Case Study

Crush Injury, Combative Patient

Situation: A scene response is requested at a shopping center in a rural community. The initial report is that the patient is a man, who is trapped between the axle and the body of a motor home. He has sustained crushing neck and chest injuries. The time to the scene is 24 minutes.

The ALS crew found a 65-year-old, 100-kg man, who had reportedly been changing a tire on a 35-foot motor home when the jack slipped. Extrication of the injured man took 20 minutes.

The updated report to the flight crew is that the patient "is in severe respiratory distress with bruising from the third intercostal space up, cyanosis, and subcutaneous air and edema." At the time of the air medical team arrival, the patient is in the ambulance in severe respiratory distress. Oxygen (100%) is being delivered by bag-valve-mask. Numerous oral and nasal intubation attempts are unsuccessful The patient has stridor, copious amounts of blood coming from the mouth and nares, and a radial pulse. The patient is extremely combative and requires restraints. Two large-bore intravenous lines are in place.

Q. *What is your initial approach to the patient?*

DHART (Lebanon, N.H.): On entering the ambulance we would request a verbal report from the EMS crew while we conducted a rapid primary survey. We would verify that spinal immobilization was in place. Airway management is clearly the highest priority at this time. One crew member would attempt an oral intubation without neuromuscular blockade (NMB) because we may not know the proficiency of the ground EMS providers. This would also give us the opportunity to assess the extent of the pharyngeal injury. We would maintain cervical spine alignment manually and prepare for suctioning. The other crew member would be preparing for rapid-sequence induction.

HELP Flight (Billings, Mont.): Our program provides interfacility transport and scene response. Our care priorities on arrival at the scene would include assessment of ABCs and treatment of life-threatening conditions. Simultaneously, cervical spine immobilization would be performed. In this case, with the updated patient information received en route, it is obvious that the patient requires definitive airway management. Information regarding estimated patient weight would be requested from on-scene personnel. Our crew would then make preparations en route (i.e., ready airway equipment, prepare cricothyrotomy kit, calculate rapid-sequence induction drug dosages, and draw up appropriate medications. Because of the patient's severe respiratory distress, copious amounts of blood in the airway, stridor, and combativeness, we would make no further attempts at unrelaxed intubation. A rapid-sequence induction would be performed.

University of Chicago Hospitals Aeromedical Network, (Chicago, IL): As stated in the case study, additional unrelaxed oral intubation attempts were unsuccessful. En route, we would prepare all medications for rapid-sequence induction and all equipment for a surgical airway. One attempt would be made by the flight team to visualize the vocal cords before proceeding to full rapid-sequence induction. We presume the patient is hypoxic as evidenced by his combativeness. His oropharynx should be cleared with suction, and ventilation continued with 100% oxygen by bag-valve-mask, with cricoid pressure maintained until a definitive airway is obtained. All airway maneuvers would be accompanied by cervical spine stabilization. The patient's radial pulse indicates a systolic pressure of at least 80 mm Hg; however, fluid resuscitation should continue and would be assisted with pressure bags on the isotonic IV fluids.

Q. *Additional unrelaxed oral intubation attempts are unsuccessful. The patient is increasingly combative and unable to be restrained. What is your protocol for use of rapid sequence induction and criteria for its use? Does your protocol allow neuromuscular blockade use for restraint? How would you proceed in this case?*

DHART: Our protocol for rapid-sequence induction allows for NMB to facilitate intubation in the patient with a compromised airway when standard methods have failed or would delay care. Patient indications for pharmacologically assisted intubations would include (a) impaired airway maintenance in the combative patient as a result of injury or illness and (b) trismus, with or without vomitus present; difficulty opening the airway; or difficulty maintaining the airway.

In our protocols we are allowed to use chemical restraint, including NMB, for any combative patient if necessary to ensure flight safety.

In this case we would induce NMB by administering midazolam, 5 mg, and succinylcholine, 100 mg, by intravenous (IV) bolus. Our protocol also calls for consideration of lidocaine, 1 mg/kg, for intracranial pressure control, which we would not use because this patient's combativeness is most likely due to hypoxia and not a head injury. A 1-mg dose of vecuronium is a protocol option in preventing fasciculation; time does not permit this option in this case. Once relaxation is complete, we would proceed with oral intubation while maintaining cervical spine alignment.

