AMERICAN HEALTH CONSULTANTS

CRITICAL CARE ALERT®

A monthly update of developments in critical care and intensive care medicine

American Health Consultants Home Page—http://www.ahcpub.com

CME for Physicians—http://www.cmeweb.com; CE for Nurses—http://www.ceweb.com

The 'Sigh' as a Recruitment Maneuver in ARDS?

ABSTRACT & COMMENTARY

Now that the use of small tidal volume ventilation (3-6 mL/kg predicted body weight) is the accepted method of managing patients with the acute respiratory distress syndrome (ARDS), prevention of atelectasis and improvement of gas exchange by alveolar recruitment is a topic of much study. This report evaluates the effect of a single ventilator-delivered sigh breath once a minute on patients receiving pressure support ventilation (PSV) during treatment for ARDS. Thirteen intubated patients were studied within 7 days of the onset of symptoms and the diagnosis of ARDS. Patients were lightly sedated and managed with PSV and positive end-expiratory pressure (PEEP) levels set by the primary clinicians, based on individual patient needs. Average tidal volume was about 400 mL and PEEP about 11 cm H_2O during the control study period. Control PaO_2 was 91.4 ± 27.4 mm Hg.

Sighs were produced by using the "BiPAP" mode on the Dräger Evita-4 ventilator. This mode consists of continuous positive airway pressure (CPAP) delivered in alternating periods of high and low levels. Spontaneous ventilation is possible during both periods, but no pressure support is applied during the high CPAP period. The high CPAP during the single sigh period was set at 20% greater than the peak airway pressure during spontaneous breathing, or at 35 mm Hg, whichever was higher. The sigh duration was 3-5 seconds depending on patient tolerance. "Intolerance" was determined individually if the patient showed hemodynamic compromise or involuntary cough. Patroniti and colleagues used a lower PEEP during the sigh period to maintain mean airway pressure the same as during spontaneous ventilation. The sigh was delivered once each minute for at least 1 hour. At the conclusion of this period gas exchange, respiratory system mechanics, lung volumes (determined by helium dilution), and drive to breathe (airway occlusion pressure, $P_{0.1}$) were measured and compared to the control period. After the experimental period another hour at baseline conditions was applied and the studied parameters repeated.

During the sigh period, PaO_2 increased (91.4 vs 133 mm Hg), $PaCO_2$ was unchanged (45.8 vs 47.3 mm Hg), and total respirato-

INSIDE

Volume 10 • Number 4 • July 2002 • Pages 37-48

ry system compliance improved (40 ± 12 vs 45 ± 15 mL/cm H_2O). Tidal volume (418 ± 57 vs 370 ± 81) declined, as did $P_{0.1}$ (2.1 ± 1.5 vs 1.2 ± 0.7 cm H_2O). Lung volume increased during the hour when sighs were delivered (1242 vs 1378 mL). All changes returned to baseline within an hour after removal of the sigh. (Patroniti N, et al. *Anesthesiology*. 2002;96:788-794.)

COMMENT BY CHARLES G. DURBIN, Jr., MD

This is one of a number of studies that have attempted to describe the effects of alveolar recruitment maneuvers in patients with ARDS who are managed with small tidal volume ventilation as part of a lung-protective therapy. It demonstrates that rapid improvements in gas exchange occur when a 3-5 second period of CPAP breathing (greater than 35 cm H_2O) is delivered in patients breathing spontaneously with PSV. While the observations of this study are interesting (and predictable) it is not clear what the implications are for ARDS treatment. While all the studied patients met the criteria for ARDS, most had relatively good pulmonary compliance and probably were in an early stage of the disease. Only 13 patients were studied, and no attempt was made to systematically study all patients with this disorder. Thus, the patients represent a highly selected population, although the selection criteria were not stated. This weakens the study's conclusions.

The baseline pulmonary treatment was not standardized. No attempt was made to optimize PEEP, and no pressure-volume curve information was determined. The relationship of the chosen PEEP to the lower inflection point was not determined. Rather low PEEP levels were used (about 10 cm H_2O) considering the current understanding of derecruitment. Tidal volume was measured during spontaneous ventilation and undoubtedly varied substantially from breath to breath. The tidal volume was not controlled by protocol, but was determined by the primary clinician. The study conditions are relevant in that spontaneous ventilation is often desirable to optimize ventilation to perfusion matching.

There are significant limits to the usefulness of this study. Pressures were measured at the airway. Without knowing intrathoracic pressures, the lung and chest wall contributions cannot be separated. The recruitment maneuver was only applied for the hour of the study, and was not used in comparison to another approach or in a therapeutic way throughout the course of ARDS. The way the "sigh" was created is specific to the ventilator used, and may not apply to other types of "sighs." The duration of the sigh was determined by "patient tolerance," a subjective and not easily reproducible approach. This paper should help stimulate more studies of sighs for longer periods of time. It is essential to show that these short-term improvements translate into a better long-term outcome. ■

Critical Care Alert, ISSN 1067-9502, is published monthly by American Health Consultants, 3525 Piedmont Rd., NE, Bldg. 6, Suite 400, Atlanta, GA 30305.

VICE PRESIDENT/GROUP PUBLISHER: Donald R. Johnston.

EDITORIAL GROUP HEAD: Glen Harris.

MANAGING EDITOR: Robin Mason.

ASSOCIATE MANAGING EDITOR: Neill Larmore.

SENIOR COPY EDITOR: Robert Kimball

MARKETING PRODUCT MANAGER: Schandale Kornegay.

GST Registration Number: R128870672.

Periodicals postage paid at Atlanta, GA.

POSTMASTER: Send address changes to ***Critical Care Alert,*** P.O. Box 740059, Atlanta, GA 30374.

Back issues: $37.

Missing issues will be fulfilled by customer service free of charge when contacted within one month of the missing issues date.

