Revista Mexicana de Anestesiología

CONFERENCIAS MAGISTRALES
Vol. 29. Supl. 1, Abril-Junio 2006
pp S15-S20

The intensive care unit: The role of the anesthesiologist as perioperative consultant

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One thousand one hundred and thirty five anesthesiologists possess ABA special certification in Critical Care Medicine nationwide as of December 2004. There are 37,736 Diplomates of the American Board of Anesthesiology. Individuals possessing double board certification in both Anesthesiology and Critical Care Medicine comprise only 3% of the total population of Board Certified Anesthesiologists. However, many practicing anesthesiologists, without specific critical care specialization, are frequently involved with the perioperative care of ICU patients. Perioperative consultation in the ICU occurs in a myriad of settings including: preoperative evaluation, airway management, ventilator management, pain management, and ICU based procedures such as central line placement. A number of operative procedures traditionally performed in the OR are now commonly performed safely in the ICU setting avoiding the need for transport of the critically ill ICU patient.

Preoperative consultation may occur in patients destined for the ICU postoperatively on the basis of their planned operative procedure or in those patients already residing in the ICU. Two common areas of perioperative concern are the prevention of postoperative pulmonary complications as well as the prevention of perioperative cardiac events. Nonfatal myocardial infarction and death are significant perioperative cardiac complications in patients undergoing major vascular surgery[1]. Beta blockers prevent cardiac complications in patients after an acute myocardial infarction, silent myocardial ischemia and heart failure[2-5]. Beta blockers have been proposed to reduce the risk of perioperative cardiac events[6-8].

Poldermans et al. recently published an interesting study of the effect of the Beta blocker Bisoprolol on perioperative mortality and myocardial infarction in high-risk patients undergoing vascular surgery[9]. This randomized, multicenter trial assessed the effect of perioperative Beta blockade on the incidence of death from cardiac causes and nonfatal myocardial infarction within 30 days of major vascular surgery in patients assessed to be at high risk for these events. High-risk patients were identified by the presence of clinical risk factors for coronary artery disease as well as the presence of a positive dobutamine stress echocardiogram. Eligible patients were randomly assigned to receive standard perioperative care or standard care plus perioperative beta-blockade with bisoprolol.

One thousand three hundred and fifty one patients were screened and 846 patients were found to have at least one cardiac risk factor. One hundred and seventy three of these patients had a positive dobutamine stress echocardiogram. Fifty nine patients were randomized to receive bisoprolol and 53 to receive standard care. Fifty three patients who were already taking Beta blockers were excluded from randomization. Eight patients were excluded due to extensive pre-existing wall motion abnormalities either at rest or during stress testing.

The authors found that 2 patients in the bisoprolol group died of cardiac causes (3.4%) compared with nine patients in the standard care group (17%, $p = 0.02$)[9]. Nonfatal myocardial infarction occurred in nine patients in the standard care group (17%). None of the bisoprolol group had this complication ($p < 0.001$). The study end point of death from cardiac causes or nonfatal myocardial infarction occurred in 2 patients in the bisoprolol group (3.4%) and 18 patients in the standard care group (34%, $p < 0.001$). The observed treatment effect was not attributable to differences between the two groups with regard to clinical characteristics, anesthetic or analgesic technique or the length of ICU stay. The authors concluded that bisoprolol reduces the perioperative incidence of death from cardiac causes and nonfatal myocardial infarction in high- risk patients undergoing abdominal aortic or infra-inguinal arterial reconstructive surgery. Based on their results the authors recommended that high- risk surgical patients receive Beta blockers perioperatively beginning one to two weeks prior to the planned operative procedure. The goal is to reduce the heart rate to less than 70 beats/minute preoperatively and less than 80 beats/minute in the perioperative period. Therapy should be continued at least two weeks postoperatively.