HELP: Our program's protocol allows us to use paralyzing agents for intubation when intubation cannot be accomplished

Participants

Dartmouth-Hitchcock Air Response Team, Lebanon, N.H.: DHART is based at the Dartmouth-Hitchcock Medical Center. The service area includes the states of New Hampshire and Vermont, and parts of western Maine, northeastern New York, and northern Massachusetts. DHART (pronounced "dart") began operations July 1, 1994. During the first year, 323 patients were transported; in the second year, 430 transports are expected. Crew configuration is a nurse/paramedic team flying on an Augusta 109 C/MAX. **Respondents:** Judy Dubovsky, RN, CCRN, flight nurse; and Clay Odell, EMT-P, BS, flight paramedic.

HELP Flight, Billings, Mont.: Established in 1979, HELP Flight is a multispecialty (adult, pediatric, high-risk OB, NICU) helicopter and fixed-wing air medical transport service based at Saint Vincent Hospital and Health Center, an ACS-accredited Level II trauma center. Additionally, the program has a separate, more specialized NICU-staffed team that has existed since 1973 to complete the broad spectrum of transport needs. HELP Flight averages 450 helicopter and 450 fixed-wing transports per year. The helicopter, a BO 105LS, services a radius of 150 miles around Billings and provides interfacility transports, as well as scene responses. The average one-way distance of helicopter transport is 90 miles. The fixed-wing, a King Air B-200, covers Montana and surrounding states and long-range transports on an as-needed basis. Standard crew configuration for transport is RN/EMT-P. **Respondents:** Maggie Wood, RN, CFRN, CEN, CCRN; Tom Coble, RN, CFRN, CEN, REMT-P; and Jason Gartner, REMT-P.

University of Chicago Hospitals Aeromedical Network, Chicago: UCAN is a hospital-based helicopter service at the University of Chicago Hospitals that also provides ground transport. UCAN currently uses a Dauphin-N1 helicopter for rotor-wing transports and last year completed 960 transports. Crew configuration is that of dedicated flight nurses and senior emergency medicine residents. Most transports are interhospital; however, scene responses do make up a small percentage of patient transports. **Respondents:** Scott DeBoer, RN, MSN, CFRN; Mary Jo Dunne, RN, MSN, CFRN; Gail Tagney, RN, MSN, CFRN; Jane Duda, RN, MSN, CFRN; Bruce Lindsay, MD (chief flight resident); Jeff Dubin, MD {chief emergency medicine resident); and Ira Blumen, MD, FACEP (UCAN medical director).

without them. Generally, paralyzing agents are used when jaw clenching, hypertonus, or combative behavior prevents or impedes direct laryngoscopy. The patient would be prepared, including preoxygenation and manual in-line cervical spine immobilization, while the equipment is being set up and checked. Because of probable airway edema, we would consider decreasing the tube size by a half to a full size. Immediate access to surgical airway equipment will be ensured. Pulse oximetry and cardiac monitoring will be accomplished.

Succinylcholine, 150 mg (1.5 mg/kg), would be given by rapid IV push followed by the Sellick maneuver, which would be maintained until the airway was secured. Immediately after the paralytic agent was administered, fentanyl (2 flg/kg), would be administered IV push as the sedative agent. Hyperventilation with a bag-valve-mask using 100% oxygen would be continued until thorough relaxation is achieved. Direct laryngoscopy would be performed followed by suctioning as needed to clear the airway and allow for visualization of the anatomic structures. If adequate visualization of the chords is obtained, endotracheal tube insertion would be attempted. After insertion of the tube, the placement would be verified by assessing lung sounds, epigastric sounds, chest wall movement, unequivocal color change on an end-tidal carbon dioxide (ETC02) detector, skin color changes, and improvements in pulse oximetry.

