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Authoritative, evidence-based summaries for the critical care clinician

ABSTRACT & COMMENTARY

Multicenter Quality Improvement Project Resulted in a 23% Reduction in Medical Errors

By Leslie A. Hoffman, RN, PhD

Professor Emeritus, Nursing and Clinical & Translational Science, University of Pittsburgh

Dr. Hoffman reports no financial relationships relevant to this field of study.

SYNOPSIS: Implementation of a quality improvement project focused on handoffs reduced medical errors by 23% and preventable adverse events by 30%.

SOURCE: Starmer AJ, et al. Changes in medical errors after implementation of a handoff program. *N Engl J Med* 2014;371:1803-1812.

Numerous studies have tested strategies to improve handoff communication. Most were conducted in a single center and, therefore, the ability to generalize findings remains unclear. The goal of this study was to test the ability of a resident-handoff improvement program to reduce error rates when implemented as a multicenter approach. The nine selected pediatric residency programs ranged in size from 36 to 182 residents and were located in the United States and Canada. The intervention included a mnemonic to standardize oral and written handoffs, handoff and communication training, a faculty development and observation program, and a sustainability campaign. Impact of the program was measured for 6 months pre- and 6 months post-intervention by comparing the number of medical errors, preventable adverse events and miscommunications, as well as resident workflow. Error rates were measured through active surveillance. Handoffs were assessed using printed documents and audio recordings. Workflow was assessed through time-motion observations. In 10,740 patient admissions, the medical error rate decreased by 23% pre- to post-intervention (24.5 vs 18.8 per 100 admissions, $P < 0.001$); preventable adverse events decreased by 30% (4.7 vs 3.3 events per 100 admissions, $P < 0.001$). There was no change in non-preventable adverse events (3.0 vs 2.8 events

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per 100 admissions, $P = 0.79$). Institution-level analyses showed significant error reduction at six of nine sites. Across all sites, increases were observed in the inclusion of key elements during handoffs (nine written, five oral elements; $P < 0.001$). There was no change pre- to post-intervention in duration of oral handoffs (2.4 and 2.5 minutes per patient, respectively; $P = 0.55$) or in resident workflow, including patient–family contact and computer time. Length of stay, medical complexity and patient age did not differ between the pre- and post-intervention period.

■ COMMENTARY

The intervention developed for this study, termed the I-PASS Handoff Bundle, included seven elements: the I-PASS mnemonic (I = Illness Severity, P = Patient Summary, A = Action Items, S = Situation Awareness and Contingency Plans, S = Synthesis Restatement by Receiver), a 2-hour workshop to teach communication skills and handoff techniques, a 1-hour role-playing and simulation session to practice skills from the workshop, a computer module to allow for independent learning, a faculty development program, tools to provide feedback to residents, and a process and culture change campaign that included a logo, posters, and materials to promote program adoption. All components are available at no cost through the website (http://ipasshandoffstudy.com).
Measurement was rigorous, including review of medical records, orders, and formal incident reports on study units by a research nurse. Reports were solicited from nursing staff on study units, and daily medical error reports from residents. Two physician investigators, unaware of the time records were collected, classified incidents as preventable or non-preventable. Time and motion data were also collected to determine the time residents spent in various activities. Findings indicated a significant error reduction without an increase in time required to conduct handoffs or a decrease in direct contact time with patients.

A characteristic of this study, which can be viewed positively and negatively, relates to the comprehensive nature of the intervention and extent of time and institutional commitment required for its implementation. This suggests that handoff communication can be positively influenced, but to achieve this goal, there must be a major effort, including education, practice, availability of online and written support materials, and an institutional effort designed to promote culture change. Of note, error rates did not change significantly at three of the nine institutions. Reasons were unclear, given there was significant improvement in written and oral handoff processes at these institutions. This finding highlights the challenges too often encountered when attempting to change behavior — systematic initiatives can be successful but may not be equally so in different institutions that are influenced by different variables. ■

ABSTRACT & COMMENTARY

Benefits of NIV in COPD Supported in Routine Clinical Practice

By Leslie Hoffman, RN, PhD

SYNOPSIS: In a large cohort study, patients with chronic obstructive pulmonary disease managed with noninvasive ventilation had lower inpatient mortality, shorter length of stay, and lower costs compared to those managed with invasive ventilation.

