Best Practice

TOPIC IN REVIEW

An approach to critically ill patients

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In this article, we address the initial aspects of the management of critically ill patients—namely, resuscitation, stabilization, monitoring, and disposition. Because dysrhythmias, airway management, shock, and mechanical ventilation are covered in detail as future topics in this series and because the background of our expected readers may vary substantially, we provide a general framework to or from which readers may add or subtract their own experiences. For this discussion, we assume that a clinician is called to a "code" situation. Resuscitation issues have been addressed, and the patient desires all life-sustaining treatments.

Summary points

- The key to resuscitation of a critically ill patient is attention to the ABCs: airway, breathing, and circulation (perfusion)
- In evaluating perfusion, clinicians should assess not only blood pressure and pulse but also mentation, urine output, skin color, temperature, and lactate levels
- In a patient with clear lung fields and adequate oxygenation, boluses of intravenous fluids are an essential part of the initial therapy for poor perfusion
- The management of patients in intensive care consists of three categories of care: ventilatory and hemodynamic support, treatment of specific illnesses, and preventive care
- To best use the information derived from commonly used intensive care unit monitors, clinicians must recognize the strengths and limitations of each device

METHODS

The discussion of the initial resuscitation phase is based on our clinical experience, supplemented by recommendations from practice guidelines developed by the Society of Critical Care Medicine and the American Heart Association. For the review of intensive care unit (ICU) monitoring, we conducted MEDLINE literature searches by crossing the terms *pulse oximetry, end-tidal carbon dioxide (etCO$_2$) monitoring,* and *pulmonary artery catheter* with the term *review.*

RESUSCITATION

The ABCs: airway, breathing, and circulation

The site of practice (outpatient clinic vs monitored hospital ward) dictates much of what the clinician will do in this initial resuscitation. Much of the chaos surrounding some codes arises from insufficient experience with local resuscitation devices, so clinicians should familiarize themselves with the location and operation of all the tools in their facility's resuscitation "crash" cart, especially the bag-valve mask and the defibrillator. In addition, they should know the availability of support personnel, such as anesthesiologists, emergency physicians, and hospitalists. In some outpatient clinics and other sites with limited resuscitation capability, the best initial course of action, in addition to attending to basic life support, may be to activate emergency medical services by calling 911.

As simple as it sounds, resuscitation always begins with the well-known ABCs—airway, breathing, and circulation. Clinicians must not only initially take care of the ABCs, but also continually reevaluate them. Occasionally in the struggle of a complicated resuscitation or in the postresuscitation phase, this fundamental principle is overlooked, and the airway is lost, or a pulseless patient does not receive adequate chest compressions. Remember the basics: always attend to the ABCs.

The airway

Beginning with the airway, the clinician should evaluate whether a patient is maintaining his or her airway independently or needs support or intervention. Intervention may be as simple as a chin lift or jaw thrust for a somnolent or comatose patient or as invasive as a cricothyrotomy. The provider should maintain cervical spine precautions in trauma patients and others with possibly unstable cervical spines. Obstructions of the airway, such as secretions, blood, and food, must be rapidly detected and treated by suction or directly removed.

Clinicians should acquaint themselves with adjuncts to airway management that may be used to relieve an airway obstruction and facilitate ventilation. Both the nasopharyngeal airway and the oral airway may allow for improved ventilation in patients with posterior oropharyngeal relaxation and obstruction.

The oral airway, a curved piece of hard plastic with a hollow core, is generally used only in a comatose patient with an absent gag reflex, whereas the nasal trumpet, a flexible rubber tube with a phalanged end, can be used in both comatose and awake patients. In an apneic or hypopneic patient, a bag-valve mask is typically used initially for ventilation and oxygenation. The mask consists of a gas reservoir that is squeezed to deliver oxygen through a valve and a face mask that is tightly sealed over the patient's nose and mouth (figure 1). Bag-valve-mask ventilation does not prevent the pulmonary aspiration of gastric contents and may produce abdominal distention. However, airway positioning and mask ventilation are essential rescue management skills, and their proper enactment may keep a patient alive until a more definitive airway can be established. Some clinicians may have experience with the use of the laryngeal mask airway, which is attached to the standard bag valve (from the bag-valve mask). As with the bag-valve mask, it does not completely protect the airway from aspiration.

Finally, definitive airway control usually occurs with the introduction of an endotracheal tube, which allows maximum delivery of oxygen, efficient ventilation, and overall best protection against pulmonary aspiration of oropharyngeal secretions and gastric contents.

It is critical to remember that providers with insufficient intubation experience should focus on providing effective bag-valve-mask ventilation and obtaining airway assistance, rather than attempting to intubate a patient themselves.

