Management of the Airway in Acute Trauma

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Techniques and devices: techniques include fiber-optic intubation (for awake intubations), light wand, retrograde intubation, and several options for ventilation; invasive surgical access may be required when intubation and ventilation are problematic (common in trauma patients); esophageal detector device — self-inflating bulb; used in addition to exhaled carbon dioxide (CO₂) detector, CO₂ detected when trachea intubated and cardiac output adequate; however if patient has pulseless electrical activity (PEA), CO₂ not seen even if correctly placed; esophageal detector device placed over end of endotracheal tube; bulb reinflates quickly if endotracheal tube in trachea and slowly if in esophagus

Modification of American Society of Anesthesiologists algorithm for use with trauma patients: looking at likelihood of difficult intubation and ventilation and actively pursuing opportunities to deliver supplementary oxygen remain unchanged; differences occur for patients with recognized difficult airway, performing awake intubation may not be possible if patient uncooperative or unstable; rapid sequence induction (RSI) normally contraindicated with difficult airway, but may need to attempt (surgical airway may be needed if fails); if awake intubation fails, cancelling case or considering other options may not be feasible, emergency airway access typically cricothyroidotomy (can be converted to tracheotomy when time permits); after induction — algorithm states patient can return to spontaneous breathing, but maintaining spontaneous breathing may be preferable; awakening patient may not be possible; thus or other options may be less desirable than surgical airway access

Scenarios

Closed head injury: Glasgow Coma Scale measures best eye opening, verbal response, and motor response; if suspected difficult airway, perform awake intubation; patient must be stable, cooperative, and able to maintain spontaneous breathing (Glasgow >9); if Glasgow score <9, do RSI (possibly modified); modification may include gentle ventilation to maintain oxygenation, concerns about hypoxemia probably outweigh concerns about aspiration and regurgitation; use of cricoid pressure controversial, in 1 of 5 patients esophagus not directly below trachea, so can be laterally displaced by cricoid pressure; key management points — if patient cooperative, perform awake intubation, maintain cerebral perfusion pressure >70 mm hg, avoid hypoxia; expedite airway management, temporary hyperventilation may be necessary

Cervical spine injury: for difficult airway, perform awake intubation if patient stable, cooperative, and able to maintain spontaneous ventilation, especially if neurologic findings present; maintain in-line immobilization for RSI, provide support to neck from behind while applying cricoid pressure; do not employ inline traction (increases risk of dislocation of head from cervical spine), if patient uncooperative or unstable (even if difficult intubation), perform RSI, for nondifficult intubation, perform awake intubation if neurologic deficit present

Airway disruption: often caused by blunt traumatic injury to airway, neck may be edematous, distorted, with crepitation; may be hoarse voice, stridor, or apnea, radiologic examination may show air in neck and deformity of air column; determine whether major laryngeal or tracheal tear present; perform awake intubation if major tear, perform RSI if lesion small or supraglottic; consider avoiding ventilation to prevent air from entering tear; maintain spontaneous ventilation, even with modified RSI, place endotracheal tube below tear to avoid air entering mediastinum, do not pressurize airway proximal to tear (avoid transtracheal jet ventilation and use of supraglottic airway); consider lung separation using double-lumen endotracheal tube, for major tear in uncooperative or unstable patient, RSI required, if patient deteriorates, femoral route may be required for distal complex tear requiring cardiopulmonary bypass

Traumatic injury to face: maxilla or mandible injury, awake intubation for cooperative, stable patients who can maintain spontaneous breathing, have satisfactory oxygen saturation, and able to clear airway of blood and foreign bodies; mask ventilation — may be difficult if intubation easy, blind nasal technique may be contraindicated; initial decision making must include possibility of later jaw wiring (may require nasal route); if obstruction life threatening, need immediate surgical airway

Facial fracture: oral or nasopharyngeal airway useful for airway obstruction, may be continued risk to airway due to swelling, hematoma, or bleeding, decreased consciousness from intracranial injury and fracture of cervical spine common, place surgical airway if unable to clear airway after life-threatening trauma, perform RSI if not life threatening, able to clear airway, and airway not difficult; if difficult airway, perform fiber-optic awake intubation or RSI if patient uncooperative

