CRITICAL CARE ALERT®

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

Thomson American Health Consultants Home Page— www.ahcpub.com

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

THOMSON AMERICAN HEALTH CONSULTANTS

INSIDE

Does Lung-Protective Ventilation Require More Sedation?

ABSTRACT & COMMENTARY

Synopsis: *In this in-depth examination of 111 patients at a center in the original ARDS Net low-tidal-volume study, patients managed with 6 mL/kg or less did not require more sedation during the first 48 hours than those managed with tidal volumes of 12 mL/kg.*

Source: Cheng IW, et al. *Crit Care Med*. 2005;33(1):63-70.

San Francisco General Hospital and Moffitt-Long Hospital of the University of California, San Francisco, were participating sites in the well-known ARDS Net study of low vs traditional tidal volumes in the management of acute lung injury (ALI), and acute respiratory distress syndrome (ARDS).[1] Cheng and colleagues at these institutions collected information on hemodynamics, vasopressor use, fluid balance, diuretics, and the use of sedatives and neuromuscular blockade—data in addition to what was required for the larger ARDS Net study—on their 111 patients during the initial 48 hours following entry. Patients were randomized to ventilator tidal volumes of 6 or 12 mL/kg predicted body weight, with reductions if needed to keep end-inspiratory plateau pressures below the designated limits for the 2 groups. Except for ventilator management, which was controlled by protocol, all patients were managed at the discretion of their primary teams.

The groups were not different by any of the demographic or other descriptors recorded at study entry, except that the mean minute ventilation was higher in the patients randomized to receive lower tidal volumes. Hemodynamic variables (systolic, diastolic, and mean blood pressures, plus heart rate) were the same in the 2 groups, both immediately after randomization and during the 48-hour study period. There were no differences in the use of supportive therapies, including vasopressors, intravenous fluids, or diuretics. Similarly, there were no differences in body weight, urine output, or recorded fluid balance.

At the discretion of their physicians, the patients received fentanyl, propofol, midazolam, lorazepam, and/or morphine for sedation, either as intravenous boluses or as continuous infusions. There were no differences, either for the drugs individually or in the

EDITOR
David J. Pierson, MD
Pulmonary and Critical Care Medicine
Harborview Medical Center
University of Washington

ASSOCIATE EDITORS
Saadia R. Akhtar, MD, MSc
Pulmonary and Critical Care Medicine
Yale University School of Medicine

Francisco Baigorri, MD, PhD
Corporacio Sanitaria Parc Tauli
Sabadell, Spain

Kay Ball, RN, MSA
Perioperative Consultant/ Educator, K&D Medical, Lewis Center, OH.

Stephen W. Crawford, MD
Pulmonary Medicine
Naval Medical Center
San Diego, CA

Charles G. Durbin, Jr., MD
Department of Anesthesiology
University of Virginia

Dean R. Hess, PhD, RRT
Respiratory Care
Massachusetts General Hospital
Department of Anesthesiology
Harvard Medical School

Leslie A. Hoffman, PhD, RN
Department of Acute/Tertiary Care
School of Nursing
University of Pittsburgh

Karen Johnson, PhD, RN
School of Nursing
University of Maryland

James E. McFeely, MD
Medical Director Critical Care Units, Alta Bates Summit Medical Center, Berkeley, CA

Uday B. Nanavaty, MD
Pulmonary and Critical Care Medicine
Rockville, Maryland

Grant E. O'Keefe, MD
Department of Surgery
Harborview Medical Center
University of Washington

Gordon D. Rubenfeld, MD, MSc
Pulmonary and Critical Care Medicine
University of Washington,

Jun Takezawa, MD
Director of Emergency and Intensive Care Medicine
Professor, Department of Emergency Medicine

NOW AVAILABLE ONLINE!
www.ahcpub.com

aggregate, with respect to the use of these medications in the low- and high-tidal-volume groups. The number of patients who received neuromuscular blocking agents was variable but relatively small, ranging from 16% of patients in the large-tidal-volume group on day 1 to 4% of patients in the low-tidal-volume group on day 2, and there were no statistical differences between the groups in this respect.

COMMENT BY DAVID J. PIERSON, MD

In the ARDS Net trial, management of ALI and ARDS with tidal volumes of 6 mL/kg or less as compared to 12 mL/kg of predicted body weight, along with limitation of end-inspiratory static airway pressure to 30 cm H_2O or less, reduced overall mortality from 40% to 31%, with a number needed to treat in order to save a life of 11. Very few interventions studied in critically ill patients have effects that come close to this magnitude, and this benefit was achieved not through the use of some expensive new high-tech pharmacologic agent or medical device but simply by setting the ventilator's tidal volume control in a certain way. That's the good news. The bad news is that clinicians are not using this information in managing their patients. Several studies have documented that, at least in the first couple of years after the ARDS Net study was published, the large majority of patients with ALI/ARDS, even at participating centers, were still being ventilated with tidal volumes substantially larger than those shown to reduce mortality.[2-4]