This is an educational publication designed to present scientific information and opinion to health professionals, to stimulate thought, and further investigation. It does not provide advice regarding medical diagnosis or treatment for any individual case. It is not intended for use by the layman.

Subscriber Information

Customer Service: 1-800-688-2421

Customer Service E-Mail Address: customerservice@ahcpub.com

Editorial E-Mail Address: robin.mason@ahcpub.com

World Wide Web: http://www.ahcpub.com

Subscription Prices

United States

$249 per year. (Student/Resident rate: $100)

Multiple Copies

1-9 additional copies: $197 each; 10 or more copies: $175 each.

Canada

Add GST and $30 shipping.

Elsewhere

Add $30 shipping.

Accreditation

American Health Consultants (AHC) designates this continuing medical education (CME) activity for up to 28 hours in category 1 credit toward the AMA Physician's Recognition Award.

Each physician should claim only those hours of credit that he/she actually spent in the educational activity.

This CME activity was planned and produced in accordance with the ACCME Essentials.

AHC is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

For CME credits, add $50.

AHC is accredited as a provider of continuing education in nursing by the American Nurses Credentialing Center's Commission on Accreditation. Provider approved by the California Board of Registered Nursing, Provider Number CEP 10864, for approximately 16 contact hours.

THOMSON

AMERICAN HEALTH CONSULTANTS

Questions & Comments

Please call **Robin Mason,** Managing Editor, at (404) 262-5517 or e-mail at robin.mason@ahcpub.com between 8:30 a.m. and 4:30 p.m. ET, Monday-Friday.

Statement of Financial Disclosure

In order to reveal any potential bias in this publication, and in accordance with Accreditation Council for Continuing Medical Education guidelines, we disclose that Ms. Ball serves as a consultant to Steris Corp, IC Medical, and AMT-Coherent (Canada), is a stockholder of Steris and SLT, and is on the speaker's bureau of AORN. Dr. Hoffman is involved in research with an NIH-funded grant that has no industry support. Dr. Pierson is a consultant to SeQual and Lynntech and is on the speaker's bureau of GlaxoSmithKline, Boehringer-Ingelheim, 3M, and Bayer. Dr. Rubenfeld is a paid consultant to Eli Lilly and has received educational grants from Byk-Gulden and Bayer in his name to the University of Washington. Drs. Baigorri, Durbin, Hess, Johnson, and O'Keefe report no consultant, stockholder, speaker's bureau, research, or other financial relationships with companies having ties to this field of study. Drs. Crawford, Gladwin, Nanavaty, and Takezawa did not return a 2002 financial disclosure form.

Special Feature

Analgesic Considerations in the Critically Ill and Injured Patient

By Charles G. Durbin, Jr., MD

Pain is receiving increased attention from hospital regulators, public entities, and patients. Inadequate pain relief is often reported as a source of

dissatisfaction with the health care experience. New standards suggest that pain in hospitalized patients be assessed frequently, to the extent as to be considered the "fifth vital sign" along with pulse rate, blood pressure, respiratory rate, and temperature. While pain management is essential to good care, pain is a subjective experience, something that is difficult to quantitate and especially challenging in the critically ill or injured patient. Opiates (opioids) are the mainstay of treatment of most cases of severe pain. There are a number of significant problems from use of opiate medications in the critically ill, especially when they are used as continuous infusions for sedation. Expanded understanding of pain mechanisms and application of specific techniques used in the operating room to the ICU has contributed to improved patient outcome from pain management in these challenging patients in this difficult environment. In this review I consider some ideas for pain management that apply to the critically ill and injured patient, areas that are often overlooked in more general reviews.

Pain and Agitation

Agitation is a common condition in the critically ill. More than 70% of ICU patients experience some degree of agitation during their ICU stay.[1,2] Altered mentation, drug use, as well as the underlying disease, often render ICU patients unable to comprehend the purpose of the therapies or monitoring devices that are a normal part of their care. The causes of agitation in the ICU are numerous. Medical and surgical conditions resulting in ICU admission may by themselves trigger confusion and agitation; for example, sepsis and the systemic inflammatory response syndrome (SIRS) often alters mentation and produces agitation. Other issues resulting in agitation include the discomfort associated with endotracheal intubation, mechanical ventilation, therapeutic surgical and diagnostic procedures, injuries, anxiety, sleep deprivation, and delirium.[3]

Agitation itself can have deleterious consequences in the critically ill, including interfering with effective mechanical ventilation, causing acute myocardial stress and failure, and aggravating cerebral ischemia.[4,5] Agitated patients are often unable to cooperate with diagnostic evaluations (ie, pain assessment), and may interfere with the performance of therapeutic procedures. Of particular importance is the self-removal or disruption of devices used for the diagnosis, treatment, or monitoring of the critically ill. This occurrence may cause injury or death, increase length of stay, and increase costs.[6,7] Patient agitation frequently contributes to the stress and discomfort experienced by family and friends, and may affect overall satisfaction with health care delivery.[8]

Treatment of Agitation and Use of "Chemical Restraints"

In many ICU patients, agitation is a major clinical problem. While classic treatment of agitation consists of identification and elimination of its cause, due to the significance of uncontrolled behaviors associated with agitation in these patients, restraints or pharmacologic agents are often needed to prevent harm prior to specific therapies. In fact, agitation associated with delirium is so common that it could be considered a disease or condition in its own right. Indiscriminant use of physical and chemical restraints is rightfully under attack by regulatory agencies. Confusion exists in the ICU surrounding use of restraints. While the same devices and drugs may be used, these are used "therapeutically" in the ICU, not to reduce the need for careful observation and attention by caregivers. As with chemical and physical restraints used elsewhere, appropriate patient assessment, frequent close observation, and time-limited orders in the ICU will help prevent unnecessary limitation of liberty and morbidity.

