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MAC Should Stand for Maximum Anesthesia Caution, Not Minimal Anesthesiology Care

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IN this issue of ANESTHESIOLOGY, Bhananker *et al.*[1] draw attention to an age-old problem that continues unabated. Depression of spontaneous ventilation by opioids and sedative–hypnotic–anesthetic drugs (hereafter referred to as central nervous system [CNS] depressants) can lead to severe central nervous system injury and death. The authors also identify a surprisingly high frequency of on-patient fires.

The authors compared the incidences of these and other injuries for patients under monitored anesthesia care (MAC) to those found in closed claims data for patients who had received general anesthesia or regional anesthesia. Their most striking conclusion is that MAC is no less risky than general anesthesia in terms of the occurrences of permanent brain injury and death for patients undergoing predominantly elective operations mostly in outpatient settings.

Factors Contributing to Late Recognition of Respiratory Depression during MAC*

Attitudes of Anesthesia and Surgical Personnel

Most MAC cases are for simple or superficial operations that are regularly performed in a routine fashion in relatively healthy patients (American Society of Anesthesiologists physical status class I or II). As such, they are considered to require simple, low-risk anesthesia care. In some cases, the least qualified anesthetist is assigned to the case. Drugs used in MAC are routinely used in the postanesthesia care unit and other sites where patients are more or less awake and breathing on their own. With familiar drugs and routine operations, diligence is often less by both the anesthetist and the surgeons. In many situations, there has been a lengthy history of "safety," which makes everyone quite comfortable.

The preanesthetic evaluation may be limited, and relevant data about the patient's medical history, drug regimen, physical examination, laboratory results, and medical consultations may be missing. Demands by the surgeon may be in conflict with the patient's request. For example, the patient may wish to be totally "unaware" while the plastic surgeon wishes to avoid having to deal with an endotracheal tube or a laryngeal mask airway, which distorts the face and risks dental damage, coughing, and increased bleeding. Some surgeons explain the intraoperative experience to their patients as being similar to "taking a nap at a spa" and do not wish to upset their patients or drive them away to a competitor by anyone mentioning anything related to general anesthesia.

Operating Conditions

Approximately one-half of the cases described by Bhananker *et al.*[1] involved operations about the head and neck which denied the anesthetist direct access to the patient's airway during the procedure. Some antiseptic solutions used to prepare the skin disguise changes in skin color (*e.g.*, cyanosis), and draping of the head and trunk reduces the visibility of respiratory movements. Monitor displays may be positioned in less than ideal locations. Audible signals from the monitoring systems may be drowned out by operating room noise or music, deliberately reduced in volume or inactivated. Auscultation of the heart and lungs may be impeded. The cumulative impact of these factors leads to delayed recognition of depressed spontaneous ventilation until late in its course, and cardiac arrest may be the initial signaling event. The personnel attending to the patient may be inexperienced in resuscitation techniques. A common clinical impression is that resuscitation at the sudden onset of ventricular fibrillation is more successful, especially in terms of preserving brain functions, than that for cardiac arrest after a period of inadequate ventilation during which time the oxygen reserves are depleted.

Respiratory Depression by CNS Drugs

Generally speaking, the required doses of analgesic and sedative–hypnotic drugs are proportional to the

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* Observations about the attitudes of personnel and operating conditions are taken from peer reviews ofcases and practices in the United States.

intensity of noxious stimulation.[2] Noxious stimulation is said to be a "natural antagonist" to the depressant effects of such drugs. Contrary to claims that skin incision is a "supramaximal stimulus," there are more stimulating procedures, such as cauterizing the periosteum or manipulation of the carina. If drug doses are matched to intense stimuli, stopping the stimulation leaves the patient with residual drug effects that depress spontaneous respiration.

Analgesic doses of opioids depress spontaneous breathing and the reflex responsiveness to hypercapnia and hypoxemia, and these effects are increased by natural sleep and by sleep-inducing drugs.[3,4] Progressive accumulation of carbon dioxide adds to CNS depression. Oxygen supplementation of the patient's inspired air can delay the onset of hemoglobin desaturation while carbon dioxide accumulation continues.[5]