Why should this be? Are there really ICUs and respiratory care departments in the United States where they don't yet know about lung-protective ventilation? I doubt it. However, there are a number of other possible reasons.[5] A major one is failure to make the diagnosis. When accepted, objective diagnostic criteria are deliberately sought, and, as was done for the ARDS Net study, many patients can be identified whose physicians have not diagnosed as having ALI/ARDS. In addition, some clinicians have been unduly influenced by initial criticisms of the ARDS Net study, despite vindication of its methods and results after extensive investigation. Others may succeed in convincing themselves that low-tidal-volume ventilation as used in that study is somehow not applicable to their patients. However, that *number needed to treat* figure (11 patients managed according to the ARDS Net protocol saves one life) is pretty compelling, and in the absence of good outcome evidence to the contrary (as opposed to extrapolations from short-term surrogate end points) the onus in 2005 would seem to be squarely on those who do not adopt this strategy or something very close to it.

Another potential reason why clinicians may be reluctant to adopt ARDS Net-style lung-protective ventilation is the impression that this strategy is sufficiently distressing to patients to require more sedation or even paralysis in order to be carried out effectively, and that these effects may in turn lead to prolongation of ventilatory support or other adverse effects. I must say that this has been my clinical impression. But is that impression correct? Not according to this study by Cheng et al, at least in the initial 48 hours. Their patients, who were part of the larger ARDS Net cohort, did not require more sedatives or more frequent paralysis when managed with low tidal volumes.

This paper makes the very important point that patients with ALI/ARDS can be ventilated according to best available evidence without increasing the administration of sedatives or muscle relaxants. In the area of sedation and paralysis, however, I believe there is enormous practice variation among different physicians,

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

VICE PRESIDENT/GROUP PUBLISHER: Brenda Mooney.

EDITORIAL GROUP HEAD: Lee Landenberger.

MANAGING EDITOR: Robert Kimball.

ASSOCIATE MANAGING EDITOR: Leslie Hamlin.

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.

Copyright © 2005 by Thomson American Health Consultants. All rights reserved. No part of this newsletter may be reproduced in any form or incorporated into any information-retrieval system without the written permission of the copyright owner.

Back issues: $40.

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: robert.kimball@thomson.com

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

Subscription Prices

United States

1 year *with* free AMA Category 1 credits: $269

(Student/Resident rate: $120)

Multiple Copies

Documents are available for multiple subscriptions. For pricing information, please call Steve Vance at (404) 262-5511.

Canada

Add GST and $30 shipping.

Elsewhere

Add $30 shipping.

Accreditation

Thomson American Health Consultants (AHC) designates this educational activity for a maximum of 25 hours in category 1 credit toward the AMA Physician's Recognition Award. Each physician should claim only those credits that he/she actually spent in the activity.

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.

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.

This CME activity is intended for the critical care physician. It is in effect for 36 months from the date of publication.

THOMSON AMERICAN HEALTH CONSULTANTS™

Questions & Comments

Please call **Robert Kimball,** Managing Editor, at (404) 262-5413 or e-mail at robert.kimball@thomson.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. Pierson is on the speaker's bureau of GlaxoSmithKline, Boehringer-Ingelheim, 3-M, Bayer, and Astra Zeneca. Dr. Rubenfeld is a consultant to Eli Lilly and is involved in research with the National Institutes of Health. Drs. Baigorri, Durbin, Hess, Hoffman, 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 2004 financial disclosure form. Thomson American Health Consultants accepts pharmaceutical sponsorship of some programs but only in the form of unrestricted educational grants that must meet all ACCME and ANCC requirements.

ICUs, and geographic areas. I have made rounds in ICUs in which patients with ARDS were kept completely motionless, often with neuromuscular blockade added to heavy sedation. I have also rounded in units in more than one country outside the United States in which apparently similar patients were receiving very little sedation and were awake. There is good evidence that, at least in this country, deliberate measures to decrease the amount of sedatives given to ventilated patients gets them off the ventilator and out of the ICU sooner than if these measures are not pursued.[6]

How the issue of sedation for patients with ALI/ARDS is approached remains largely a matter of local medical culture. However, the study by Cheng et al shows us that, however one chooses to titrate sedation in such patients, the use of lung-protective ventilation may not necessarily require greater quantities or the addition of paralytic agents. ■

References

1. The Acute Respiratory Distress Syndrome Network. *N Engl J Med*. 2000;342:1301-1308.
2. Rubenfeld GD, et al. *Am J Respir Crit Care Med*. 2001;163:A295.
3. Weinert CR, et al. *Am J Respir Crit Care Med*. 2003;167:1304-1309.
4. Young MP, et al. *Crit Care Med*. 2004;32(6):1260-1265.
5. Rubenfeld GD, et al. *Crit Care Med*. 2004;32: 1289-1293.
6. Ibrahim EH, Kollef MH. *Crit Care Clin*. 2001; 17(4):989-1001.