Pharmacologic restraints are those medications that are primarily used to control extreme behavior emergently or to restrict the patient's freedom of movement. Under this definition, a number of pharmaceutical agents commonly used in the ICU could be included in this category. Among them are analgesics, particularly opioid analgesics, sedative agents, particularly benzodiazepines, neuroleptic agents and other major tranquilizers, dissociative agents, and neuromuscular blocking agents. Since most agitated patients in the ICU are treated with one or more of these medications, some people contend that these patients are having chemical restraints applied. The usual goal of therapy with these agents is to treat the underlying cause of the patient's agitation, and not to simply prevent the patient's movements. The use of these therapeutic modalities should not be considered synonymous with application of chemical restraints, even though an expected outcome of the therapy will be a decreased level of inappropriate movement and greater cooperation with other needed therapies. Use of these pharmacologic treatments (other than neuromuscular blockers) is analogous to the use of oxygen in treating an agitated patient who is hypoxic. Thus, the use of sedatives, analgesics and neuroleptics in agitated ICU patients is often an appropriate therapy rather that a chemical restraint.

The primary goal in using analgesics is the reduc-

tion of pain; sedative agents, the relief of anxiety; and neuroleptic agents, the normalization of thought processes. The appropriate use of these medications during treatment of the agitated patient will not only alleviate pain and anxiety, but will also ameliorate the physiological derangement engendered by the underlying disorder. Thus, these agents in the agitated patient are considered as alternatives to physical and chemical restraints, rather than chemical restraints themselves.

Neuromuscular Blockers and Sedation

Neuromuscular blockers should never be used solely to restrain a patient but only as part of a therapeutic plan. For instance, muscle relaxants may be a necessary part of a low tidal volume ventilation plan with permissive hypercapnia. Sedation and analgesia must also be part of the therapeutic medication plan. The analgesic and sedative medications are more difficult to titrate to appropriate end points if the patient is paralyzed.

Sedation vs. Analgesia

While I wish to confine this discussion primarily to analgesia, some analgesics are used for sedation and often sedatives are used in conjunction with analgesics. Opiates, the most commonly used analgesics in the ICU, are often inappropriately used for their sedative side effects. This is true mostly in poorly responsive, nonverbal, and delirious patients in whom it is anticipated that pain is an expected consequence of therapy or injury. Clinician belief that the patient is in pain drives therapy in many of these cases. Since opiates are well tolerated hemodynamically, they are often used for sedation in agitated patients who may or may not be in pain. Several are short acting (fentanyl), and all opiates may be reversed with a specific antagonist (naloxone) should inadvertent overdose occur. If the patient remains agitated despite a bolus of what is expected to produce adequate analgesia, then small doses of a drug in a different category should be titrated in order to achieve the desired sedation. This approach, although not absolutely perfect, should produce a low incidence of drug induced delirium and inappropriate opiate dependence.

Opiates: Good, Bad, and Ugly

Continuous infusion of opiates in the critically ill and injured patient is common. When sedation or treatment of agitation is the goal, often this is the wrong approach. Bolus dosing helps prevent overdose and tolerance. Analgesia should be measured with a visual or numerical analogue scale and drug dosages titrated or administered to achieve an acceptable reduction in or level of severity. If patients cannot cooperate with a pain assessment process, it is dangerous to place them on a continuous infusion of opiate. Because tolerance to the effects of opiates occurs rapidly, especially the sedative side effects, the dose needs to be increased frequently to achieve the same initial effect. If patients can be evaluated with a visual analogue scale, there is little risk of inappropriate drug escalation. There is no ceiling effect on most opiates and the dose can be advanced until the desired level of analgesia is achieved. If a patient is maintained on the same continuous infusion rate for a period of days, it is not likely that pain is the reason that the opiate drip is being used.

The routine use of continuous opiate infusions to provide sedation is a practice that should be abandoned. Patients rapidly develop tolerance. A major problem with using opiates is that painful withdrawal symptoms will occur when opiate is discontinued. Other problems and side effects of the opiates are listed in Table 1. After prolonged continuous infusion (2-3 days), a patient must be slowly withdrawn from these agents to avoid these extremely unpleasant and potentially dangerous symptoms. Length of stay and cost of care are greater with continuous infusions.[9,10] It is better to not start the drip in the first place than to have to treat the withdrawal syndrome that follows removal.

A more logical approach to sedation in patients without severe pain is to use a nonopiate analgesic (if necessary) and a sedative agent. There are sedative scales that can be used to assess the degree sedation and one of these should be employed to avoid over use and to document the success of the therapy. A typical sedation scale is shown in Table 2. Benzodiazepines are the agents of choice for sedation in the crucially ill due to their lack of organ toxicity, lack of cardiovascular effects, predictable effects, and reduction of memory formation. They may cause disorientation and confusion in some patients. They do accumulate in the body and a withdrawal syndrome is now recognized. Symptoms are usually mild with agitation and anxiety being common. Less frequently patients will experience profound withdrawal symptoms, which include: agitation, anxiety, panic, and even seizures in some cases. Withdrawal symptoms can be minimized and seizures prevented by slowly withdrawing the benzodiazepine over a period of weeks. Benzodiazepines can be given by bolus or continuous infusion. Midazolam, a short act-

ing agent, is often administered by continuous infusion, titrating the infusion rate to signs of agitation or complaints of anxiety.

Propofol

A better choice for sedation may be propofol. This agent is an anesthetic-amnestic drug dissolved in a fat emulsion. It has a short half-life, does not accumulate, and must be given by continuous infusion. At low infusion rates (10-30 µg/kg/min) it is primarily a sedative. Patients not receiving simultaneous opiates will be able to communicate. However, they are usually calm, often falling asleep when not stimulated. At higher dosage levels (eg, 50-200 µg/kg/min), general anesthesia is produced. The effects on hemodynamics are related to volume status and cardiac reserve. In general, blood pressure falls due to the reduced sympathetic tone resulting from loss of consciousness. Bolus doses of propofol often cause hypotension due to this mechanism as well as through a direct (although minor) cardiac depressive effect.