The pharmacokinetic features of some drugs may contribute to inadvertent overdose. It is important to distinguish the onset of drug effect from its peak effect.[6] If the response is considered inadequate at a time when the drug is still climbing to its peak concentration in the brain, the physician or nurse may be inclined to give an additional dose. In the case of continuous drug infusions, there is even a longer period of time for the drug to reach a steady state, and if the effect is inadequate during that interval, there may be an inclination to increase the infusion rate rather than give a supplemental intravenous bolus dose. Doubling the infusion rate will double the ultimate drug concentration at steady state. The duration of action of most CNS depressants used for MAC and general anesthesia is proportional to dose. With repetitive doses or long-term infusions, there is progressive accumulation of drug in the body.[4,7]

Variability in Patient Response

Individual patients vary up to eightfold in terms of the opioid dose required to produce analgesia.[8] The most prominent factors contributing to this variability include intensity of pain or noxious stimulation,[2] drug interactions with other CNS depressants,[4] and yet unknown factors intrinsic to the patient (pharmacogenetics).

The average dose requirements and blood concentrations associated with opioid effects decline progressively with age, but occasionally an octogenarian requires considerably more opioid than 20-yr-old patients.[9] Knowledge of the trend is useful in choosing an initial dose, but the effective and safe use of opioids requires titration to response in each individual patient.

Other factors contributing to variability include health status, hemodynamics, hepatic and renal function, and body composition. Trends have been reported, but titration of dose to effect is always required.

Analgesia and Sedation for Patients Outside of the Operating Room

Numerous malpractice claims and suits have been filed for drug-induced respiratory depression occurring after painful interventions. In addition to the issues noted above, there are three other important considerations.

1. A surgeon or other interventionalist prescribing postoperative analgesic and sedative drugs should be cognizant of the residual effects of drugs administered during the procedure.
2. With the recent emphasis on treating pain aggressively, the nurse caring for the patient should recognize that a sleeping patient does not experience significant pain, and an additional dose of opioid should not be administered even if the patient requests one during momentary arousal.
3. The evaluation of pain and suffering is purely subjective, and patient-controlled analgesia is a logical means of addressing variability and achieving effective and safe treatment.

Additional Considerations in Producing and Monitoring Analgesia and Sedation

A number of electroencephalogram-based methods have been developed to track the hypnotic effects of CNS depressants, but these are not affected by *analgesic* doses of opioids,[10] and the methods cannot be used to assess the degree of analgesia or of respiratory depression. Analgesia and respiratory depression parallel each other in a dose-related fashion. A respiratory rate of 12–15 breaths/min usually indicates sufficient opioid has been administered. Propofol is an anesthetic drug with a dose-effect range going from sedation to loss of consciousness. It interacts synergistically with opioids in terms of CNS and respiratory depression and hypotension. Its reputation of having a rapid recovery may lull the person administering it into complacency and an assumption of safety. Recovery may not be fast enough to prevent serious consequences after a period of ongoing respiratory depression.

Analogous to airplane pilots who compulsively run through a check list before taking off in either a Piper Cub or a Boeing 777, the anesthesiologist/anesthetist should compulsively check the anesthesia and resuscitative equipment before any type of anesthetic care, be it MAC, general anesthesia, or regional anesthesia. *Vigilance* is the key word on the seal of the American Society of Anesthesiologists.

Factors Contributing to Claims of Malpractice

Physician competence and technical skill are essential for good outcomes. Most patients and members of juries

recognize that physicians are human beings and perfection is not always possible. If mistakes are acknowledged forthrightly and plans for dealing with the consequences are explained, patients and their families usually are forgiving. But when patients become frustrated with the lack of communication, perceive that they are being deceived by a cover-up, or otherwise are being ignored and avoided, they become angry. Anger and deception are strong incentives to make a claim and file a suit. Hickson *et al.*[11] have consistently found in closed claim studies as well as in studies of the relationships between the numbers of patient complaints and the numbers of malpractice claims and suits that 50% of complaints are attributable to only 9% of physicians across all specialties and types of practice. Some patients and families file suits when there in fact is no malpractice.[12] Bhananker *et al.*[1] found that the standard of care was met in 59% of the MAC closed claims, 64% of general anesthesia closed claims, and 74% of regional anesthesia closed claims.

Institutions are beginning to adopt a policy of full disclosure of mistakes and untoward events. Early offers of payment of the actual financial losses to the patient are made in an attempt to minimize the risk of unrealistic judgments for pain and suffering, which are often based on unhappiness with the outcome and distrust of the healthcare providers and institutional administrators.

Burn Injuries

The factors contributing to on-patient fires during MAC are described by Bhananker *et al.*[1] They and others[13] offer suggestions for avoiding them. Especially important is the fact that the oxygen used to supplement inspired air and to minimize hypoxemia during MAC is the oxidizer that intensifies fires.