UCAN: Our protocol is to use rapid-sequence induction for any patient in whom sedation and chemical paralysis are necessary or when it would facilitate airway control/maintenance or patient/crew safety. Our contraindications include massive facial injuries, epiglottitis, and evidence of airway obstruction. If the airway needs to be controlled (i.e., inability to maintain a patent airway, presumed increased intracranial pressure, or hypoxia), chemical sedation and paralysis are administered along with ventilatory support. In addition to chemical restraints, soft or leather restraints may be used at the crew's discretion.

In this particular crush injury case, IV sedation and short-acting paralytic agents would be administered. Paralytic agents would be given only after the patient was prepped and draped for a surgical airway, including setup of appropriate instruments. Full rapid sequence induction would be used: lidocaine, 1.5 mg/kg IV push, is given to diminish the cough reflex and the increased intracranial pressure in the case of possible head injury; a defasciculating dose of vecuronium, 0.1 mg/kg IV push, will minimize the hyperkalemic effects of succinylcholine in crush injuries; midazolam, 0.1 mglkg, and succinylcholine, 1.5 mg/kg, IV push would then follow, along with IV fentanyl, 1 11g/kg, for analgesia. After adequate sedation/paralysis is manifested (60 to 120 seconds), two attempts at oral intubation would be made.

a. *The air medical team administers paralysis and visualizes the airway. Massive injury to the posterior pharynx is apparent. Attempts are made to pass an endotracheal tube, but ventilations are heard in the chest and abdomen.*

If oral intubation is unsuccessful after paralysis, what is the next step in your airway management protocol?

DHART: If oral intubation is unsuccessful after paralysis, our next step depends on what we saw during the intubation.

According to the scenario, the posterior pharynx seems to have massive injury. Attempts are made to pass an endotracheal tube, but ventilations are heard in the chest and in the abdomen.

If the endotracheal tube was passed without full visualization of the glottis because of secretions, we might try a second attempt with more vigorous suctioning. With the extent of pharyngeal trauma described in the scenario, we would be more likely to do a surgical cricothyrotomy and insert a cuffed endotracheal tube through the surgical opening as opposed to a needle cricothyrotomy. A surgical cricothyrotomy will allow us to provide ventilation, not just oxygenation, and the cuffed endotracheal tube will help protect the lungs from blood, vomitus, etc.

After the cricothyrotomy, the scenario says ventilations are heard both in the chest and in the abdomen. It appears most of the oxygen is escaping through the upper airway. Oxygen saturation momentarily improves to 80%, and the patient's neck and upper chest are becoming more edematous and rigid.

HELP: If adequate visualization cannot be obtained, airway anatomical structures are unrecognizable, or endotracheal intubation is not successful, we would immediately proceed to a surgical cricothyrotomy for definitive airway control. After landmarks are identified, the skin is prepped, incisions are made, and the tracheal rings are palpated for verification of proper placement, a No. 4 cuffed Shiley endotracheal tube is inserted into the trachea. The cuff is inflated and further verification of proper placement is confirmed by assessing lung sounds, epigastric sounds, chest wall movement, unequivocal color change on ErC02 detector, skin color changes, and improvements in pulse oximetry. If finding revealed air exchange over the chest and the abdomen, revisualization for tube placement would be performed. Any continued concern regarding tube placement will result in endotracheal tube removal and reassessment of the airway.

UCAN: If oral intubation is unsuccessful after paralysis, even though a laryngeal fracture and tracheoesophageal rupture are suspected, we would proceed directly to a surgical cricothyrotomy without delay to obtain a definitive airway. A surgical airway allows for true airway access, providing superior oxygenation, ventilation, and airway suctioning. We would not perform a needle cricothyrotomy as indicated in the case study because our flight nurses and emergency medical residents are trained in surgical airway techniques.

a. *A needle cricothyrotomy is performed and again ventilations are heard both in the chest and abdomen. It appears that most of the oxygen is escaping through the upper airway. Oxygen saturation momentarily improves to 80%, and the patient's neck and upper chest are becoming more edematous and rigid. What is your next procedure?*

DHART: The further deterioration of the patient and the continued breath sounds in the chest and abdomen would suggest a tracheal or bronchial disruption farther down. Our priority for this case is rapid transport to the trauma center. En route, we would perform bilateral needle thoracostomy because the mechanism of injury indicates a high index of suspicion for tension pneumothorax, which could be contributing to the patient's deterioration.