Zaugg et al[10] recently published a study to examine the proposed mechanism surrounding the reduction of perioperative myocardial infarction seen as a result of perioperative Beta blockade. They hypothesized that Beta blocker induced alteration in the stress response was responsible for the improvement in cardiovascular outcome. Sixty-three patients were randomly assigned to one of three groups. Group I: no atenolol, Group II: preoperative and postoperative atenolol, Group III: intraoperative atenolol. Hormonal markers of the stress response were measured preoperatively and for 72 hours after surgery. Although perioperative Beta blockade did not significantly alter the hormonal stress response, hemodynamic stability was improved perioperatively. In addition, narcotic requirements, early recovery, lower pain scores, and less analgesic medication were found in the Beta blocker groups. The authors concluded that Beta blockade does not significantly reduce the neuroendocrine stress response although it does confer several other perioperative advantages in terms of decreased analgesic requirements, faster recovery from anesthesia and improved hemodynamic stability.

Several recent review articles summarize preoperative pulmonary evaluation[11,12]. Postoperative pulmonary complications (PPC) are a frequent and important risk of surgery and are documented to prolong hospital stay for an average of one to two weeks[13]. PPC include pneumonia, respiratory failure, prolonged mechanical ventilation, bronchospasm, atelectasis, and exacerbation of chronic lung disease. Patient related risk factors that contribute to PPC include smoking, poor general health status, older age, obesity, COPD and asthma. The anticipated surgical site is the most important predictor of pulmonary risk. Upper abdominal and thoracic surgeries carry the greatest risk of PPC. The incidence of these complications ranges from 10 to 40 percent in published reports[11]. The length of the surgical procedure also increases the risk of development of PPC. Surgical times of greater than three hours are associated with a higher risk of PPC[14,15]. Several studies have reported a lower risk of pulmonary complications with epidural, spinal or regional anesthesia. A retrospective review of COPD patients found that 8% of 464 patients undergoing general anesthesia died from respiratory failure whereas no deaths were reported in 121 patients who received spinal or epidural anesthesia[16]. Berg et al. found that patients receiving pancuronium had a higher incidence of PPC than those patients who received vecuronium or atracurium[17]. This prospective study of 691 patients found that PPC were three times more likely in patients receiving pancuronium. The etiology was due to more frequent and prolonged neuromuscular blockade with subsequent postoperative hypoventilation. Several small case series have concluded that a partial pressure of arterial carbon dioxide greater than 45 mm Hg is a strong risk factor of PPC[18,19]. All patients in these studies with an elevated $PaCO_2$ had significant airway obstruction via spirometric evaluation.

Preoperative pulmonary evaluation should include a thorough history and physical examination. Symptoms of exercise intolerance, chronic cough, unexplained dyspnea should be sought. The physical exam should elicit signs of pulmonary disease such as decreased breath sounds, wheezing, rhonchi, and a prolonged expiratory phase[11]. Significant snoring and apnea is suggestive of undiagnosed sleep apnea which may result in unrecognized pulmonary disease as well as a potentially difficult airway. Preoperative spirometry should be utilized in patients undergoing thoracic or upper abdominal surgery, those with symptoms of cough, dyspnea, or exercise intolerance and in those patients with COPD or asthma where airflow obstruction has not been optimized clinically[11].

Risk reduction strategies include maneuvers that can be employed throughout the perioperative setting. Preoperatively, cigarette smoking should be discontinued for at least 8 weeks and airflow obstruction should be treated in patients with COPD or asthma. If a respiratory infection is present, antibiotics should be administered and the surgery delayed in the non-emergent setting. Patients should be taught lung-expansion maneuvers preoperatively. Intraoperative considerations to reduce PPC include limitation of the duration of surgery to less than 3 hours in high risk patients, use of spinal or epidural anesthesia when feasible and avoidance of long acting neuromuscular blocking agents such as pancuronium. Laparoscopic procedures should be employed in high- risk patients when indicated[11]. Postoperatively, maneuvers such as deep breathing exercises, incentive spirometry and CPAP should be employed. Epidural analgesia reduces the rate of PPC in high-risk patients[20]. Seventy-five patients undergoing open cholecystectomy, including 31 patients with pulmonary disease, were randomized to receive epidural analgesia or parenteral narcotics. Pulmonary complication rates were 24% and 56% respectively. Intercostals nerve blocks are a treatment option in the event that epidural analgesia is ineffective or technically difficult. Ballyntyne published a meta-analysis of postoperative intercostals nerve blocks and reported a relative risk of 0.47 for all pulmonary complications. This risk reduction did not reach statistical significance however[21].