Clinical Implications of ICU-Acquired Urinary Tract Infection

ABSTRACT & COMMENTARY

Synopsis: *This 3-year cohort surveillance study of all adult patients admitted to ICUs in one region found that they were common (developing in 6.5% of patients, or 9.6 UTIs per 1000 ICU days) but did not contribute independently to mortality.*

Source: Laupland KB, et al. *Crit Care*. 2005;9:R60-R65. http://ccforum.com/content/9/2/R60. Accessed March 15, 2005.

LAUPLAND AND COLLEAGUES AT THE UNIVERSITY of Calgary performed a surveillance cohort study of ICU-acquired urinary tract infections (UTIs) in all adult multisystem and cardiovascular surgery ICUs in the Calgary Health Region, an area with approximately 1 million inhabitants. All patients aged 18 or older who remained in the ICU for more than 48 hours were included. ICU-acquired UTI was defined as a positive urine culture (at least 100,000 colony-forming units per mL) obtained at least 48 hours after ICU admission or during the last 48 hours prior to ICU discharge. Patients with and without ICU-acquired UTI were compared for demographics, in-hospital mortality, and severity of illness as assessed by APACHE II and TISS scores.

During the 3-year surveillance period, 4465 patients were admitted to the study ICUs for at least 48 hours, for a total of 4915 ICU stays, ICU-acquired UTIs occurred in 290 (6.5%) patients, or 9.6 UTIs per 1000 ICU days. UTIs were more common in women (174/1755 vs 116/2709; relative risk 1.58; 95% CI, 1.43-1.75; $P < 0.0001$), and in medical as compared to cardiovascular, and noncardiovascular surgical patients. The incidence of UTI increased with increasing lengths of ICU and hospital stay, but not with increasing APACHE II or TISS scores. There were only 4 instances of bacteremia or fungemia among patients acquiring a UTI in the ICU (0.1 per 1000 ICU days). The most commonly isolated organisms were *Escherichia coli* (23%), *Candida albicans* (20%), and *Enterococcus* species (15%). In-hospital mortality correlated with APACHE II score, length of stay, and admission to services other than medicine, but not with the acquisition of a UTI in the ICU.

COMMENT BY DAVID J. PIERSON, MD

This study extends Laupland et al's previous work on the incidence and characteristics of ICU-acquired UTI, using a larger and more all-inclusive patient population. It shows that UTI develops more frequently the longer patients remain in the ICU, but does not appear to increase the likelihood of death as an independent risk factor. Unlike previous studies of this issue, the investigation of Laupland et al was adequately powered to detect such an increase. Although the crude mortality risk was higher, once confounding by measures of severity of illness, diagnostic category, and length of ICU stay were controlled for, ICU-acquired UTI was not independently associated with death. ■

Use of CPAP for Post-Operative Hypoxemia

ABSTRACT & COMMENTARY

Synopsis: *CPAP may decrease the incidence of endotracheal intubation and other severe complications in patients who develop hypoxemia after elective major abdominal surgery.*

Source: Squadrone V, et al. *JAMA*. 2005;293:589-595.

THE OBJECTIVE OF THIS STUDY WAS TO DETERMINE the effectiveness of continuous positive airway pressure (CPAP) compared with standard treatment in preventing the need for intubation and mechanical ventilation in patients who develop acute hypoxemia after elective major abdominal surgery. It was a randomized, controlled trial with concealed allocation conducted in 15 intensive care units in Italy. Patients who developed severe hypoxemia (PaO_2/FIO_2 300 mm Hg or less) after major elective abdominal surgery were enrolled. The trial was stopped for efficacy after 209 patients had been enrolled (n = 104 received oxygen and n = 105 received oxygen plus CPAP). The primary end point was incidence of endotracheal intubation. Secondary end points were intensive care unit and hospital lengths of stay, incidence of pneumonia, infection and sepsis, and hospital mortality.

Patients who received oxygen plus CPAP had a lower intubation rate (1% vs 10%; relative risk, 0.099; 95% CI, 0.01-0.76; $P = 0.005$) and had a lower occurrence rate of pneumonia (2% vs 10%; RR, 0.19; 95% CI, 0.04-0.88; $P = .02$), infection (3% vs 10%; RR, 0.27; 95% CI, 0.07-0.94; $P = 0.03$), and sepsis (2% vs 9%; RR, 0.22; 95% CI, 0.04-0.99; $P = 0.03$) than patients treated with oxygen alone. Patients who received oxygen plus CPAP spent fewer days in the intensive care unit (1.4, 1.6 vs 2.6, 4.2; $P = 0.09$) than patients treated with oxygen alone. Use of CPAP did not affect the time that patients spent in the hospital (15 ±13 days vs 17 ± 15 days, respectively; $P = 0.10$). None of those treated with oxygen plus CPAP died in the hospital and 3 deaths occurred among those treated with oxygen alone ($P = 0.12$). CPAP was applied for 19-22 hours and interrupted only when the oxygenation target for stopping treatment was reached ($PaO_2/FIO_2 > 300$).