Regional anesthesia: useful for repair of superficial extremity (eg, leg or arm) in cooperative hemodynamically stable, non-intoxicated patients; not recommended for major head, neck,
Cardiopulmonary Resuscitation

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International guidelines: formulated in 2000 for cardiopulmonary resuscitation (CPR) and emergency cardiac care, areas of agreement — how to perform emergency cardiac care, efficacy of chain of survival and early defibrillation, role of advanced life support, public access to CPR training and automated external defibrillators (AEDs)

2010 guidelines: introduction of evidence-based medicine, ABC now CAB (compression first), emphasis on effective postresuscitation care, changes in CPR — for lay public, perform chest compression only, dispatchers now guide laypersons via phone; circoid pressure eliminated; pulse checks eliminated for lay providers; advanced cardiac life support (ACLS) — drugs administered during chest compressions; intravenous or intrasosseous administration of drugs superior to endotrachéal administration; amiodarone preferred over lidocaine; team approach — one person in charge of team, with all persons having separate roles; leader should attempt to determine cause of cardiac arrest to prevent second arrest if ACLS successful, chronotropes and transcutaneous pacing recommended for bradycardia

Evidence: telephone-assisted CPR — linked to 911 system, uses simplified CPR training that emphasizes effective and sustained chest compression, Japanese study — improvements seen when bystanders provide faster rates of chest compression, when public has access to AED, and when CPR provided using chest compressions only, Japanese study — compared conventional CPR including mouth-to-mouth resuscitation to chest compressions only, with and without AED; best neurologic and survival outcomes seen with chest compression only plus AED; worst outcomes with mouth-to-mouth plus chest compressions but without AED, other studies — in study of telephone-assisted CPR, survival improved 3-fold with chest compression only, in study of out-of-hospital cardiac arrest, minimal interruption of cardiac chest compression resulted in substantial improvement in survival, most mouth-to-mouth ventilation ineffective and interferes with continuous chest compressions; high-quality chest compressions (correct depth, placement, and rate) most effective for out-of-hospital arrests; canine study — showed functional residual capacity (FRC) of lungs contains 21% oxygen at time of arrest, does not substantially decrease to oxygen delivery levels for ≤10 min, elastic recoil of chest after compressions produced some degree of ventilation

Early defibrillation: improves survival; reduces time “off the chest”; increases probability of return of spontaneous circulation (ROSC); goal to perform compressions until defibrillator ready to shock, with immediate resumption of compressions; 3-phase electrical model of cardiac arrest — heart cells biochemically normal during first 4 min after arrest (early defibrillation effective for treating nonperfusing rhythm), during 4 to 10 min phase, pH drops; good chest compressions to perfuse heart and brain before defibrillation most effective; by third phase (>10 min), damage to tissues occurs; requires early focus on treating global ischemic injury in addition to chest compressions before defibrillation

Chest compression: in study, compressions for 1 to 3 min before defibrillation improved outcomes, no change in outcomes in 2 other studies, widened QRS on electrocardiography may indicate need for chest compressions before defibrillation; chest compressions alone superior to compressions with ventilation early in resuscitation due to oxygen in FRC (decrease in cardiac filling associated with ventilation also avoided), pig study — neurologic outcome improved for ≤15 min of CPR without ventilation, canine study — interrupted chest compressions immediately stopped coronary flow; 2 to 4 additional compressions needed to initiate forward flow; study of chest compressions — looked at code teams; inadequate pressure applied in 50% of cases; quality of compressions fair to poor in 50%, rate inadequate in 30% to 50%, frequent training and feedback needed, even for expert clinicians; meta-analysis — compression rate of 85 to 100/min improves survival, mannequin study — showed decay in performance of compressions at 1 min, frequent switch (at 2 min) important to provide better compressions