SOURCE: Lindenauer PK, et al. Outcomes associated with invasive and noninvasive ventilation among patients hospitalized with exacerbations. *JAMA Intern Med* 2014;174:1982-1993.

Prior studies, including several meta-analyses, have concluded that nonivasive ventilation (NIV) can reduce the need for intubation

and improve short-term survival of patients experiencing a chronic obstructive pulmonary disease (COPD) exacerbation. Little is known, however, about the effectiveness of NIV in routine clinical practice. To determine effectiveness, this study compared outcomes in 25,628 patients hospitalized with a severe exacerbation of COPD who received mechanical ventilation on the first or second ICU day in 420 U.S. hospitals. Patients were included if they were > 40 years of age, had a principal discharge diagnosis of COPD, or a secondary diagnosis of COPD with a principal diagnosis of acute respiratory failure (determined by ICD-9 codes). Patients were excluded who were not treated with short-acting bronchodilators or systemic corticosteroids (to reduce misclassification), received palliative or hospice care, or were diagnosed with sleep apnea. Data retrieved from electronic medical records were used to compare outcomes in patients managed using NIV (n = 17, 978; 70%) or invasive mechanical ventilation (IMV), and subgroups were defined by age, comorbidity, and comorbid pneumonia. Two additional analyses were performed to address differences among hospitals and control for unmeasured confounders.

The primary study outcome was in-hospital mortality. When compared with those initially managed with IMV, NIV managed patients were older, more likely to have been admitted for COPD in the past year, and had a lower comorbidity score. The incidence of NIV failure was 15.3%. NIV was associated with a lower risk of mortality than IMV (odds ratio [OR], 0.54; 95% confidence interval [CI], 0.48-0.61), lower risk of hospital-acquired pneumonia (OR, 0.53; 95% CI, 0.44-0.64), a 19% shorter length of stay (OR, 0.81; 95% CI, 0.79-0.82), and 32% lower costs, which averaged $5673 per patient (OR, 0.68; 95% CI, 0.67-0.69). There was no difference in 30-day all-cause readmission (OR, 1.04; 95% CI, 0.94-1.15) or COPD-specific readmission (OR, 1.05; 95% CI, 0.91-1.22). The benefits of NIV were similar in a sample restricted to patients younger than 85 years. Benefits were less for patients with higher levels of comorbidity and comorbid pneumonia, but remained significant. Using the hospital as an instrumental variable, the strength of association between NIV and mortality was modestly less (OR, 0.66; 95% CI, 0.47-0.91). In sensitivity analyses, the benefit of NIV was robust in the face of a strong hypothetical unmeasured confounder.

■ COMMENTARY

A major strength of this study is the use of a large, externally generalizable population. Patients were recent admissions (January 2008-June 2011) to 420 geographically diverse hospitals; all were participants in a fee-supported data repository designed to support quality improvement (Premier Healthcare Informatics). This data-sharing repository enabled access to an extensive database and sophisticated analytic techniques.

Findings supported benefits reported from randomized, controlled trials. NIV was associated with lower mortality, a lower risk of hospital-acquired pneumonia, a shorter hospital length of stay, and no increase in COPD-specific or all-cause readmission within 30 days of discharge. Although NIV has been strongly endorsed in clinical guidelines, surveys suggest that many eligible patients are not managed using NIV. One frequently cited reason relates to concern that benefits seen in a carefully selected sample of patients managed by experienced clinicians might not transfer to the "real world" of clinical practice. Successful implementation of NIV requires appropriate patient selection, 24-hour availability of an experienced team, close patient monitoring, and the ability to quickly to convert to IMV if NIV fails.