COMMENT BY DEAN R. HESS, PhD, RRT

Recovery from abdominal surgery is usually uncomplicated, but postoperative hypoxemia complicates 30% to 50% of cases even in patients undergoing uneventful procedures. Oxygen therapy and deep breathing are effective in treating most cases of postoperative hypoxemia. However, respiratory failure may require endotracheal intubation and mechanical ventilation in 8% to 10% of patients.[1] This is usually attributed to a loss of lung volume (atelectasis) but might also be due, in part, to pulmonary edema resulting from intraoperative fluid administration. With CPAP, the patient breathes spontaneously through a pressurized circuit that maintains a positive airway pressure. Although several studies have demonstrated the efficacy of CPAP to reduce atelectasis and improve oxygenation in patients after abdominal surgery,[2-4] no clinical trials have confirmed that the improvement in oxygenation with CPAP results in a reduced need for intubation and mechanical ventilation in patients who develop hypoxemia after abdominal surgery.

This study demonstrates that early treatment with CPAP may reduce the need for intubation, the ICU length of stay and the incidence of pneumonia, infection, and sepsis in patients who develop acute hypoxemia after elective major abdominal surgery. In this study, 209/1322 (16%) of patients met criteria for enrollment in the study, suggesting that the use of CPAP in such patients may be indicated relatively frequently.

A helmet device was used as the interface to apply CPAP. This interface is not available in the United States and, moreover, has recently been shown to be associated with the potential for carbon dioxide rebreathing.[5] In the United States, respiratory therapists and physicians are more familiar with using a face mask (nasal or oronasal) to apply CPAP and noninvasive ventilation.[6]

The results of this study should not be extrapolated to all patients with acute hypoxemic respiratory failure. In a study of 123 patients with hypoxemia from diverse etiologies, Delclaux et al[7] reported no difference in intubation rate or hospital mortality between patients receiving CPAP or oxygen therapy alone. Moreover, they reported a higher number of adverse events occurred in patients receiving CPAP. Thus, although the current study reports benefit for CPAP in patients developing hypoxemia after abdominal surgery, the results may not apply to other patient populations.

The mechanism whereby CPAP was beneficial in this study is unclear and was not examined in the study design. Squadrone and associates speculate that the CPAP improved the impairment in ventilation-perfusion ratio due to atelectasis caused by recumbent position, high oxygen concentration, temporary diaphragmatic dysfunction, impairment of pulmonary secretion clear-

ance, and pain. However, it is also possible that CPAP improved hypoxemia secondary to pulmonary edema resulting from intra-operative fluid administration. It is well known that CPAP is effective in patients with acute cardiogenic pulmonary edema.[8,9] Regardless of the mechanism, this well designed study provides evidence to support the use of CPAP in patients who develop hypoxemia following major abdominal surgery. ■

References

1. Arozullah AM, et al. *Ann Surg*. 2000;232:242.
2. Stock MC, et al. *Crit Care Med*. 1985;13:46.
4. Lindner KH, et al. *Chest*. 1987;92:66.
5. Taccone P, et al. *Crit Care Med*. 2004;32:2090.
6. Hess DR. *Respir Care*. 2004;49:810.
7. Delclaux C, et al. *JAMA*. 2000;284:2352.
8. Pang D, et al. *Chest*. 1998;114:1185.
9. Park M, et al. *Crit Care Med*. 2004;32:2407.

Neuropsychological Effects of ARDS Persist 2 Years Later

ABSTRACT & COMMENTARY

Synopsis: *This single center observational cohort study reveals that ARDS survivors have persistent neurocognitive, psychiatric and quality of life impairments at 2 years.*

Source: Hopkins RO, et al. *Am J Respir Crit Care Med*. 2005;171(4):340-347.

The study objective was to assess neurocognitive and emotional function and quality of life in survivors of the acute respiratory distress syndrome (ARDS) 2 years after hospital discharge. The primary outcome was the overall impairment score (defined below). Surviving patients at least 16 years of age with ARDS (defined by usual criteria) who were prospectively enrolled from 1994-1999 in a randomized trial of mechanical ventilation were invited to participate in long-term follow-up. Traumatic brain injury or prior neurocognitive deficits were among the exclusion criteria for the initial study. One-year follow-up was reported in a prior publication.[1]

Nine standardized neuropsychological tests were performed at 2-year follow-up. *Neurocognitive sequela* was defined as 2 or more tests with scores at least 1.5 standard deviation (SD), or 1 test more than 2 SD, below normative population means. An overall impairment score was calculated for each subject by summing the total number of SD below the normative means for all tests. Quality of life was measured by the Medical Outcome Study 36-Item Short Form Survey (SF-36).