There are several other drawbacks and problems with propofol. It is an ideal bacterial growth medium. Bottles must be discarded after 12 or maybe 24 hours after being opened depending on the preservation technique, and deaths due to infusion of contaminated propofol have been reported. A major benefit of this drug is its short duration of action. Prolonged infusions, for peri-

Table 1

Problems With Opiates When Used for Analgesia

Problem	Comments	Treatments
Respiratory depression	Impaired CO_2 response—always preceded by CNS depression, including somnolence and cognitive impairment	1. Dose-dependent effect; use lowest effective dose 2. Not a problem with mechanical ventilation although rate may need adjustment 3. Give naloxone (Narcan) only for patients who are not breathing adequately or have become progressively obtunded after the opioid has been stopped. 4. Naloxone should NOT be given if patient is arousable and the peak opioid level has been reached. 5. If patient requires naloxone, the adult dose is 0.1 mg to 0.4 mg every 2-3 min. Half life about 20-30 min. 6. For infants and children, the dose is 5-10 µg/kg every 2-3 min. 7. In ICU patients, naloxone can cause hypertension, arrhythmias, pulmonary edema, and seizures.
Constipation	Occurs in 40-70% with chronic use	1. Prophylactic laxatives and stool softeners should be used. 2. If no bowel movement by 72 h, rule out impaction. If no impaction, use enemas. Note: Constipation is the most common side effect with the continuous use of opioids, and the only side effect to which the patient does not develop tolerance. The patient who is on a standing opioid regimen should always be on a regular laxative regimen.
Urinary retention	Occurs in 15-70% following intrathecal/epidural administration	1. Indwelling catheter will prevent problem. 2. Consider alternate opioid agent. 3. Consider alternate route.
Sedation	Occurs in 2-60% of patients—tolerance usually develops	1. Use lowest effective dose. 2. Morphine is more sedating than fentanyl. 3. If sedation is a concern, eliminate other drugs that depress the CNS, consider addition of psychostimulant (eg, methylphenidate, dextroamphetamine, or caffeine) in adults.
Cognitive Impairment	Mild cognitive impairment is common; no data on prevalence of severe opioid-induced cognitive failure	1. Use lowest effective dose. 2. Eliminate adjuvant medications with CNS effects. 3. If necessary, consider use of neuroleptic agent, such as haloperidol, for symptomatic management in adults.
Nausea/vomiting	Occurs in 10-40% of patients—Incidence is higher following intrathecal/epidural administration.	1. Tolerance develops rapidly, so prophylactic antiemetics are not usually needed. 2. Consider use of antiemetic agent.
Myoclonus	Appears to be dose-related and seen at very high levels	1. Use lowest effective dose for analgesia. 2. Consider use of benzodiazepines.
Pruritus	Occurs in 2-10% of patients—incidence is higher following intrathecal/epidural administration	1. Consider alternate opioid agent. 2. Consider alternate route. 3. Consider administration of antihistamine. 4. Consider low-dose naloxone (approximately 2 µg/kg/h)

Table 2

Sedation Scale*

Level	Patient Response
1	Anxious, agitated, or restless
2	Cooperative, oriented, tranquil
3	Quiet, responds to verbal commands
4	Asleep, brisk response to forehead tap or loud verbal stimulus
5	Asleep, sluggish response to forehead tap or loud verbal stimulus
6	Unresponsive

** A sedation scale such as this can be used to assess and document the patient's degree of sedation.*

ods up to weeks, are still followed by rapid awakening when the drug is stopped. The major disadvantage is drug cost. This changes with patent protection and will not always be as much of a concern. Accumulation of lipids in the blood is possible with prolonged infusions at high rates, as is calorie overload. The rare association of propofol infusion and the development of fatal lactic acidosis is suspected, but not proven. Use of this agent in children is controversial. Tachyphylaxis does occur with propofol but rarely is more than a doubling of the rate needed to achieve the same sedation end point.

Midazolam, a short-acting benzodiazepine, has been suggested as an alternative to propofol. After prolonged continuous administration or repeated doses, its duration of action increases. Wake up time is prolonged when compared to propofol. When used as a continuous infusion, level of consciousness cannot be used as the end point as with propofol. The benzodiazepine effects on mood (sedation, anxiolysis) and the prevention of memory formation are useful properties of this class of drugs. However, these beneficial effects can easily be achieved with bolus administration of midazolam or a less expensive, longer acting agent such as lorazepam.

Nonopioid Analgesic Medications

One of the frequently used analgesic classes outside the ICU, nonsteroidal anti-inflammatory drugs (NSAIDs), is used to treat moderate pain. NSAIDs work by affecting the hypothalamus and by inhibiting the production of inflammatory mediators, primarily prostaglandins, at the peripheral site of the painful stimulus. The salicylates are the oldest member of this class, and have been known for over 100 years for their effects as antipyretics. Aspirin decreases the synthesis of prostaglandin by irreversibly inhibiting both of the cyclooxygenase enzymes, COX-1 and COX-2. COX-1 is primarily located on tissues, including blood vessels, the kidney, and gastric mucosa, while COX-2 is primarily associated with inflammation. Unlike aspirin, other NSAIDs reversibly inhibit these enzymes, and may have fewer or less severe side effects. Selective COX-2 agents appear to have similar efficacy and a better safety profile.

Gastric irritation and ulceration are major problems with administering NSAIDs. Renal injury can result from prolonged use and high dosage of these medications. They also inhibit platelet aggregation; and this compounds the problem of gastrointestinal bleeding. The anti-platelet effects are used therapeutically following or to prevent cardiac thrombosis. Aspirin use in childhood febrile illness has been associated with an increased incidence of Reye's syndrome, an often-fatal rise in intracranial pressure with massive hepatic dysfunction.[11,12] The use of aspirin in critically ill children is controversial. Allergic reactions, although usually minor, to this class of drugs, are common. Rashes, urticaria, angioneurotic edema, asthma, and anaphylaxis can also occur.