Ventilation: American Heart Association (AHA) states clinicians unable to move from chest compressions, to bag-valve mask, back to chest compressions; recommend use of laryngeal mask airway (LMA) and ventilating before intubating emphasized, Aufderheide studies — 13 consecutive patients in field did not survive after use of hyperventilation; pig study showed hyperventilation causes increase in inotrope pressure (decreased venous return, cardiac output), decrease in systolic pressure, and decreased survival; carbon dioxide monitoring — severe hypoxia and hypercapnia during resuscitation independently correlated with marked decrease in neurologic survival

Intubation: timing — early intubation does not improve outcomes; Japanese study — advanced airway management in out-of-hospital arrests worsened neurologic outcomes and survival vs bag-valve mask in effectively ventilated patients; early intubation attempts 97% successful; chest compressions stopped during intubation; paramedics experienced technical difficulty in 31% of prehospital intubation; patients who were intubated did not have better outcomes compared to ventilation by bag-valve mask (however, intubation important in children), significantly more failed intubations occurred in patients with body mass index >40, capnography — best method to confirm successful intubation; good results associated with higher probability of ROSC; for hypoxia — hyperventilation, laryngeal mask, etCO2 monitoring, large pulmonary embolism, extreme bronchospasm

Drug therapy: 2010 recommendations — vasopressor after one cycle of chest compressions; epinephrine every 3 to 5 min unless using vasopressin (use only once), adenosine for narrow complex monomorphic tachycardia, atropine for bradycardia (not for PEA/asystole); use transcutaneous pacing after atropine for bradycardia; amiodarone antiarrhythmic of choice (lidocaine if amiodarone not available or ventricle known to be normal), magnesium only for long QT interval; calcium and bicarbonate used only with evidence of need

Vascular access: peripheral access preferred due to rapid placement; central lines preferred if already in place; intravenous access recommended if peripheral access unobtainable; if endotracheal tube necessary, may give epinephrine, atropine, and lidocaine via tube, but at 2 to 3.5 times dose followed by flush

Care after ROSC: emphasis on homeostasis, maintenance of heart rate and mean arterial pressure within 20% of baseline; evidence for effectiveness of mild hypothermia increasing; advanced cerebral resuscitation may be possible in future; Japanese study — improved neurologic outcome with ROSC and with management of hemodynamics, respiration and ventilation, mild hypothermia, and cardiac catheterization as needed; medical center study — evidence of organ injury in
96% of survivors, 66% had severe dysfunction in ≥2 organ systems, possibly due to hemodynamic and/or ventilatory insufficiency immediately after ROSC, so heightened level of attention required; miscellaneous data points — cooling improves neurologic outcomes (varying approaches to cooling possible cause for no improvement in some studies); hypothermia shown to demonstrate “appropriate survival” by end point of return to work; nitric oxide often impractical, but improves neurologic outcome; attempts to cool outside hospital did not improve outcomes

Surgical patients: database studies — causes for cardiac arrest in operating room include bleeding, sepsis, and hyperthermia; 70% mortality seen in nontrauma cardiac arrest in operating room; 7 arrests per every 10,000 cases; 30-day mortality 65% and closely associated with amount of blood lost and transfused; 41% survival to discharge in patients with ventricular tachycardia or fibrillation, but as low as 26% with PEA and asystole; 64% of discharged patients neurologically intact; logarithmic decay in survival rate based on delay of defibrillation begins at ≈5 min, quality of resuscitation declines over nights and weekends

AHA algorithms: based on 3-phase model and performance studies; ventricular tachycardia/fibrillation vs PEA/asystole first step, bradycardia requires early recognition and atropine (followed by dopamine or epinephrine if needed); use tranexamic acid if available; tachyarrhythmias — narrow vs wide complex, stable vs unstable, adenosine if narrow and stable, immediate cardioversion if narrow and unstable, amiodarone or beta blockers for stable and wide complex, treat wide and unstable as ventricular tachycardia or fibrillation

Acknowledgments

Drs. Doyle and Tetzlaff were recorded at Comprehensive Anesthesiology Review, held March 24–29, 2014, in Cleveland, OH, and sponsored by the Cleveland Clinic Anesthesiology Institute. For upcoming meetings sponsored by the Cleveland Clinic, visit clevelandclinicmeded.com. The Audio Digest Foundation thanks the speakers and the Cleveland Clinic Anesthesiology Institute for their cooperation in the production of this program.