HELP: In this particular case, information provided indicated a transient increase in saturated oxygen to 80% accompanied by increasing edema and rigidity of the patient's neck and upper chest. We would suspect a tension pneumothorax, possibly bilateral. As a result, we would perform bilateral needle decompression of the chest. This would be accomplished by inserting a large-bore IV catheter into the second intercostal space at the midclavicular line. Reassessment for improvement in status will be performed after aspirating as much air as possible to relieve the patient's acute symptoms. However, as in this case, if blood is returned, a massive hemothorax is suspected and rapid transport for definitive care is required.

UCAN: The airway is now secured and the patient is being ventilated with 100% oxygen. Bilateral needle thoracostomy would be performed using 10-gauge catheters inserted in the second intercostal space at the midclavicular line to attempt decompression of suspected pneumothoraces. We would then follow with formal bilateral tube thoracostomy regardless of patient progress. This patient is in extremis from blunt chest/neck trauma with probable tracheal disruption and subcutaneous air. His only hope of survival depends on intervention performed in the field.

a. *The patient further desaturates, an oropharyngeal airway is placed, and the patient is given oxygen by bag-valve-mask. The patient deteriorates into bradycardia and then asystole. CPR is initiated. The nearest hospital is 10 minutes by ground and the trauma center is 24 minutes by air. Do you consider returning the care of the patient to the ground ALS personnel to be taken to the nearest hospital? What additional procedures are indicated?*

DHART: If the patient further deteriorated into cardiac arrest, we would initiate CPR following ACLS algorithms and with aggressive fluid resuscitation. We would have to reevaluate our destination decision. The case scenario presents a difficult choice. The nearest hospital is 10 minutes by ground, and the trauma center is 24 minutes by air.

The patient requires emergency thoracotomy. The shorter ground transport, with the flight crew accompanying, would be preferable if the local hospital was prepared to treat the patient aggressively. Otherwise, the longer air transport to the trauma center would be preferable, with the realization that 24 minutes of CPR in this setting does not leave the patient with much hope of survival even if emergency surgery successfully isolates the injury.

Other procedures that we would consider during transport if time and crew resources permit would be bilateral chest tube placement and pericardiocentesis.

HELP: Further stabilization priorities focus on completion of cervical spine immobilization, maintenance of IV access, rapid egress from the scene to the nearest appropriate facility, and completion of assessment including measure-

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ment of vital signs. Our policy is that once we have initiated care, it would be continued until the patient arrived at an appropriate facility. If, as in this case, the patient has a cardiac arrest and it occurs before transport, medical control would be consulted regarding transport options. However, if the arrest occurs during transport, resuscitative measures would be initiated and medical control would be consulted for consideration of continuation of resuscitative efforts.

UCAN: We would elect to accompany the ground ALS crew to the nearest hospital 10 minutes away. We would instruct the ground unit to alert the receiving hospital of the critical condition of this patient. The patient would be kept on the backboard, but we would try to position the backboard with the right side and foot portion higher than the head. We chose this position in the event that the patient has an air embolism along with his other known injuries. We would continue airway management with 100% oxygen; CPR with high-dose epinephrine, 1:1000, 1 mg, 3 mg, and 5 mg every 3 to 5 minutes; and other indicated ACLS medications, vigorous fluid administration, and pericardiocentesis. The aircraft would reposition to the nearest hospital to rendezvous with the crew and to facilitate transport to a level I trauma center if resuscitation efforts are successful.

Outcome: The air medical crew remains with the patient and goes to the nearest hospital with CPR in progress. Bilateral needle decompressions are performed with a large amount of blood returned. A transient return of pulses is noted. On arrival, the emergency department physicians are unable to intubate and chest tubes are placed with additional return of blood. The resuscitation is stopped after 50 minutes. The cause of death was determined to be a disrupted trachea and lacerations to the thoracic vessels.

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