Seventy-four subjects were enrolled in the initial study, of whom 66 (93%) were available for 1-year follow-up. From 1-2 years, there were 2 deaths and 2 patients declined further follow-up. Thus 62 (90%) were available for evaluation at 2 years. At that time, 34% of them were full-time students or working, 34% had been on disability since hospital discharge, and 32% were retired or unemployed. Intelligence quotients were in the normal range at 2 years. Although paired comparisons revealed that individual neurocognitive test scores and overall impairment scores improved from hospital discharge to 1 year, there were no significant changes between 1 and 2 years.

Neurocognitive sequelae were present in 47% of the patients. Moderate-to-severe symptoms of depression and anxiety were found in 23%; these did not correlate with neurocognitive test results, suggesting that neurocognitive impairment was independent of depression or anxiety. No correlation was found between neurocognitive scores at 2 years and duration of hypoxemia, intubation or sedation, mean blood pressure less than 60 mm Hg, ICU length of stay, or severity of illness scores. SF-36 scores in all domains were below normal at 2 years. Physical, role emotional, pain and general health scores were stable from 1 to 2 years but mental health domain scores declined.

■ COMMENT BY SAADIA R. AKHTAR, MD, MSC

This report by Hopkins and colleagues is one of the longest follow-up studies with certainly the most comprehensive neuropsychological assessment at follow-up of survivors of ARDS published to date. Their follow-up rate is excellent at 90%. Their findings are striking and important; although survivors of ARDS may have improvement in neurocognitive function and quality of life from hospital discharge to 1 year later, there is no further improvement or normalization over the following year.

Almost half the patients in this cohort had persistent neurocognitive sequelae and about a quarter had depression or anxiety at 2 years. (In contrast, at hospital discharge and during rehabilitation, only 12% of patients in this cohort were identified as having cognitive deficits and needing cognitive rehabilitation.) These results are similar to those in other reports that have revealed persistent reductions in quality of life and neuropsychiatric functioning, among other problems, as

much as 8 years (median follow-up) after hospital discharge from ARDS.[2,3]

It is less clear from this and prior studies whether the degree of impairment noted is more severe for survivors of ARDS compared to survivors of other critical illnesses. This is the primary limitation of this work—the absence of a control group of age, severity-of-illness, and date-of-admission matched critically ill patients without ARDS. One prior study evaluated quality of life after ARDS using a matched parallel cohort of critically ill patients and found more severe reductions in quality of life for survivors of ARDS.[4] Further similar analyses are needed to confirm these findings.

Other limitations of Hopkins et al's study include lack of information on subjects' baseline neuropsychological status and quality of life (something that may be near-impossible to attain) and limited generalizability of results. These patients were not all-comers with ARDS; they were already enrolled in another study and were recruited from a single center in Utah, an area not clearly representative of other US urban regions.

Nevertheless, this report is an important reminder that critical illness and ARDS may adversely affect long-term outcomes other than survival and physical health. As acute care of patients with ARDS continues to improve and survival continues to increase, greater attention must be given to maximizing long-term quality of life and neuropsychological functioning. ■

References

1. Orme J, et al. *Am J Respir Crit Care Med*. 2003;167(5): 690-694.
2. Kapfhammer HP, et al. *Am J Psychiatry*. 2004;161(1): 45-52.
3. Herridge MS, et al. *N Engl J Med*. 2003;348(8): 683-693.
4. Davidson TA, et al. *JAMA*. 1999;281(4):354-360.

Special Feature

Changing to a Closed Model of ICU Organization: Why and How

By James E McFeely, MD

OVER THE LAST DECADE THERE HAS BEEN A growing trend from an *open* to a *closed* model of ICU care delivery. The open model is an ICU where day-to-day management decisions are made by an admitting physician with the assistance of consultants. The admitting physician may be any member of the medical staff and need not necessarily have any particular expertise in the provision of critical care services. There are many models of *closed* unit care. The most stringent example requires a trained intensivist to be completely responsible for admission, management, and discharge of all patients in the intensive care unit, with the aid of consulting physicians. There are also a number of intermediate patterns between these two. In this article I will review some of the relevant literature comparing these two modes of care delivery and discuss issues related to changing from a more open to a more closed unit structure.

What Does the Literature Show?

Carson et al[1] retrospectively reviewed 120 medical ICU patients before and after changing from an open to a closed ICU system. They showed that while patients admitted after the change to a closed system tended to be sicker (APACHE II score, 20.6 vs 15.4), there was no appreciable difference in hospital mortality. There was a trend towards decreased actual mortality as compared to predicted mortality, although it was not statistically significant. Despite increased severity of illness of patients admitted during the closed system, there was no significant difference in ICU or hospital length of stay or resource utilization. Interestingly, patient families felt that communication with physicians was easier in the closed format; and the nursing staff reported they felt more confident in the clinical judgment of physicians in the closed system compared with the open system.

Multz et al[2] used a slightly different technique, comparing ICU outcomes in 2 hospitals in the same city, one that had changed to a closed system and one that continued with an open model. They found that ICU and hospital stays were shorter and days on a mechanical ventilator were decreased under the closed system, while mortality was unaffected.