In this study, patients spent a median of 2 (range 1-4) days on NIV and 3 (range 2-5) days on IMV. In-hospital mortality rates were 4.8%, 8.6%, and 13.8% among those initially treated with NIV, IMV, and those who failed NIV, respectively. The higher mortality rate in those who fail NIV supports the need for careful patient selection. Notably, the relative advantage of NIV was less in patients with COPD if pneumonia was present at admission, a finding that has potential clinical significance. Unlike an acute exacerbation of COPD, patients with pneumonia are less likely to experience a rapid reversal of acute respiratory failure. In such situations, NIV may not be the optimum choice, given the likely longer recovery interval and higher patient acuity. Findings of this study are subject to the limitations of all observational studies, namely inability to identify causality. They suggest that, among patients hospitalized for a COPD exacerbation, NIV is a prudent initial choice given its many benefits with the caveat that benefits may be more limited or absent when pneumonia is present at admission. ■

ABSTRACT & COMMENTARY

Adherence to Sleep-promoting Interventions for Critically Ill Patients: One Checklist at a Time

By Linda Chlan, PhD, RN, FAAN

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Dr. Chlan reports no financial relationships relevant to this field of study.

SYNOPSIS: A checklist can be used to implement comprehensive sleep-promoting interventions, but it remains a challenge to maintain adherence and sustainability among ICU clinicians.

SOURCE: Kamdar BB, et al. Developing, implementing, and evaluating a multifaceted quality improvement intervention to promote sleep in an ICU. *Am J Med Quality* 2014;29:546-554.

It is no surprise to any clinician that ICU patients do not get much sleep while hospitalized for a critical illness or injury. Sleep disturbances emanate from many sources, including noise, lights, care procedures, staff conversations, and receipt of mechanical ventilation to name but a few. Efforts have been made over the past couple of years to test and implement interventions in the ICU to promote sleep with the goal of improved quality and quantity of sleep. Given the complexity of sleep and the numerous factors that impair sleep in the ICU, the problem requires a much more comprehensive approach for promoting sleep among critically ill patients.

The quality improvement (QI) project by Kamdar and colleagues summarized a multifaceted, comprehensive approach to improving sleep in one medical ICU (MICU) at the Johns Hopkins Hospital in Baltimore, MD. The MICU consists of 16 beds that are staffed by registered nurses, nursing technicians, respiratory therapists, pharmacists, and physical and occupational therapists. Two physician teams comprised of an intensivist, fellow, and resident physicians round out the multidisciplinary care team.

The team based their sleep improvement project on an established four-step QI model[1]: 1) summarizing the evidence to identify beneficial relationships, 2) identifying barriers to implementation, 3) selecting and developing performance measures, and 4) ensuring all patients receive the interventions. The QI model also applies the four Es algorithm to engage and educate staff, execute the intervention, and evaluate performance.[1]

The team first reviewed the literature for potential, feasible sleep-promoting interventions (step 1). A "bundled" approach was selected and included environment modifications for day (window blinds open) and nighttime (dimming overhead lighting); nonpharmacological sleep aids such as ear plugs, eye masks, or tranquil music; and development of a pharmacological sleep guideline that discouraged medications known to influence sleep, such as benzodiazepines. The interested reader should refer to the original article and reference list for additional details or suggestions to promote sleep. A key component for any QI program is to address barriers to implementation. A prominent, team-identified barrier was that the MICU staff might be overwhelmed with multiple interventions and included the physical limitations of the MICU itself, such as the inability to adjust lighting to a desired level or ability to fully minimize overhead paging to reduce noise (step 2). A checklist was developed to document whether the specific shift interventions were implemented per the sleep bundle (step 3). These checklists were completed by nurses on the day shift and night shift, as well as by the unit clerk.

The four Es model was applied to make sure all patients received the bundled sleep interventions (step 4). The team made a concerted effort to garner buy-in from the staff; education was provided throughout the project. Daily nurse completion of the checklists ranged from 84-90% for day-shift and 76-86% for night-shift. Checklist completion by clerks was 79-94%. The nonpharmacological sleep aids saw the lowest implementation rates due to patients being asleep, delirious/comatose, or refusing. Medications to appropriately promote sleep increased from 0% to 60% across the project period. The two main challenges to adherence to the sleep bundle interventions were: 1) the large number of interventions required on each

shift (three on days, 14 on nights), and 2) sleep bundle intervention adherence was achieved 60-80% of the time, which was significantly below the 100% goal. The team also discussed the challenges of bundle sustainability among the clinical staff, which can be extremely difficult in any setting.