American Society of Anesthesiologists Resources

The American Society of Anesthesiologists has developed numerous Standards, Guidelines, Statements, Practice Parameters, and Advisories to assist practitioners in providing safe, effective, and efficient care to patients undergoing all types of anesthesia in a variety of circumstances.† Prudent anesthesiologists and anesthetists should be intimately familiar with the contents of these documents.

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Endotracheal Tubes

The Conduit for Oral and Nasal Microbial Communities to the Lungs

OUR French and other European colleagues have been instrumental in defining and investigating the pathogenesis of ventilator-associated pneumonia (VAP).[1–3] This infection occurs in patients who have endotracheal tubes for prolonged periods, and generally greater than 48 h. It has been shown that endotracheal tubes are covered with bacterial biofilms, inside and outside, within 11 h[4,5] and that the longer a patient remains intubated, the greater the chances are for the development of VAP.[6,7] It has also been documented that many of the microbes found in the lungs of hospitalized patients originate in the dental plaque and in the oral flora of these patients.[8] Therefore, it seems that aspiration of the oral flora, before or during tracheal intubation, is probably a major mechanism for VAP. This also suggests that we need a greater understanding of microbial communities in patients to fully understand the pathogenesis of this condition.

Many bacteria live in a stable relationship on our oral and nasal mucosa. The composition of the bacterial flora inhabiting these sites is highly specific to particular host species, suggesting host factors must be an important determinant in the selection of colonizing microbes.[9] *Haemophilus influenzae* is a gram-negative bacteria that colonizes the epithelium of the nasopharynx in many normal people as well as the upper and lower respiratory tracks of patients with lung disease.[10,11] The mucosal surfaces are populated by diverse populations of bacteria that are altered by the use of selective antimicrobials and vaccines that target a limited array of colonizing species or strains. An example of this is with the advent of *Streptococcus pneumoniae* vaccination, children now have lower rates of vaccine-type *S. pneumoniae* carriage but higher rates of *Staphylococcus aureus* nasal colonization.[11]

Dr. Stéphan *et al.*[12] are to be congratulated for their careful investigation of trauma-associated ventilator associated pneumonia. Their results further document the importance of the oral–nasal flora in the pathogenesis of VAP. They also present data that suggest this same flora is involved in the pathogenesis of acute lung injury (ALI)/acute respiratory distress syndrome. *Haemophilus influenzae* was found to be the most frequent gram-negative bacteria associated with VAP and the most frequent bacteria associated with the development of ALI and the adult respiratory distress syndrome.[12] Although the mortality of the trauma patients did not seem to be affected by the development of VAP, trauma victims who had development of ALI or acute respiratory distress syndrome had a significant increase in mortality.[12] Therefore, prevention of VAP could possibly prevent ALI or acute respiratory distress syndrome.

Although the findings of Stéphan *et al.* are interesting and provocative, an air of caution is needed. The sample size of patients with VAP/ALI was small, and there was uneven distribution of patients with preexisting chronic lung disease in the VAP/ALI group. Colonization of the upper the airway with nontypeable *H. influenzae* is common, occurring in up to 80% of healthy adults. In addition, lower respiratory colonization is common in individuals with chronic lung disease, and acquisition of new strains is associated with an increased risk of exacerbation of chronic obstructive pulmonary disease.[13] Therefore, the association between VAP, ALI, and *H. influenzae* may have been artifactual and due to unequal randomization. In addition, amoxicillin-clavulanate, an antibiotic with superb activity against both β-lactamase–positive and –negative *H. influenzae*, was prescribed for 48 h for patients with open fractures. Although the number of patients with fractures was evenly distributed among groups, it is not clear whether those with open fractures who received amoxicillin-clavulanate were evenly distributed. Clearly, pretreatment could have skewed the results.

If the findings of Stéphan *et al.* are confirmed, administration to adults of a vaccine against nontypeable *H. influenzae* (under development) might provide protection against colonization and potentially prevent VAP due to this organism. Other preventative therapies for VAP might include a preoperative or premorbid assessment of the nasal–oral flora of patients who require prolonged tracheal intubation and might involve the addition of protective commensal bacteria or local, targeted therapies to decrease pathogenic flora in these locations. However, to develop these therapies, we need to understand which communities of bacteria exist in

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which patients, how these communities of bacteria interact with each other, and what happens to these communities when we administer prophylactic antibiotics.

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