Other studies also point to the comparative advantages of a closed system. For example, a retrospective comparison of data before and after closing a surgical ICU showed that among this diverse group of surgical patients mortality was lower, the complication rate was statistically reduced, and resource utilization was relatively unchanged in the closed system.[3] In another study, changing to a closed system of care at the Hammersmith Hospital in London was associated with a decrease in crude hospital mortality by nearly half (OR 0.51; CI, 0.32-0.82; $P > 0.005$).[4] More recent data

from a developing country shows similar results—in a prospective and retrospective comparison of outcomes after closing an ICU and adding an intensivist to manage the unit, patients were approximately 4.5 times more likely to survive their hospital stay during the closed policy than during the open ICU era.[5] As with the other papers mentioned, patients admitted during the period when the ICU was closed tended to be sicker.

While there certainly are pitfalls in this type of organizational research, essentially all of the data published in the last 10 years has come to a similar conclusion, favoring a closed vs open unit structure.[6] A literature review in 2002 came to a similar conclusion.[7]

How to Set Up a Program

Presuming one agrees that a closed ICU structure is beneficial as compared with an open structure, the difficult question then is how to implement such a change. There will be a unique solution for each hospital and ICU depending on a number of factors, including needs, resources, and talents available in the local community, as well as the size of the unit, the number of patients available to be seen, the economic resources of the hospital, and the number of physicians in the community. Options range from mandatory intensivist consultation for all patients admitted to the ICU at a minimum, to a closed ICU with 100% management by intensivists and 24-hour on-site physician coverage.

One appropriate option may be use of a remotely connected intensivist (eICU).[8] Another option is simply to add daily rounds by an ICU physician, which has been shown to result in a 3-fold decrease in in-hospital mortality in patients undergoing abdominal aortic aneurysm surgery.[9] Some institutions may use a hospitalist as part of the team with an intensivist as backup at night. This has been shown to improve survival and shorten length of ICU stay (as compared with housestaff) in a pediatric unit.[10] Any one of these options may be appropriate for a given institution.

Once a decision has been made to go to a more closed unit structure, buy-in will need to be obtained from the relevant parties affected by the decision. Certainly the medical staff leadership will have to be brought into the process. One possible mechanism for implementing the change, for instance, is the use of credentialing to develop a set of ICU management privileges for participating physicians. In this case, minimum standards that should be objective as possible will be required for physician credentialing. Depending on the resources available, completion of a critical care training program may be an appropriate benchmark, with consideration given to grandfathering those trained prior to availability of formal critical care training programs.

The nursing department will also be integral to the development of the program, as it may require changes to nursing policy and procedures. Among ICU nurses, it will unquestionably result in a significant change in mindset in terms of how patient care is coordinated and with whom they interact for various problems and management decisions. Nurses generally prefer a closed ICU system, as it makes their jobs easier. Instead of having to call doctor X for fluids, doctor Y for ventilator orders, and doctor Z for vasopressors, they now have one-stop shopping. In a closed system, phrases such as "managing physician," "captain of the ship," and "I'll take care of that for you" suddenly appear in the physician vocabulary, to the delight of the nursing staff. If a system is developed with 24 hr on-site physician coverage, night shift nurses in particular will benefit and will feel more a part of the overall care team. This can be a particular benefit in units with relatively inexperienced nurses working at night, providing them ready access to a trained experienced physician.

Hospital administration will also have to be brought in early in the process. Depending on the volume of work available for a critical care physician, there may be a need for monetary supplementation of the program, either through the use of medical directorships or perhaps payment for on call services until such time as the program can be independently economically viable.

Barriers to Implementation

There are a number of obstacles to overcome in developing a closed ICU structure. The most formidable may be reluctance on the part of the affected members of the medical staff. Physicians, in particular general internists, currently practicing in an open ICU environment, almost certainly see themselves as capable of continuing the care they have provided in the past. Younger physicians who trained in institutions with a closed ICU program may have less difficulty adapting to a closed system. The physicians most difficult to convince may be the more senior, classically trained, general internists who have long managed their patients (though infrequently) in the ICU and who pride themselves on their ability to provide such care. These physicians often regard the change to a closed system as taking away a part of their practice—a part they value both intellectually and economically. When added to the other invasions into their practice style associated with managed care, reduced ability to care for hospitalized patients through the use of hospitalist services, and increasing pressure for more office productivity, this can become yet another chink in the armor

of the already battered general internist physician.

Acknowledging these issues directly is important. Objectively using the medical literature as a point to start the discussion is probably the best way to proceed, and physicians should always be reminded that they are welcome to continue to follow their patients while in the ICU and bill appropriately for those services they provide. They should certainly be included in, and are important to, discussions about overall goals of care and maintaining continuity outside the ICU.