Breathing

Although airway evaluation always takes precedence, often the airway and breathing are evaluated simultaneously. All critically ill patients should receive supplemental oxygen initially, which may be useful as preoxygenation if intubation is required. The assessment of breathing consists of an evaluation of both respiratory rate and tidal volume. The respiratory rate, which is normally between 10 and 20 breaths per minute, may be too low because of respiratory suppression from encephalopathy or drug ingestion. In such patients, the rescuer should supplement ventilation by administering a bag-valve mask.

In addition to measuring the respiratory rate, the clinician must also assess for effective ventilation. This involves evaluating the patient's chest wall movement and breath sounds during respiration. Is the patient receiving adequate tidal volume, or is there a leak in the system or some other physical obstruction that is preventing adequate ventilation volumes? Inadequate ventilation can occur with a mucus plug, a right main-stem intubation, or a pneumothorax.

Circulation

After the airway and breathing have been addressed, the clinician should evaluate circulation or, more accurately, perfusion. Maintaining adequate perfusion is a cornerstone of the treatment of shock and in the prevention of multiorgan failure, both of which will be discussed in future articles.

Pulse and blood pressure are key elements in the evaluation of perfusion. However, the clinician must recognize the limitations of using these as primary gauges. Slow, full pulses are generally indicative of adequate perfusion, whereas rapid, thready pulses may signal shock. Remember that patients receiving β-blockers may have inappropriately slow heart rates in shock states. Concomitant evaluation of the patient's electrocardiographic rhythm is also paramount and will be discussed, along with antiarrhythmic therapy, in a future contribution.

Figure 1 A bag-valve mask is used to aid a patient's breathing

Blood pressure values must also be interpreted in the context of the patient's history and clinical presentation. A systolic blood pressure of 85 mm Hg may be entirely normal in a pregnant woman in her second trimester, whereas a systolic pressure of 120 mm Hg may be excessively low in a patient with severe chronic hypertension. For this reason, the clinician should consider other perfusion markers, such as mentation, urine output, and skin color and temperature. With the notable exception of patients in septic or distributive shock, patients with warm skin and less than 2-second capillary refill generally have adequate perfusion.

If after this initial evaluation the patient is deemed to be in shock, the clinician must decide how to augment perfusion. The consideration of the cause of the shock is obviously paramount because the treatment of hemorrhagic shock is clearly different from that of cardiogenic shock. As a general rule, however, if the patient has clear lung fields, the administration of a bolus of intravenous fluid is the first therapy. In fact, outside of the cardiogenic shock scenario, bolus fluid therapy should continue in a patient with poor perfusion until signs of hypervolemia—generally rales or hypoxia—prevent further boluses. Vasopressor therapy to augment cardiac output or increase vascular tone (or both) may be administered concomitantly with fluids but should generally be avoided until the patient has a replete intravascular volume.

POSTRESUSCITATION DISPOSITION AND THE INITIAL ICU PLAN

After the ABCs have been addressed and the patient's condition has been stabilized, the clinician must determine the optimal site for further patient care. The usual choices include a transitional or intermediate care unit, a coronary care unit (CCU), or an ICU. Institutional differences clearly influence this decision, but often the most prudent choice may involve an initial period of close observation in an ICU or CCU. Regardless of the choice, the clinician must continue to vigilantly monitor the patient's airway, oxygenation, ventilation, and perfusion.

The three main categories of care

At this stage, management of the critically ill patient may be simplified into three main categories—supportive care, the treatment of primary critical illness, and the prevention of secondary insults.

Supportive care

The clinician must continue to aggressively sustain the patient's airway, oxygenation, ventilation, and hemodynamics to allow the patient time to recover from the initial insults. This not only involves adherence to the aforementioned principles of resuscitation, but also mandates frequent adjustments in support made according to changes in the patient's status. For example, a patient recovering from pneumonia and sepsis may need less ventilatory support, but a patient progressing to the acute respiratory distress syndrome will likely need more.

Treatment of primary critical illnesses

The treatment of the primary critical illness refers to the development of a plan to treat the primary problems, such as infection or hemorrhage, that led to the ICU admission. For most patients, the standard problem list with differential diagnoses, diagnostic workup, and therapeutic plans will suffice. However, for more complex patients with multisystem disease, the head-to-toe organ system approach may assist in compartmentalizing and organizing this plan. Regardless of the approach chosen, the clinician should always remember to include the important topic of family and social issues that influence patients' long-term care.

ICU preventive care

The complete approach to a critically ill patient includes ICU preventive care, which is analogous to preventive care in the general population. The clinician should consider measures to prevent nosocomial infection, such as raising the head of the bed of a ventilated patient to 30 degrees, and should provide prophylaxis for gastrointestinal bleeding and deep venous thrombosis when indicated.