Acetaminophen, although a weak inhibitor of the cyclooxygenase system, has no significant anti-inflammatory effects, although it is effective in relieving mild-to-moderate pain. It does not inhibit platelets or cause gastric ulcers. In large doses, greater than 4 g/d, it can cause lethal hepatic necrosis.

While all the NSAIDs are rapidly absorbed from the gastrointestinal tract, the effects of administration by this route are unpredictable in the critically ill. One NSAID, ketorolac, is available in an IV form. It is as effective as others in this group, and probably no safer. Recently, selective COX-2 inhibitors have been released into clinical practice. They should have fewer gastrointestinal side effects and fewer effects on platelet and white blood cell function. Their role in treatment of pain in the critically ill patients is yet to be determined. Patients with sulfa allergies and asthma need to be cautious with these as well as all of the NSAIDs.

Critically ill patients reporting moderate to severe pain who can receive one of these agents should have a baseline administration of a NSAID. They may also require intermittent administration of an opiate based on their visual analogue pain scale changes.

Regional and Neuraxial Anesthesia

Another approach to pain management is to block or modify the pain transmission pathway. This can be done with local anesthetics delivered in a variety of ways. The most common technique is epidural administration. Continuous epidural infusions for analgesia have

improved postoperative and traumatic pain treatment. There is even evidence that patient survival is improved with epidural infusions, especially in the very ill.[13-15] The quality of the analgesia and the ability to eliminate pain in many body areas is superior with local anesthetic infusion when compared to systemic analgesics. Minimal effects on normal sensory and motor function can be achieved with very dilute local anesthetics. Addition of opioids to the mixture permits even less local anesthetic to be infused. If sympathetic blockade produces unacceptable hypotension, local anesthetics can be eliminated completely with significant analgesia obtained from narcotic infusion alone.

Pain modulation from epidural opioids occurs at receptors at the spinal cord segmental level. In fact, even systemic opioids probably have their major analgesic affects at the spinal cord level. The central nervous system effects are primarily modification of the pain perception. The technique of epidural catheter placement in the critically ill is complicated due to mental status changes, patient positioning, and coagulopathy. The major side effects and concerns of providing epidural analgesia in the critically ill are listed in Table 3.

Spinal placement of narcotics is an alternative to epidural analgesia. The technique is less complicated, but analgesia is limited since no catheter is left in place. When morphine (eg, 100-300 µg) is placed in the lumbar intrathecal space, analgesia for up to 24 hours is usually obtained.

If major neuraxial analgesia is contraindicated or technically difficult, peripheral nerve block may eliminate pain and reduce the need for systemic analgesics.

Summary and Conclusions

Opioids are poor analgesics. They mainly alter pain perception and cause sedation. Opioid infusions are often used for sedation in the critically ill patient. Tolerance to the sedative effects of opiates leads to increased infusion rates. Withdrawal of opiate infusions leads to severe, painful symptoms and must be done slowly. Prolonged ICU stay can result as a consequence of these inappropriate opiate infusions. Opioids should be give intermittently in response to reported pain.

Sedatives, such as propofol or the benzodiazepines, are alternatives to opiates for sedation. Sedatives and analgesics in delirious patients are not "chemical restraints": they are treatment for the delirium.

Pain should be measured and documented in the critically ill. The use of analgesics other than opiates should be considered to decrease the patients' reported pain. Epidural, spinal, and regional analgesia with local anesthesia are reasonable and possibly superior alternatives for pain relief in some critically ill patients and may actually improve survival as well as the quality of analgesia. ■

References

1. Fraser GL, et al. Frequency, severity, and treatment of

Table 3

Technical Issues, Concerns, Side Effects, and Complications from Epidural and Spinal Analgesia

Placement	
Patient positioning	Sitting is best, lateral possible
Level of consciousness	Patient must be awake and responsive to avoid nerve root injury (pain on injection) identify correct placement
Coagulation	Normal coagulation is mandatory including platelet count at least 50K, INR < 1.4 if catheter to be inserted or removed
Drug Considerations	
Local Anesthetics	
Motor weakness	Concentration dependent
Numbness	Concentration dependent
Hypotension	Concentration and dose dependent
Difficulty diagnosing epidural hematoma	The severe back pain from an epidural hematoma may not be apparent in a heavily sedated patient.
Opioid Side Effects	
Respiratory depression	Equal or less than systemic opioids
Reduced GI motility	Greater than systemic opioids
Nausea and vomiting	Equal to systemic opioids
Difficult micturition	Greater than systemic opioids
Pruritus	Much greater than systemic opioids