Hospitalists may also be opposed to development of a closed ICU structure, especially if they feel excluded either because of economic or turf related issues. Given the lack of critical care physicians in this country, and the rise of hospitalist services even in small institutions, development of cooperative models of care between an intensivist-driven closed ICU and a hospitalist service is probably a wave of the future. Development of a closed ICU structure may require additions of intensivists to the staff, which in turn could require monetary input from an already financially strapped hospital. In negotiating with hospital administration, one can refer to the literature showing reductions in length of stay, and decreases in mortality and in resource utilization, to help convince reluctant hospital administrators of a reasonable return on their investment.[11] Once the change has been implemented, measuring improvements in quality and cost reductions will be important feedback to all parties affected by the change.

Conclusion

Moving to an intensivist-led closed ICU system seems to be the natural evolution of critical care. In this change, all members of the care team have a role to play, and these roles should be based on training and expertise and backed up by the literature. Any one unit may need to evolve in steps toward a closed system, as resources and mindsets change. When working through the process, remember to under-promise and over-deliver. Be as objective as possible in setting up the rules, and attempt to document the value of your interventions with the collection of local data. ■

References

1. Carson SS, et al. *JAMA*. 1996;276(4):322-328.
2. Multz AS, et al. *Am J Respir Crit Care Med.* 1998;157(5 Pt 1):1468-1473.
3. Ghorra S, et al. *Ann Surg*. 1999;229(2):163-171.
4. Baldock G, et al. *Intensive Care Med*. 2001;27(5): 865-872.
5. Topeli A, et al. *Crit Care Med.* 2005;33(2):299-306.
6. Hall JB. *Crit Care Med*. 1999;27(2):229-230.
7. Pronovost PJ, et al. *JAMA*. 2002;288(17):2151-2162.
8. Breslow MJ, et al. *Crit Care Med*. 2004;32(1):31-38. Erratum in: *Crit Care Med*. 2004;32(7):1632.
9. Pronovost PJ, et al. *JAMA*. 1999;281(14):1310-1317.
10. Tenner PA, et al. *Crit Care Med*. 2003;31(3):847-852.
11. Pronovost PJ, et al. *Crit Care Med*. 2004;32(6): 1247-1253.

CME / CE Questions

1. **Based on the results of the ARDS-Net study of low- vs traditional tidal volumes in patients with ALI/ARDS, the number of patients one would need to ventilate with 6 mL/kg in order to save one life is:**
   a. 11.
   b. 21.
   c. 36.
   d. 52.
   e. 112.

2. **ICU-acquired urinary tract infection was more common in:**
   a. women.
   b. patients who stayed longer in the ICU.
   c. patients admitted to medical as compared to non-medical ICUs.
   d. All of the above
   e. None of the above

3. **In the study of ICU-acquired urinary tract infections, which of the following was independently associated with increased in-hospital mortality?**
   a. Being admitted to a non-medical ICU
   b. Having a higher-admission APACHE II score
   c. Developing a UTI while in the ICU
   d. All of the above
   e. a and b but not c

Answers: 1 (a); 2 (d); 3 (e)

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: **Transfer of Enterococcus Via A Health Care Worker's Hands**

PHARMACOLOGY WATCH

Supplement to *Clinical Cardiology Alert, Clinical Oncology Alert, Critical Care Alert, Infectious Disease Alert, Internal Medicine Alert, Neurology Alert, OB/GYN Clinical Alert, Primary Care Reports, Travel Medicine Advisor.*

Preparing for the Possibility of a Bird Flu Pandemic

The possibility of a bird flu pandemic has health officials worldwide in a high state of alert. The highly pathogenic avian influenza A virus is responsible for the death of more than 100 million birds in Southeast Asia, but less than 100 cases have been documented in humans, and only 2 of those have been from human-to-human contact. Still, influenza A viruses are known to undergo an antigenic shift periodically, marking an abrupt change in the viral genome. It is the possibility of a mutation that has health officials concerned. If the virus suddenly became infectious in human populations, the resulting pandemic could kill millions, as similar avian influenza virus pandemics did in 1968, with one to four million deaths, and 1918, when the avian flu pandemic killed as many as 50 million people. The World Heath Organization is urging all countries to develop or update their influenza pandemic preparedness plans. From a pharmaceutical perspective, the WHO has singled out oseltamivir (Tamiflu) as the treatment of choice to reduce symptoms and prevent spread of avian influenza. Roche Holding AG, the makers of oseltamivir, recently announced that Britain and the United States are discussing large purchases of the drug, with the intent of stockpiling supplies for a potential avian influenza outbreak. Other governments around the world have been stockpiling the drug as well, and Roche is increasing its production capacity to meet the additional demand.