Anesthesiologists are often consulted for airway management in the Intensive Care Unit[22]. Nayyar and Lisbon surveyed anesthesiology residency training programs with regard to emergency airway management practices outside the operating room[23]. In the vast majority of programs surveyed, anesthesiologists performed most of the intubations on the hospital ward, including the ICU. Mort reviewed the incidence of hemodynamic and airway complications associated with tracheal reintubation after unplanned extubation in the ICU[24]. Fifty-seven patients who were reintubated after self-extubation were analyzed over a 27-month period. 93% of reintubations occurred within 2 hours of self-extubation. Of these patients, 72% had hemodynamic compromise and/or airway-related complications such as hypotension (35%), tachycardia (30%), hypertension (14%), multiple laryngoscopic attempts (22%), difficult laryngoscopy (16%), difficult intubation (14%), hypoxemia (14%), and esophageal intubation (14%). One patient required a surgical airway. One case of “cannot ventilate, cannot intubate” leading to cardiac arrest and death occurred. Less than one third of the patients studied had a “mishap-free” reintubation in the ICU[24]. The author suggests that individual ICU’s develop strategies to decrease the rate of self-extubation based on patient safety and the impact of emergency airway management.

Mort recently authored two additional studies of airway management in the ICU setting[25,26].

The first study utilized an emergency intubation database from 1990-2002 in support of the ASA Guidelines for management of the difficult airway which suggests that when conventional intubation techniques fail following 3 attempts, advanced airway devices should be utilized and immediately available[25]. The database was divided into 2 periods. Period A (1990-1995) included 340 intubations where accessory airway devices, such as the LMA, Bougie, Combitube or Fiberoptic bronchoscope, were not routinely available. Period B (1995-2002) included 437 patients where these devices were readily available. The author reviewed the relationship of the accessory airway device used with airway and hemodynamic complications including number of intubation attempts, hypoxemia, regurgitation, aspiration, bradycardia and dysrhythmia. The study found a 33% reduction in hypoxemic episodes ($SpO_2 < 90\%$) and a 50% reduction in severe hypoxemic episodes ($SpO_2 < 70\%$) in group B patients where accessory airway devices were readily available. Regurgitation was reduced from 4% in Group A to 1.7% in Group B. Aspiration was reduced from 2.1% in Group A to 0.2% in Group B. Bradycardia was reduced from 5% in Group A to 2% in Group B. Dysrhythmia was reduced from 9.1% in Group A to 3.7% in Group B. Multiple intubation attempts dropped from 30% in Group A patients to 15% in Group B patients. The use of accessory airway devices increased from 5% in Group A patients to 42% in Group B patients. Notably LMA use increased 21 fold. The author’s aggressive approach of incorporating the ASA Difficult Airway Management guidelines by early intervention with accessory airway devices lead to a remarkable reduction in multiple attempts at laryngoscopy and a decreased incidence of airway and hemodynamic complications. This study confirms the importance of application of the ASA Difficult Airway Management algorithm outside of the operating room setting and also justifies the immediate availability of a well stocked Difficult Airway Cart in all hospital locations where emergency airway management is performed, especially the ICU.