agitation in young versus elderly patients in the ICU. *Pharmacotherapy*. 2000;20:75-82.
2. Ely EW, et al. Evaluation of delirium in critically ill patients: validation of the confusion assessment method for the intensive care unit (CAM-ICU). *Crit Care Med*. 2001;29:1370-13791.
3. Treggiari-Venzi M, et al. Overnight sedation with midazolam or propofol in the ICU: Effects on sleep quality, anxiety, and depression. *Intensive Care Med*. 1996;22:1186-1190.
4. Mazzeo AJ. Sedation for the mechanically ventilated patient. *Crit Care Clin*. 1995;11:937-955.
5. Bruder N, et al. Energy expenditure and withdrawal of sedation in severe head-injured patients. *Crit Care Med*. 1994;22:1114-1119.
6. Fraser GL, et al. The frequency and cost of patient-initiated device removal in the ICU. *Pharmacotherapy*. 2001;21:1-6.
7. Boulain T. (Association des Reanimateurs du Centre-Ouest). Unplanned extubations in the adult intensive care unit: a prospective multicenter study. *Am J Respir Crit Care Med*. 1998;157:1131-1137.
8. Osterman ME, et al. Sedation in the intensive care unit: A systematic review. *JAMA*. 2000;283:1451-1459.
9. Kollef MH, et al. The use of continuous i.v. sedation is associated with prolongation of mechanical ventilation. *Chest*. 1998;114:541-548.
10. Kress JP, et al. Daily interruption of sedative infusions in critically ill patients undergoing mechanical ventilation. *N Engl J Med*. 2000;342:1471-1477.
11. Hurwitz ES, et al. Public Health Service study of Reye's syndrome and medications: Report of the main study. *JAMA*. 1987;257:1905-1911.
12. Forsyth BW, et al. New epidemiologic evidence confirming that bias does not explain the aspirin/Reye's syndrome association. *JAMA*. 1989;261:2517-2524.
13. Yeager MP, et al. Epidural anesthesia and analgesia in high-risk surgical patients. *Anesthesiology*. 1987;66:729-736.
14. Ackerman WE 3d, et al. Beneficial effect of epidural anesthesia on oxygen consumption in a parturient with adult respiratory distress syndrome. *Southern Med J*. 1993;86(3):361-64.
15. Kirsch JR, et al. Preoperative lumbar epidural morphine improves postoperative analgesia and ventilatory function after transsternal thymectomy in patients with myasthenia gravis. *Crit Care Med*. 1991;19(12):1474-1479.

CME/CE Questions

15. A "sigh" breath during pressure support ventilation in patients with ARDS:
a. reduces cardiac output and causes hypotension in most patients.
b. improves compliance and PaO_2.
c. improves survival compared to delivering no sigh.
d. increases barotrauma and volutrauma.
e. improves PaO_2 only in ARDS from sepsis.

16. Alveolar recruitment maneuvers:
a. are mandatory when using lung protective therapy for ARDS.
b. can be provided with a periodic "sigh."
c. are effective in improving survival from ARDS.
d. should be used with tidal volumes greater than 10 cc/kg.
e. will only improve PaO_2 in patients with normal pulmonary compliance.

17. Which of the following statements about opiates is true?
a. They are best given as a continuous infusion for sedation.
b. They are best given a bolus for pain relief.
c. They are never appropriate in agitated patients.
d. They are usually withheld unless the patient is receiving continuous ventilatory support.
e. Their discontinuation is always associated with severe withdrawal symptoms.

18. Epidural analgesia is:
a. contraindicated if the platelet count is < 150,000.
b. not possible if the patient is turned prone.
c. associated with improved survival in the very ill.
d. no better than a nonsteroidal analgesic following surgery.
e. associated with a 5-10% risk of paralysis if placed in a sedated patient.

CME/CE Objectives

After reading each issue of *Critical Care Alert*, readers will be able to do the following:

- Identify the particular clinical, legal, or scientific issues related to critical care.
- Describe how those issues affect nurses, health care workers, hospitals, or the health care industry in general.
- Cite solutions to the problems associated with those issues.

In Future Issues:

Thoracentesis in the Medical ICU

CRITICAL CARE Plus

EXPANDING YOUR FOCUS IN INTENSIVE CARE

Respiratory Isolation Measures Underused, Researcher Finds

Administrative, engineering, personal controls are all necessary

By Julie Crawshaw, CRC Plus Editor

Despite measures taken following the resurgence of tb cases in the late 1980s and early 1990s, many health care workers still poorly understand respiratory isolation procedures, says Kevin P. Fennelly, MD, MPH, researcher at the Center for Emerging Pathogens of the New Jersey Medical School

Because that resurgence was successfully quashed, today's health care workers are less likely to have such expertise because they have less clinical experience with the disease, adds Fennelly. The decrease in TB incidence to historically low levels also creates problems for public health officials working to sustain existing disease control programs and systems because low incidence doesn't indicate the extent of the efforts required for TB control.

Fennelly notes that part of the impetus for the Centers for Disease Control and Prevention (CDC) in-progress revision of its 1994 "Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-Care Facilities"[1] is that a good deal of research has been done since the original document.

"More importantly, there's been a realization that the document was written at a time when there appeared to be some uncertainties in the risk of transmission," he says. Fennelly's facility is one of three National Tuberculosis Model Centers funded by the CDC that offer training curricula, course materials and technical assistance.

Basically, Fennelly says, controlling *Mycobacterium tuberculosis* transmission in the ICU boils down to three categories: administrative, engineering and personal respiratory protection.

Administrative Controls Most Important

Administrative controls entail having a system in place so that health care workers are well educated about TB and have a high index of suspicion, Fennelly says. The most important of these is a having a set of policies and procedures for assuring rapid identification and treatment of potential TB-carrying patients.

Patients suspected of having TB should be placed in respiratory isolation in an airborne infection isolation room without delay, Fennelly says, and sputum specimens and other respiratory secretions sent for smears immediately. He notes that there has been a huge problem because results of such diagnostics can come back months after the patient has died from HIV and TB, leaving ICU personnel ignorant of their risks in the interim.

According to recommendations prepared by John A. Jereb, MD, for the CDC's Division of Tuberculosis Elimination, most low-incidence state TB programs find it hard to assure reports if private medical providers and hospitals send specimens to local hospital laboratories or to out-of-state contract laboratories for testing. Jereb points out that state TB labs require substantial fixed facility and personnel investments that do not decrease even when the TB burden becomes very low.

This situation is similar in the remainder of the country. It puts the TB program at a disadvantage because these laboratories might fail to report critical results promptly to the health department. They also might discard *M tuberculosis* isolates before subsequent testing, such as DNA fingerprinting, can be done.