Amoxicillin-Clavulanate vs Ciprofloxacin

The search for effective antibiotics to treat common infections is a high priority, given increasing resistance patterns for many commonly used antibiotics. This was the basis for a new study by researchers at the University of Washington, in which they compared ciprofloxacin to amoxicillin-clavulanate in women with uncomplicated cystitis. The study was driven by an increasing rate of resistance to trimethoprim-sulfa and other antimicrobials among *E. coli* strains causing acute cystitis in women. While ciprofloxacin is a common alternative, amoxicillin-clavulanate has not been well studied. In a randomized, single-blinded trial, 370 women aged 18 to 45 with symptoms of acute uncomplicate cystitis with a positive urine culture were randomized to amoxicillin-clavulanate 500/125mg twice daily or ciprofloxacin to 250 mg twice daily for 3 days. Clinical cure was observed in 58% of women treated with amoxicillin-clavulanate, compared with 77% of women treated with ciprofloxacin ($P < .001$). Amoxicillin-clavulanate was not as effective as ciprofloxacin, even among women infected with *E. coli* strains suscepti-

This supplement was written by William T. Elliott, MD, FACP, Chair, Formulary Committee, Kaiser Permanente, California Division; Assistant Clinical Professor of Medicine, University of California-San Francisco. In order to reveal any potential bias in this publication, we disclose that Dr. Elliott reports no consultant, stockholder, speaker's bureau, research, or other financial relationships with companies having ties to this field of study. Questions and comments, call: (404) 262-5416. E-mail: leslie.hamlin@ thomson.com.

ble to amoxicillin-clavulanate. At follow-up visits 2 weeks after treatment, 45% of women in the amoxicillin-clavulanate group had vaginal colonization with *E. coli*, compared to only 10% in the ciprofloxacin group ($P <$ .001). The authors point out that *E. coli* resistance is an increasing problem worldwide, especially with trimethoprim-sulfa. However, resistance is also been seen with fluoroquinolones including ciprofloxacin. Amoxicillin-clavulanate was chosen in the study in the hopes of finding an effective fluoroquinolone-sparing antibiotic for the treatment of uncomplicated cystitis. Unfortunately, amoxicillin-clavulanate is not a reliable option and alternatives will need to be found (*JAMA.* 2005;293:949-955).

AD Therapy and Cognitive Function

Men with prostate cancer who note worsening cognitive function in the early stages of androgen deprivation (AD) therapy should consider that the change is due to the treatment not the disease, according to new study published online in the "Early View" section of *Cancer*. Researchers from Finland followed 23 men undergoing AD for prostate cancer. Thirty-one cognitive tests were performed at baseline, 6 months, and 12 months into therapy. Testosterone and estradiol locals were followed throughout treatment. Visual memory of figures in recognition speed of numbers were significantly impaired at 6 months. Surprisingly, some men with the lowest change in estradiol levels had an improvement in verbal fluency and 12 months. The author suggests that cognition may be adversely affected during androgen deprivation (*Cancer*-published online 2/16/05).

LDL Lowering in CHD Patients

An LDL target in the 70s for CAD patients may become the standard, as evidence continues to mount for the benefit of intensive cholesterol lowering. The latest study from the "Treating to New Targets" or TNT investigators looked at 10,000 patients with stable coronary disease and LDL levels less than 130. Patients were randomized to atorvastatin 10 mg/day (low dose) or 80mg/day (high dose) and were followed for an average of 4 years. Mean LDL cholesterol was lowered to 101 mg/dL in the low-dose group and to 77 mg/dL in the high-dose group. Persistent elevations in liver enzymes was more common in the high-dose group (0.2% low dose, 1.2 % high dose [$P <$ .001]). The study end points were cardiovascular events including death from CHD, nonfatal MI, resuscitation after cardiac arrest, or stroke (fatal or nonfatal). A primary event occurred in 548 patients in the low-dose group (10.9%) and 434 patients in the high-dose group (8.7%) for a 2.2% absolute rate reduction (HR, 0.78; 95% CI, 0.69-0.89; $P <$ .001). There was a higher death rate from noncardiovascular causes in the high-dose treatment group, and no difference in overall mortality. There were no trends in the noncardiovascular deaths, specifically no higher rate of cancer or violent deaths. The authors conclude that aggressive LDL lowering is warranted in CHD patients (*N Engl J Med*-published online March 2005). An accompanying editorial suggests more caution, stating, "Patients and their physicians will need to carefully weigh the benefits or a reduction in the risk of cardiovascular events. . . against the uncertainty of an increase in the risk of death from noncardiovascular causes" (*N Engl J Med*-published online March 2005).

FDA Actions

The FDA and federal marshals from the Department of Justice have seized Paxil CR and Avandamet tablets manufactured by GlazxoSmithKline at its plants in Knoxville, TN, and Puerto Rico. The FDA stated that the seizures were prompted by violations of manufacturing standards that resulted in the production of poor quality drug products, including tablets that could split apart and tablets that had inaccurate doses of the active ingredient.

In late February, the FDA issued a public health advisory regarding nataluzimab (Tysabri), Biogen's recently approved drug for the treatment of relapsing forms of multiple sclerosis. Marketing of the drug has been suspended while the agency and the manufacturer evaluate 2 cases of progressive multifocal leukoencephalopathy in MS patients who were using the drug, one of which resulted in death. Nataluzimab received accelerated approval in November 2004, and 8000 patients have received the drug, including 3000 who received it during clinical trials. ■