■ COMMENTARY

This QI project reported by Kamdar and colleagues highlights a comprehensive, multicomponent intervention to promote sleep among ICU patients that utilized day- and night-shift specific checklists to promote adherence. Unfortunately, the report also provides a stark reminder to the reader of the realities of promoting adherence to any new initiative and sustaining "buy-in" after completion of any QI project. Perhaps the most significant contribution of the article is the frank discussion of barriers to implementation and strategies used by an experienced QI team to improve adherence rates to the sleep bundle during the study period. For example, the sleep promoting interventions were implemented in stages, which demonstrates the iterative nature of any QI project. Efforts to promote adherence to the checklist interventions included staff education throughout the project.

The QI model and four Es algorithm[1] can be a useful framework for conducting a QI project in the ICU to improve patient-centered outcomes. The interested reader is advised to examine the article's reference list for suggestions on conducting and reporting a QI project. ■

REFERENCE

1. Pronovost PJ, et al. Translating evidence into practice: A model for large scale knowledge translation. *BMJ* 2008;337:a1714.

ABSTRACT & COMMENTARY

Cost of ICU Care at the End of Life Affects Perception of Dying

By Elaine Chen, MD

Assistant Professor, Department of Internal Medicine, Division of Pulmonary and Critical Care Medicine, Section of Palliative Medicine, Rush University Medical Center

Dr. Chen reports no financial relationships relevant to this field of study.

SYNOPSIS: Nurses perceive increased quality of dying with lower cost end-of-life care, while underinsured families perceive increased quality of dying with higher average daily cost end-of-life care.

SOURCE: Khandelwal N, et al. End-of-life expenditure in the ICU and perceived quality of dying. *Chest* 2014;146:1594-1603. Nov 11 [Epub ahead of print].

Patients diagnosed with a terminal illness would prefer to die at home, if possible, and higher cost of outpatient cancer care in the final week of life is associated with worse perceived quality of death by caregivers. In the intensive care unit (ICU), however, this has not been studied. The current study aims to assess whether associations exist between cost of care and perceived quality of death for patients dying in the ICU or shortly after transfer.

This study was performed in conjunction with other large studies by a group involved in robust research on end-of-life care in the ICU. Patients were recruited from two hospitals in a single network in the Seattle area: an academic tertiary care center with a level I trauma center and a community-based hospital. Eligible patients included all patients who died in an ICU after a minimum stay of 6 hours, or who died within 30 hours of transfer to another location in the hospital. Questionnaires were mailed to family caregivers 4-6 weeks after death and distributed to the last two nurses caring for the patient within 72 hours of death. A single-item Quality of Death and Dying rating (QODD-1) ranging from 0 (worst) to 10 (best) was assessed for both nurses and families. Additionally, a 34-item tool, the Family Satisfaction in the ICU (FS-ICU), was assessed for families. Costs assessed included direct and indirect costs and facility and professional fees, but not physician fees. Both total hospital costs and total ICU costs were assessed, and total ICU costs were divided by ICU length of stay to determine average daily ICU cost. Regression analyses were performed to explore associations between costs and outcomes, with adjustments for possible confounders.

Of 607 patients, 307 had a family member respond to either the QODD-1 or the FS-ICU and 523 had a nurse response. There were more insured (private insurance

or Medicare, n = 240) than underinsured (Medicaid or no insurance, n = 67) patients. Patients whose families responded had longer hospitalizations and ICU stays, and were more likely to die with full support, were white, and were adequately insured. Patients for whom nurses responded were younger, more likely to die in the ICU, more likely to be intubated, and had higher mean costs.

The authors found a strong positive association between family-assessed quality ratings (both the QODD-1 and the FS-ICU) and average daily ICU costs in underinsured patients. This did not extend to either total hospital cost or total ICU cost. No significant associations were found for insured patients. In nurses, higher cost was associated with lower quality of dying.