For instance, 21 TB cases reported in a small Maine community from 1989-1992 were traced back to a source case diagnosed after an eight-month delay. Fennelly describes a case reported by Anthony Tatandaro, MD, in which an ICU patient whose initial sputum smear was negative infected more than 75% of ICU personnel in attendance after the patient was intubated, mechanically ventilated, and had a bronchoscopy procedure. That particular case was notable because the ICU was poorly ventilated, Fennelly notes, adding that the best engineering protection against TB is circulating bad air out and fresh air in. "Some hospitals have used high efficiency particulate air (HEPA) filters, but they are very expensive and unproven," Fennelly says.

Old data that say that ultraviolet germicidal irradiation (UVGI) decreases the amount of viable organisms in the air, and that is supported by yet-to-be-published research in which Fennelly collaborated. It suggests that a top-of-the-line UVGI system works well.

However, the best engineering control is still pollution ventilation with at least six and preferably 12 air changes per hour, Fennelly says. "We have a lot of theoretical modeling and laboratory-based work, but actual field work is impossible," Fennelly notes. "You can't run an experiment in which hospital A has protection against TB but hospital B doesn't."

Personal Respiratory Protection Remains Controversial

Personal respiratory protection is a most controversial measure, Fennelly says. Personal respirators are controversial—many people think they are overkill. "There's a certain tension between traditional infection control practitioners and some of the environmental occupational health people who are relative newcomers to this field," Fennelly observes. "I think that's understandable when you realize that TB is only sporadically infectious."

Fennelly's main research interest is determining infectiousness of patients. "Many of us have been exposed to TB patients and not become infected," he notes. "That's probably due as much to the great variability among patients as sources of infection as it is to the variability and susceptibility of individuals who become infected.

Fennelly's research group, which is funded to study post-determinants of infectiousness, is currently examining the strength and frequency of cough and viscoelastic properties of secretions to learn which parameters are the most important. Some of the group's preliminary data suggest that N95 respirators are to be recommended. One objection, Fennelly says, is that in most locales N95s cost 75 cents apiece. Though research shows that the most dangerous patients are the ones not yet identified or being treated, Fennelly says that personal respirators may be overkill with patients being treated in isolation rooms with 6-12 air changes an hour.

"I fall down on both sides of the personal respiratory question," Kennelly says. "We know that if you are treating a patient in isolation who's been on treatment for a while the decrease in risk from personal protection is very little, but with patients not yet being treated who have a procedure such as a bronchoscopy, the risk is tremendous. With patients undergoing tracheal intubation or cough-producing procedures such as sputum induction or bronchoscopy, the staff should definitely wear some type of respiratory protection." (Contact information: Kevin P. Fennelly, [973] 972-8697.) ■

Reference

1. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health care facilities. *MMWR Morb Mortal Wkly Rep*. 1994;43:13.

Special Beds: Boon to Patients or High-Profit Boondoggle?

Continuous rotation appears beneficial, but it's certainly not cheap

Several medical manufacturers have made huge amounts of money by renting or selling specialized beds that provide continuous lateral rotation therapy (CLRT) to prevent complications of immobility associated with bed rest such as atelectasis, lower respiratory tract infection, and pneumonia. Manufacturers say these beds improve outcomes in critically ill patients and their claims appear to be substantiated by research to some degree.

Using former ICU nurses in their marketing force has undoubtedly helped companies convince ICU nursing staffs that critically ill patients need these special and expensive beds. Paula Jurewicz, RN, MS, Nurse Manager for the Intensive Care Unit at Yale-New Haven Hospital, acknowledges that ICU nurses were indeed the driving force behind the hospital's purchase of 96 TotalCare SpO2RT™ Pulmonary Therapy System beds earlier this year. The beds, manufactured by Hill-Rom of Indiana, provide continuous lateral rotation therapy, feature percussion and vibration therapy and have a

turn-assist feature that makes it easier for nursing staff to position patients for back care, linen changes, and routine nursing procedures.

Eighty-six of Yale—New Haven's special beds are in the adult ICU, with the remaining 10 are on floors with pulmonary patients.

Jurewicz says the primary reason for the purchase was not advocacy by the nursing staff, but simply that the hospital's ICU beds were old and needed to be replaced, "We knew we had to upgrade our beds and we wanted to reduce rental costs," Jurewicz says. "Sometimes we've had as many as 80 rental therapy beds on our floors at one time. "We felt by purchasing the Hill-Rom units we'd be reducing operating expenses by using a capital cost."

Expect to Pay Either Way

Buying special beds may indeed be more cost-effective in the long run than renting them, but the initial outlay is steep. The beds purchased by Yale-New Haven cost about $36,000 when fitted with the three modules that provide the various therapies. Hill-Rom declined to provide specific price information to anyone other than actual purchasers and a spokesperson said that hospitals belonging to a general purchasing group can get a better deal.

However, staff at Yale-New Haven, a 944-bed primary teaching hospital for the Yale University School of Medicine, appear pleased with the new equipment. Michael Parisi, PT, operations director for rehabilitation services and respiratory care, says he's happy with the beds thus far. One of the biggest advantages Parisi sees is that the beds convert easily into chairs, making it much easier for patients to get to their feet.

"The nursing staff don't have to have a special lifting team and can mobilize patients easily, and can fulfill physicians' "out-of-bed" patient orders by pushing a button," Parisi says.

The Body of Evidence

Nancy Price, senior product manager of pulmonary and ICU therapy for special bed manufacturer Kinetic Concepts, Inc., in San Antonio, TX, says that the body of evidence supports her company's claims that special beds improve outcomes. More than 50 studies have been done on rotational therapy, and most of these involved rotating the patient laterally to greater than 40°, the minimum angle defined by the CDC as necessary to achieve a positive pulmonary outcome, she says.

Price's company manufactures a special bed originally developed in the mid-1960s by Francis Keane, MD, an Irish physician who liked to tinker and wanted to find a way to reduce patients' pressure ulcers. Keane believed a very slow angular rotation redistributed pressure. Jim Liniger, an entrepreneurial emergency room physician now at Kinetic Concepts, became a distributor for Keane and later purchased the U.S. distribution rights for the product.