The second study reviewed the utility of exchanging an endotracheal tube in the ICU by two methods: direct laryngoscopy or airway exchange catheters[26]. Endotracheal tube exchanges from an eight year QI Database were reviewed. Patients with an uncompromised glottic view (Cormack-Lehane view 1&2) were divided by method of exchange (Direct Laryngoscopy *vs* Airway Exchange Catheter-Cook 14F or 19F). Hypoxemia, intubation attempts, esophageal intubation, bradycardia, cardiac arrest and the need for a surgical airway were compared. The author studied 133 patients with an uncompromised glottic view (DL = 99, AEC = 34). Successful endotracheal tube exchange on the first attempt was higher with use of an AEC (95% AEC *vs* 62% DL). Need for multiple attempts at laryngoscopy was higher with DL (26% DL *vs* 2.9% AEC). Rescue airway techniques were utilized more frequently in the DL group (16 cases, 5 surgical airways DL group *vs* none of the AEC group). Hypoxemia and severe hypoxemia was more common in the DL group as was esophageal intubation. Bradyarrhythmias and cardiac arrest during DL for endotrachal tube exchange were also more frequent. The author concluded that use of an AEC during endotracheal tube exchange in the ICU lowered the risk of complications considerably even in the presence of an uncompromised view of the glottic inlet.

Critically ill ICU patients often require diagnostic or surgical procedures that traditionally require transportation outside of the ICU. The risks inherent in the transport of critically ill patients are well described. A recent article by Waydhas reviewed the current literature on the intrahospital transport of critically ill patients[27]. Adverse events can occur in up to 70% of critically ill patients during transport outside of the ICU. These include hemodynamic compromise (Bradycardia, Tachycardia, Hypotension, Hypertension, Arrhythmias, Cardiac Arrest) as well as respiratory compromise (Tachypnea, Hypocapnia,Hypercapnia, Hypoxemia). In 12% of cases reviewed, long term deterioration of respiratory status was observed. In one-third of cases, mishaps during transport were equipment related.

Patient related risk factors identified with adverse events during transport included: High Therapeutic Intervention Severity Score, Mechanical Ventilation and Ventilation with PEEP. Factors unrelated to an increased rate of transport related adverse events included: Patient age, duration of transport, transport destination, APACHE II score and personnel accompanying the patient(27). The author concluded that adverse events during intrahospital transport of critically ill patients can be prevented with the development of ICU specific guidelines. Guidelines concerning patient eligibility as well as the necessary personnel, equipment and monitors utilized for transport are warranted. Alternative diagnostic modalities and techniques as well as the performance of applicable surgical procedures in the ICU should be considered in order to reduce the incidence of transport related adverse events.

Recent literature reviews the concept of the intensive care unit as an operating room(28-30). Tracheostomy and Gastrostomy are procedures which have been redesigned to include novel minimally invasive percutaneous techniques. Percutaneous techniques have eased implementation of bedside procedures in the ICU setting and fostered performance of these techniques by multiple specialists(27). Percutaneous bedside procedures avoid the need for transport outside of the ICU and have been documented to reduce cost(29). As a result, performance of these procedures is ubiquitous in ICU's worldwide mandating that anesthesiologists have a working knowledge of these techniques .

First described in 1969, percutaneous tracheostomy did not gain widespread acceptance until the 1990's. Ciaglia and colleagues first described a technique of endoscopically guided percutaneous dilatational tracheostomy(31). The Ciaglia method is recommended as a bedside procedure. The Ciaglia Blue Rhino Percutaneous Tracheostomy Introducer set is a commercially available kit (Cook Critical Care Inc., Bloomington IN) Two kits are available either with a size 6 (7 mm ID) or size 8 (9 mm ID) Shiley Percutaneous Tracheostomy Tube. The procedure begins with standard sterile preparation, surgical draping and midline identification of the interspace between the second and third tracheal rings. A needle puncture through the skin is made into the trachea at this level. A guidewire is passed through the needle into the trachea. The Ciaglia technique utilizes bronchoscopic guidance via the in situ endotracheal tube to confirm intratracheal position of the guidewire. Subsequently, a tapered dilator is advanced over the guidewire to create a tracheal stomal tract. A tracheostomy tube is then threaded over the guidewire and advanced into the trachea. Confirmation of appropriate position should occur by the traditional methods of auscultation, End-tidal CO_2 detection, symmetric chest expansion as well as fiberoptic reconfirmation(30).