Suggested Reading

AIRWAY MANAGEMENT IN TRAUMA/CARDIOPULMONARY RESUSCITATION

To test online, go to www.audiodigest.org and sign in to online services. To submit a test form by mail or fax, complete Pretest section before listening and Posttest section after listening.

1. A cooperative, stable patient with a closed head injury, a difficult airway, and Glasgow Coma Scale score >9 should undergo _______; patients with a closed head injury requiring rapid sequence induction (RSI) _______ be oxygenated.
   (A) RSI, may                              (C) RSI, should not
   (B) Awake intubation, may                (D) Awake intubation, should not

2. All of the following techniques should be applied to a patient with cervical spine injury, except:
   (A) In-line traction
   (B) Awake intubation if neurologic deficit present
   (C) In-line immobilization if RSI necessary
   (D) Support to the back of the neck if applying cricoid pressure

3. Which of the following is appropriate in treatment of an awake, cooperative patient with a major laryngeal or tracheal tear?
   (A) Placement of a supraglottic airway
   (B) Use of transtracheal jet ventilation
   (C) Maintaining spontaneous ventilation
   (D) Performing a modified RSI

4. In which of the following situations would regional anesthesia be appropriate in a trauma patient?
   (A) Patient who has altered mental status
   (B) Surgery that must be completed once it is started
   (C) Patient who is hemodynamically unstable
   (D) Patient and surgeon have agreed to awake intubation if regional anesthesia fails

5. Techniques for cardiopulmonary resuscitation (CPR) that are recommended in current (2010) guidelines include:
   (A) Administration of medications during chest compressions
   (B) Use of cricoid pressure
   (C) Pulse checking by lay providers
   (D) Endotracheal administration of drugs rather than intraosseous administration

6. Studies indicate that _______ is more effective for increasing survival in out-of-hospital cardiac arrest, and that oxygen in the functional residual capacity of the lungs _______ in the first 10 min after cardiac arrest.
   (A) High-quality chest compression alone; markedly declines
   (B) Mouth-to-mouth breathing plus high-quality chest compressions, markedly declines
   (C) High-quality chest compression alone; does not decrease substantially
   (D) Mouth-to-mouth breathing plus high-quality chest compressions; does not decrease substantially

7. Studies of chest compressions as performed by trained clinicians found that:
   (A) Adequate pressure was applied in >65% of cases
   (B) Rate of compressions was inadequate in 30% to 50% of cases
   (C) Compression rate of 65 to 80/min notably improved survival
   (D) Performance of compressions began to decay after 2.5 to 3 min

8. Which of the following results was not seen in a Japanese study of intubation of adult patients who experienced out-of-hospital cardiac arrest?
   (A) Advanced airway management worsened neurologic outcomes
   (B) Paramedics experienced 31% rate of technical difficulties
   (C) Significantly more failed intubations occurred in patients with body mass index >40
   (D) Early intubation significantly improved outcomes

9. Studies suggest that patients who have return of spontaneous circulation after cardiac arrest:
   (A) Usually recover without any organ injuries
   (B) Require close hemodynamic and ventilatory monitoring
   (C) Do not experience any benefit from induction of mild hypothermia in the hospital
   (D) Treat as ventricular tachycardia or fibrillation

10. According to an American Heart Association algorithm, the first line of treatment for a patient with a narrow complex, stable tachyarrhythmia is:
    (A) Adenosine
    (B) Immediate cardioversion
    (C) Amiodarone or beta blocker
    (D) Treat as ventricular tachycardia or fibrillation

Answers to Audio Digest Anesthesiology Volume 57, Issue 02: 1-B, 2-B, 3-C, 4-D, 5-B, 6-D, 7-A, 8-B, 9-C, 10-D

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