However, some research on rotational therapy raises questions about outcomes improvement between patients manually rotated and those on rotating beds. One study showed that nursing staff provided more respiratory care to patients who had pneumonia and were on the oscillating bed than they did to patients with pneumonia who received standard care.[1]

One possible explanation for the disparity in nursing attention is that the oscillating bed enabled patients to loosen mucus more frequently, which in turn required nurses to provide more suction to remove it.

Another study[2] found that 22% of the 51 patients treated on the standard ICU bed acquired pneumonia as compared to only 6% of patients treated with continuous oscillation.

A study[3] that used KCI therapy beds and prone positioning to test oxygenation and hemodynamics in patients with ARDS found both the beds and the prone positioning improved PaO_2/FiO_2 and intrapulmonary shunt fraction after patients received inhaled nitric oxide, and after the first 72 hours of positioning therapy.

Weighing the cost of CLRT against benefits to patient outcomes has also been studied.[4] In one example that used Kinetic Concept beds, the authors found the cost of bed rental was offset by shortened ICU stay. Researchers suggested that patients who received CLRT for one to four days had decreased duration of both mechanical ventilation and ICU stay compared to patients on standard beds.

The researchers also reported that patients treated with CLRT needed fewer antibiotics and experienced much lower rates of lower respiratory infection. However, the study authors also said such results may not be generalizable to other patient populations and suggested that future studies stratify subjects by underlying disease or degree of dysfunction.

For more information, contact Paula Jurewicz at (203) 688-2406; Michael Parisi at (203) 688-2251; Nancy Price at (210) 255-6037; and Hill-Rom at (800) 445-3730. ■

References

1. Traver G, et al. Continuous oscillation: Outcome in critically ill patients. *J Crit Care*. 1995;10:97-103.
2. deBoisblanc BP, et al. *Chest*. 1993;103:1543-1547.
3. Staudinger T, et al. *Crit Care Med*. 2001;29(1):51-56.

4. Whiteman K, et al. Effects of continuous lateral rotation therapy on pulmonary complications. *Am J Crit Care*. 1995;4:133-139.

Unsanitary Conditions Lead to Shakeup in Kansas City

A hospital in kansas city, mo, is undergoing an inquiry after a report that maggots were found in the noses of ICU patients.

The incident happened 4 years ago but only came to light recently in research published by Richard Beckendorf, MD, a physician at the Kansas City Veterans Affairs Medical Center where it happened, and Stephen Klotz, MD, who was the hospital's chief of infectious disease at the time and now is an infectious disease specialist at the University of Arizona Health Sciences Center.

Beckendorf, Klotz, and colleagues reported on the incident in a recent journal article that drew significant attention because the effect on patients was so disturbing.[1] They report that the Kansas City Veterans Affairs Medical Center "experienced an infestation of mice combated in part by broadcasting poisoned baits. Months later, there was an invasion of flies into the hospital, and two comatose patients in an intensive care unit contracted nasal maggots."

The incident did happen, but some facts are in dispute, according to Glenna Greer, a spokeswoman for the hospital. Beckendorf and Klotz report that adult flies were trapped and maggots were removed from the nose of the second patient. Subsequent examination determined that they were green blowflies (*Phaenicia sericata*). The journal report blames the incident on poor housekeeping practices—the result of staff cuts that made it impossible for workers to adequately clean some parts of the facility.

A Mouse Infestation

"Recent downsizing of hospital personnel had led to the unintended and unrecognized loss of housekeeping services in the canteen food storage areas," they wrote. "A mouse infestation of the hospital occurred, with the epicenter in the canteen area. This was initially addressed by scattering poisoned bait and using rodent glue boards. The result of such treatment was the presence of numerous mouse carcasses scattered throughout the building, attracting the green blowfly. Adult gravid female flies trapped in the new intensive care unit (where mice were not present) laid eggs in the fetid nasal discharge of 2 comatose patients."

To make matters worse, the problem went on for 2 months after the first discovery. The first patient was found with maggots on July 22, 1998, and died 2 days later of unrelated causes. Maggots were found on the second patient on Sept. 30, 1998.

Greer confirms that there was a mouse infestation, which in turn led to the fly problem. But she disputes some allegations in the journal study, including anecdotes about mice being so pervasive that they ran over the feet of executives during a boardroom meeting. And she says rumors that nurses kept some mice as pets are false. Greer says the mice initially took up residence in a food storage area serving the employee canteen, but she denies charges that the infestation was made possible by staff cuts that diminished housekeeping. She also suggests that many of the mice were displaced from a construction site next door to the hospital and just fled to the nearest building.

Beckendorf says the ICU problem was solved with live trapping of mice and removal of carcasses, which eliminated the fly infestation. But that wasn't the end of the nightmare.

"The cause-and-effect nature of the mouse carcasses and flies was underscored a year later when an outbreak of *P sericata* occurred in the operating department and was linked to the presence of mouse carcasses on glue boards not removed the previous fall," he says. "Hence, the disruption or loss of one vital link in hospital organization [in this case, housekeeping support] may lead to an unintended and bizarre outcome."

One question was asked by many observers after the Kansas City problem came to light: How could the clinicians not know that flies were laying eggs in their patients? One clue is the short time between when eggs are laid and when maggots emerge. For the green blowfly, this period is short, between 24 and 48 hours. Greer says the ICU nurses discovered the maggots during routine care and were removed before causing any tissue damage.

The situation remained under the radar until the journal article focused publicity on the hospital. Then Secretary of Veterans Affairs Anthony J. Principi reassigned two senior administrators at the hospital and ordered independent reviews of the facility and launched two investigations. ■

Reference

1. Beckendorf R, et al. Nasal myiasis in an intensive care unit linked to hospitalwide mouse infestation. *Arch Intern Med*. 2002;162:638-640.