That the positive association with increased average daily ICU cost found with the underinsured patients was not found with total hospital or total ICU costs reflects increased satisfaction with increased intensity of treatments. Prior studies have shown that more gradual withdrawal of life support is associated with increased satisfaction, allowing families time to adjust and prepare for their loved ones' death. Underinsured patients, often minorities or those of lower socioeconomic status, may seek medical care later than their insured counterparts and feel reassured by life-extending therapies.

■ COMMENTARY

Perceived quality of dying was shown to be different between family members and nurses in this study, indicating that health care providers and families value very different things at the end of life. Notably, the perceptions are in opposite directions between nurses and families of underinsured patients. Increased average daily ICU cost, reflecting increased intensity of care, leads to perceived increased quality of dying by the families of underinsured patients. Whether this reflects more rapid decline due to delayed access to medical care or mistrust of the medical system, as compared with their insured counterparts, can be hypothesized but would be difficult to study. As hospitals look for methods to decrease the cost of care at the end of life, this may come at the expense of patient and family satisfaction.

These findings are though provoking, and should challenge health care providers to approach dying patients and their families individually. Importantly, as health care providers, we should be cautious not to project our own personal biases about medical care to patients and families, but to treat as medically appropriate and make allowances for grieving families. Moral distress, defined as psychological disequilibrium when the ethically right course of action is known but cannot be acted upon, is common among ICU nurses and can lead to burnout and job turnover.[1] Nurses' perception of lower quality of death in the case of increased intensity of care at the end of life may reflect increased moral distress, as nurses were more likely to respond if care was particularly aggressive. To try to narrow this dichotomy of perception between families and nurses, one wonders whether improved counseling and palliative care, to both families and nurses, could help. Additionally, other health care providers were not assessed in this study: Do nurses' perceptions reflect those of physicians? ■

REFERENCE

1. Elpern EH, et al. Moral distress of staff nurses in a medical intensive care unit. *Am J Crit Care* 2005;14:523-530.

ABSTRACT & COMMENTARY

Early Recognition and Management of ARDS: The New Early Goal-directed Therapy?

By Kathryn Radigan, MD, MSc

Assistant Professor, Pulmonary Medicine, Northwestern University, Feinberg School of Medicine

Dr. Radigan reports no financial relationships relevant to this field of study.

SYNOPSIS: Early recognition of ARDS with subsequent strict adherence to low tidal volume ventilation is important for reducing mortality in the ICU.

SOURCE: Needham DM, et al. Timing of low tidal volume ventilation and ICU mortality in ARDS: A prospective cohort study. *Am J Respir Crit Care Med* 2014 Dec 5. [Epub ahead of print]

Although it has been known for more than a decade that reducing tidal volume decreases mortality in mechanically ventilated patients with acute respiratory distress syndrome (ARDS), the effects of the timing

of low tidal volume ventilation has not been well studied. Needham and colleagues sought to determine the association between ICU mortality and initial tidal volume with tidal volume changes over time in ARDS patients. In this multi-site, prospective cohort study, 482 ARDS patients were recruited, with more than 11,000 twice-daily tidal volume assessments. As timely recognition of ARDS is a barrier to initiation of low tidal volume ventilation, these patients were screened with daily review of data in medical records and chest X-rays according to the American-European Consensus Conference criteria, including the need for mechanical ventilation and PaO_2/FiO_2 ratio < 300.

The authors showed that an increase of 1 mL/kg of predicted body weight (PBW) in initial tidal volume was associated with a 23% increase in ICU mortality (adjusted hazard ratio [HR], 1.23; 95% CI, 1.06-1.44, $P = 0.008$). Furthermore, there was a 15% increase in mortality, with a 1 mL/kg PBW increase in subsequent tidal volumes compared to the initial tidal volume (adjusted HR, 1.15; 95% CI, 1.02-1.29, $P = 0.019$). They also compared patients receiving 8 days of mechanical ventilation with a tidal volume of 6 mL/kg PBW to those receiving 10 and 8 mL/kg PBW. They found an absolute increase in ICU mortality of 7.2% (3.0-13.0%) and 2.7% (1.2-4.6%), respectively. When comparing tidal volume profiles with 4 days of 6 mL/kg PBW and 4 days of 10 mL/kg PBW, the estimated absolute increase in mortality was greater when the 10 mL/kg was used within the first 4 days vs the last 4 days of the 8-day ventilation period (4.8% [1.9-8.5%] vs 2.0% [0.6-3.9%]).