Moe and coauthors recently reviewed all published studies involving Percutaneous Dilatational Tracheostomy evaluating six different techniques(32). The Ciaglia technique has the lowest published rates of major hemorrhage (0.2%), pneumothorax (0.2%) and laryngeal granulation (0.7%)

Anesthesiologists may be involved in the performance of percutaneous dilational tracheostomy from the standpoint of anesthetic management in the ICU as well as fiberoptic guidance during the procedure.

Anesthesiologists may be consulted to provide central venous access in ICU patients. Central venous access is an integral part of patient care and comfort in the ICU but is associated with the risk of catheter-related bloodstream infection. The strict aseptic technique and management associated with insertion of central venous catheters is well described(33). Current rates of bloodstream infection range from 4 to 13 per 1,000 patient-days when central venous access is in place(34). The crude mortality rate in nosocomial bloodstream infections is approximately 35%. Death is most often due to infection not underlying patient disease. Seventy percent of all nosocomial bloodstream infections occur in patients with indwelling central vascular catheters(35). Darouiche recently compared two central venous catheters impregnated with either minocycline and rifampin or chlorhexidine and silver sulfadiazine(36). The authors conducted a prospective, randomized clinical trial in 12 university hospitals. Catheters impregnated with minocycline and rifampin (Cook Spectrum, Cook Critical Care, Bloomington IN) were 1/3 as likely to be colonized as catheters impregnated with chlorhexidine and silver sulfadiazine (Arrowguard Blue, Arrow International, Reading PA). Catheter-related bloodstream infection was 1/12 as likely in the minocycline/rifampin catheters. The potential reduction in the morbidity and mortality at a reasonable cost warrants the use of such catheters in the ICU setting as part of a program to minimize the risk of catheter related infection(33).

An interesting multicenter, randomized, controlled clinical trial of transfusion requirements in critical care was published recently(37). Hebert and coauthors sought to determine if a restrictive strategy of red-cell transfusion and a liberal strategy of red cell transfusion produced equivalent results in a group of critically ill ICU patients throughout Canada. The death rates and organ dysfunction at 30 days were compared. The authors enrolled 838 critically ill euvolemic patients who had hemoglobin concentrations of less than 9.0 g/dl within 72 hours of ICU admission. Four hundred and eighteen patients were randomly assigned to a restrictive transfusion strategy in which red cells where transfused if the hemoglobin concentration dropped below 7.0 g/dl. Hemoglobin concentrations were maintained between 7.0 and 9.0 g/dl in the restrictive group. Four hundred and twenty patients were assigned to a liberal transfusion strategy where patients were transfused when the hemoglobin concentration fell below 10.0 g/dl. Hemoglobin concentrations were maintained between 10.0 to 12.0 g/dl. Patients were excluded for the following reasons: age < 16 years, inability to receive blood products, active blood loss at the time of enrollment, chronic anemia, pregnancy, brain death and imminent death. Other exclusion criteria included a question by the attending ICU physician whether to withhold or withdraw ongoing treatment or admission after routine cardiac surgical procedures. This was an IRB approved study in each of 25 ICU's in Canada. Informed consent was obtained from either the patient or the closest family member for participation in the study.

The 30 day mortality was similar between the two groups (18.7% *vs* 23.3%, p = 0.11) However, mortality rates were significantly lower in the restrictive strategy group in patients with an APACHE II score of less than or equal to 20 (8.7% restrictive *vs* 16.1% liberal) and in patient's less than 55 years of age. (5.7% *vs* 13%). Interestingly, there was no difference in mortality between treatment groups in patients with clinically significant cardiac disease (20.5% *vs* 22.9%). In addition, the mortality rate during hospitalization was significantly lower in the restrictive strategy group (22.2% *vs* 28.1%). The study concluded that a restrictive strategy of red-cell transfusion is equal or superior to a liberal transfusion strategy in critically ill patients. The possible exception was noted in patients with acute myocardial infarction or unstable angina.

Anesthesiologists are ideal perioperative consultants in the Intensive Care Unit providing expertise in myriad of areas that contribute to the quality of care of the critically ill patient. This role should be tempered with knowledge of the supporting literature as well as the technical skills inherent to our field.

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