ICU MONITORING

Although vital signs, urine output, and physical examination findings persist as mainstays in the evaluation of critically ill patients, clinicians should be familiar with the other commonly used monitors in the ICU.

Pulse oximetry

Pulse oximetry has largely supplanted more invasive arterial blood gas sampling for determining patient's oxygen saturation and has become so standard to the practice of inpatient medicine that it is often referred to as the "fifth vital sign."[1] However, when caring for critically ill patients, clinicians must recognize the limitations of this technology:

- Although pulse oximetry accurately estimates patients' arterial oxygen saturation in the clinically relevant range from oxygen saturations of about 75% to 95%, it provides virtually no information regarding patients' ventilation and carbon dioxide tension ($PaCO_2$). When evaluating a patient with possible respiratory failure, especially a patient with chronic obstructive airways disease, the clinician must, therefore, avoid relying solely on pulse oximetry. A patient may have a normal pulse oximeter reading but still be in frank hypercapnic respiratory failure
- The clinician must also recognize that standard pulse oximetry overestimates arterial oxygen tension (PaO_2) in patients with carbon monoxide poisoning or methemoglobinemia[2]
- Finally, difficulties with pulse tracking in patients in low perfusion states may also hinder the performance of many pulse oximeters

Capnography

Although capnography, the measurement of exhaled carbon dioxide, has not attained the same ubiquitous role as pulse oximetry, several important niches for its use have evolved.

Postintubation capnography to confirm proper endotracheal tube placement has become a level I advanced cardiac life support (ACLS) recommendation.[3] Capnography is done by using either qualitative color-change CO_2 detectors or quantitative (waveform) CO_2 monitoring devices (figure 2). Capnographically measured $etCO_2$ values are typically 3 to 5 mm of water lower than arterial $PaCO_2$. Once the $PaCO_2$-$etCO_2$ gap has been determined to be relatively stable in a patient, the $etCO_2$ value may be used as a surrogate for the arterial $PaCO_2$ in that patient, thereby reducing the need for frequent arterial sampling.[4] Capnography may be useful, in conjunction with pulse oximetry, in the noninvasive adjustment of ventilator settings or in the weaning process. An increase in the $PaCO_2$-$etCO_2$ gap in a patient may signify an increase in dead space or a drop in cardiac output, thus providing clues to the diagnoses of pulmonary embolism and low cardiac output shock, respectively.[4]

Figure 2 Use of end-tidal CO_2 monitors is recommended to confirm correct endotracheal tube placement

Arterial catheters

Arterial catheters allow for accurate, continuous blood pressure monitoring and frequent arterial blood gas sampling in critically ill patients. Although improvements in less invasive continuous blood pressure monitoring devices have been made, intra-arterial blood pressure monitoring remains the gold standard. Arterial waveform analysis may provide clues to diagnoses such as aortic insufficiency or pericardial tamponade. Furthermore, serious complications from arterial catheterization are rare. For these reasons, we agree with recent statements of the Society of Critical Care Medicine that recommend the use of intra-arterial catheter monitoring in patients who are in shock and in patients who will receive rapid-acting vasodilators or vasopressors.[5]

The pulmonary artery catheter

Approaches to the use of the pulmonary artery catheter are as numerous and diverse as those to the practice of medicine. The questions about whether the catheter is cost-effective and whether its use reduces morbidity and mortality are two of the most controversial topics in all of critical care medicine.[6,7] What is clear, however, is that the catheter is not of itself therapeutic, but rather, it merely provides information—specifically, cardiac filling pressures (central venous and pulmonary artery occlusive pressures), mixed venous oxygen saturation, pulmonary artery pressures, cardiac output, and the derived measures of vascular tone (systemic and pulmonary vascular resistances). The decision to place a pulmonary artery catheter is based on whether the benefits potentially derived from this information outweigh the risks of placing the catheter.

Lactate levels and other gauges of perfusion

Beyond data from a pulmonary artery catheter, physical examination findings, and urine output, several other gauges of shock and perfusion have been promoted. Of these, serum lactate levels have emerged as the simplest and possibly the most useful.[5,8] In patients with poor tissue oxygenation, cells increase anaerobic metabolism and lactate levels rise. The clinician may, therefore, monitor serial lactate levels in patients with normal hepatic function as measures of global perfusion. Finally, monitors of cardiac output and other hemodynamic indicators that are minimally invasive have been developed. Esophageal Doppler and transthoracic impedance devices accurately measure cardiac output and estimate vascular resistance. Gastric tonometry, which uses a semipermeable membrane to measure stomach mucosal pH, may be used to assess intestinal perfusion.[9]

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