■ COMMENTARY

This manuscript clearly reveals the importance of adherence to low tidal volume ventilation, especially early in the development of ARDS. With this new evidence, there are two distinct concepts that will need to be stressed to the critical care population and beyond: recognition and promptness. Clinicians must be attuned to the relentlessly changing critically ill patient. Much too often, ARDS is not recognized until 12-24 hours after onset of clinical deterioration. Perhaps a prompt generated from the electronic medical record may be of benefit. If the patient meets criteria by the PaO_2/FiO_2 ratio, the physician is prompted to further investigate the possibility of ARDS. Once ARDS is recognized, it needs to be stressed that prompt adherence to low tidal volume ventilation will reduce the mortality of critically ill patients. The early aspect of this may be met with certain challenges, as many of the initial volumes of ARDS patients are established in the emergency department by respiratory therapists and/or by physicians who are not yet aware of the impact those initial settings may have on patient outcomes. To appropriately guide education platforms for prompt adherence, it may be helpful to investigate who is making the initial decision on volume settings (i.e., residents, ED physicians, ICU attendings, or respiratory therapists) and whether these settings are being made based on lack of education or other barriers to care (i.e., difficulty with sedation, etc). It is expected that attending presence in the ICU overnight, as well as broader educational platforms, may help with early ARDS recognition.

Although the overall message of this manuscript will benefit the delivery of critical care, I would like to exercise a word of caution with these recommendations, as the authors brought up the idea that "there may be benefit for all mechanically ventilated patients of ICU-wide protocols that default to 6 mL/kg PBW, with a specific physician order required for use of higher tidal volumes." Although this may benefit some patients, I fear that in our enthusiasm we may go too far and may cause more harm than good. As we have all experienced, patients with low tidal volume ventilation may need excessive amounts of sedation to tolerate the low volumes. In efforts to provide low tidal volume ventilation, many of our patients may receive excessive sedation that may lead to worse outcomes, including prolonged mechanical ventilation. We must use caution, investigate further, and not confuse a broadly useful guideline with a prescription for all.

This manuscript supports the idea that early diagnosis and intervention for many issues in the ICU is critical: antibiotics in septic shock, resuscitation for patients with gastrointestinal bleeding, anticoagulation for pulmonary embolism, and now low tidal volume ventilation for ARDS. Perhaps the best treatment of our critically ill patients can be summarized by early and aggressive recognition and treatment, especially for those interventions known to improve patient outcomes. ■

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CME QUESTIONS

1. The I-PASS intervention designed to improve handoffs included:

a. a process change and culture change campaign.

b. a workshop to teach communication skills and handoff techniques.

c. a role-play and simulation session.

d. a computer module to allow independent learning.

e. All of the above

2. Increased intensity of ICU care at the end of life, as quantified by increased average daily ICU costs, was associated higher perceived quality of dying in which group?

a. Families of younger patients

b. Families of older patients

c. Families of underinsured patients

d. Families of insured patients

e. Health care providers

3. What initial tidal volume was shown to improve outcomes in patients with ARDS?

a. 6 mL/kg predicted body weight (PBW)

b. 8 mL/kg PBW

c. 10 mL/kg PBW

d. 12 mL/kg PBW

e. None of the above

4. For ICU patients, sleep is disrupted from which source?

a. Bright lights above the bed at night

b. Care processes such as suctioning the ET tube

c. Receipt of mechanical ventilation

d. Environmental noise

e. All of the above

CME OBJECTIVES

Upon completion of this educational activity, participants should be able to:

- identify the particular clinical, legal, or scientific issues related to critical care;
- describe how those issues affect physicians, nurses, health care workers, hospitals, or the health care industry; and
- cite solutions to the problems associated with those issues.

[IN FUTURE ISSUES]