com** to take a post-test; tests can be taken after each issue or collectively at the end of the semester. *First-time users will have to register on the site using the 8-digit subscriber number printed on their mailing label, invoice, or renewal notice.*
3. Pass the online tests with a score of 100%; you will be allowed to answer the questions as many times as needed to achieve a score of 100%.
4. After successfully completing the last test of the semester, your browser will be automatically directed to the activity evaluation form, which you will submit online.
5. **Once the completed evaluation is received, a credit letter will be e-mailed to you instantly.** You will not have to wait to receive your credit letter!

This activity is valid 36 months from the date of publication. The target audience for this activity includes emergency medicine physicians and nurses.

If you have any questions about the process, please call us at (800) 688-2421, or outside the U.S. at (404) 262-5476. You can also fax us at (800) 284-3291, or outside the U.S. at (404) 262-5560. You can also email us at: customerservice@ahcmedia.com.

On behalf of AHC Media, we thank you for your trust and look forward to a continuing education partnership.

Sincerely,



Lee Landenberger
Continuing Education Director
AHC Media

Trauma Reports

2014 Reader Survey

In an effort to learn more about the professionals who read *Trauma Reports*, we are conducting this reader survey. The results will be used to enhance the content and format of *Trauma Reports*.

Instructions: Fill in the appropriate answers. Please write in answers to the open-ended questions in the space provided. Please insert this survey in the provided envelope along with your continuing education evaluation, or fax it to 404-492-5933. The deadline is **July 1, 2014.**

1. Are the articles in *Trauma Reports* written about issues of importance and concern to you?

- O A. Always
- O B. Most of the time
- O C. Some of the time
- O D. Rarely
- O E. Never

2. How would you rate your overall satisfaction with your job?

- O A. Very satisfied
- O B. Somewhat satisfied
- O C. Somewhat dissatisfied
- O D. Very dissatisfied

3. What are you most dissatisfied with in your job?

- O A. staffing
- O B. heavy workload
- O C. low morale in your department or facility
- O D. impact of cost-cutting on quality of care
- O E. other ____________________

Questions 4-9 ask about coverage of various topics in *Trauma Reports*. Please mark your answers in the following manner:

A. very useful B. fairly useful C. not very useful D. not at all useful

4. Pediatric burns (July/Aug. 2013)	O A	O B	O C	O D
5. Civilian blast injury (Sept./ Oct. 2013)	O A	O B	O C	O D
6. Blunt abdominal pain in pediatrics (Nov./Dec. 2013)	O A	O B	O C	O D
7. Maxillofacial trauma (Jan./Feb. 2014)	O A	O B	O C	O D
8. Obesity in trauma care (March/April 2014)	O A	O B	O C	O D
9. Fractures in older adults (May/June 2014)	O A	O B	O C	O D

10. How do you receive *Trauma Reports*?

- O A. I am a paid subscriber (proceed to question 11)
- O B. I receive it as a supplement to another publication (skip to question 12)

11. Do you plan to renew your subscription to *TR*? O A. yes O B. no

If not, why? ____________________

12. How would you describe your satisfaction with your subscription to *TR*?

- O A. Very satisfied
- O B. Somewhat satisfied
- O C. Somewhat dissatisfied
- O D. Very dissatisfied

13. What is your title?

- O A. Practicing emergency medicine physician
- O B. Trauma surgeon
- O C. Emergency department or surgical nurse
- O D. Physician assistant
- O E. Professor/academician
- O F. Emergency medicine manager/director
- O G. Resident

14. On average, how much time do you spend reading each issue of *TR*?

- O A. fewer than 30 minutes
- O B. 30-59 minutes
- O C. 1-2 hours
- O D. more than 2 hours

15. On average, how many people read your copy of *TR*?

- O A. 1-3
- O B. 4-6
- O C. 7-9
- O D. 10-15
- O E. 16 or more

16. On average, how many articles do you find useful in *TR* each year?

- O A. 1-2
- O B. 3-4
- O C. 5-6

17. How large is your hospital?

- O A. fewer than 100 beds
- O B. 100-200 beds
- O C. 201-300 beds
- O D. 301-500 beds
- O E. more than 2,000

Please rate your level of satisfaction with the following items.
A. excellent B. good C. fair D. poor

18. Quality of newsletter	O A	O B	O C	O D
19. Article selections	O A	O B	O C	O D
20. Timeliness	O A	O B	O C	O D
21. Length of newsletter	O A	O B	O C	O D
22. Overall value	O A	O B	O C	O D
23. Customer service	O A	O B	O C	O D

24. What type of education credits do you earn from *Trauma Reports*?

O A. Continuing medical education
O B. Nursing contact hours
O C. I do not participate in the CNE/CME activity.

25. With which publication do you receive *Trauma Reports*?

O A. Emergency Medicine Reports
O B. Pediatric Emergency Medicine Reports

26. Would you subscribe to *Trauma Reports* if it were available as a 12-month subscription?

O A. yes
O B. no

27. To what other publications or information sources do you subscribe?

28. Has reading *Trauma Reports* changed your clinical practice? If yes, how?

29. What do you like most about *Trauma Reports*?

30. What do you like least about *Trauma Reports*?

31. What specific topics would you like to see addressed in *Trauma Reports*?

Contact information (optional):