Evaluating the Economic Impact of Palliative and End-of-Life Care Interventions on Intensive Care Unit Utilization and Costs from the Hospital and Healthcare System Perspective

Nita Khandelwal, MD, MS,[1] Lyndia C. Brumback, PhD,[2] Scott D. Halpern, MD, PhD, MBE,[3] Norma B. Coe, PhD,[4] Babette Brumback, PhD,[5] and J. Randall Curtis, MD, MPH[6]

Abstract

Purpose of report: Understanding the impact of palliative care interventions on intensive care unit (ICU) costs and utilization is critical for demonstrating the value of palliative care. Performing these economic assessments, however, can be challenging. The purpose of this special report is to highlight and discuss important considerations when assessing ICU utilization and costs from the hospital perspective, with the goal of providing recommendations on methods to consider for future analyses.

Findings: ICU length of stay (LOS) and associated costs of care are common and important outcome measures, but must be analyzed properly to yield valid conclusions. There is significant variation in costs by day of stay in the ICU with only modest differences between an ICU day at the end of a stay and the first day on the acute care floor; this variation must be appropriately accounted for analytically. Furthermore, reporting direct variable costs, in addition to total ICU costs, is needed to understand short-term and long-term impact of a reduction in LOS. Importantly, incentives for the hospital to realize savings vary depending on reimbursement policies.

Summary: ICU utilization and costs are common outcomes in studies evaluating palliative care interventions. Accurate estimation and interpretation are key to understanding the economic implications of palliative care interventions.

Keywords: critical care; economics; ICU costs; palliative care

Introduction

In the United States, critical care costs are estimated to exceed $82 billion annually, accounting for 13% of inpatient hospital costs and 0.7% of the Gross Domestic Product.[1,2] Although the number of hospital beds in the United States has decreased over the past decade, the number of ICU beds has increased.[3] Consequently, interventions that target reducing costs in the ICU are of great interest.

While the primary goal of palliative and end-of-life care interventions is to improve the quality of care for seriously ill and dying patients, there is evidence to suggest that these interventions can simultaneously reduce nonbeneficial ICU utilization.[4] Understanding and evaluating the impact of these interventions on ICU costs has important implications for hospitals and healthcare systems that must operate in a resource-limited setting. Robust economic evaluations are needed to help payers and policy makers guide resource allocation[5,6] and decide the utility of investing in palliative and end-of-life care programs.

Conducting these evaluations in the ICU setting, however, can be challenging for a variety of reasons and may be fraught with common errors.[7,8] Our objective is to discuss important considerations when assessing the economic impact of these interventions on ICU resources, with the goal of providing recommendations on methods to consider for future analyses.

[1]Department of Anesthesiology and Pain Medicine, Harborview Medical Center, University of Washington, Seattle, Washington.
[2]Department of Biostatistics, University of Washington, Seattle, Washington.
[3]Division of Pulmonary, Allergy, and Critical Care, University of Pennsylvania, Philadelphia, Pennsylvania.
[4]Division of Medical Ethics and Health Policy, University of Pennsylvania, Philadelphia, Pennsylvania.
[5]Department of Biostatistics, University of Florida, Gainesville, Florida.
[6]Division of Pulmonary and Critical Care Medicine, Harborview Medical Center, University of Washington, Seattle, Washington.

Specifically, we will address: (1) length of stay (LOS) as an outcome measure; (2) complexities of costs and time horizon; and (3) economic evaluations from the hospital and healthcare system perspective under different payment models. This information is important for palliative care and ICU clinicians interested in making an economic case for the value of palliative care before and in the ICU.

Length of Stay as an Outcome Measure

LOS in the ICU is one of the most common outcome measures reported in studies evaluating palliative care interventions.[9–25] This is not surprising as it is an outcome of interest for patients, families, clinicians, and healthcare systems. Long ICU stays are costly to hospitals, payers, and society and more importantly, are associated with symptoms of pain, stress, and anxiety for patients and families.[26] Unlike many important outcomes of palliative care interventions, such as quality of life and quality of dying, it is also relatively easy to measure. However, this ease of measurement also creates opportunity for varied and errant measurement and analysis.

Several randomized trials evaluating palliative and end-of-life care interventions aimed at improving communication between patients, families, and medical teams have observed shorter mean LOS for ICU decedents in the intervention arm compared with the control arm.[9,10,15,27] In each of these trials, the investigators did not detect a difference in mean LOS between treatment arms for ICU survivors, nor did they detect a difference in the proportion who died in the ICU between intervention and control patients. It is therefore tempting to conclude that the primary mechanism for reducing LOS with palliative and end-of-life care interventions is earlier withdrawal of life-sustaining treatments in patients who are going to die. However, caution is needed when interpreting results from analyses that stratify on a variable (death in the ICU) that can only be known after randomization, and hence could be influenced by the intervention.[28] Thus, outcome-based subsample analyses, or analyses that stratify on events occurring after randomization, may yield biased results.[29]

Although it may be useful to demonstrate the very real possibility that a palliative care intervention's primary effect may be to shorten LOS among patients who will die in the ICU with or without the intervention, such analyses are most valid if the intervention's effect on mortality is truly null (i.e., a mortality effect of 0 with a very narrow confidence interval). This is a standard that will rarely be met given the modest sample sizes of most ICU-based palliative care trials. Nonetheless, this may be a valuable analysis, provided mortality in the ICU and overall are equivalent in the two treatment arms; however, demonstrating equivalence in this setting may be especially challenging.

An alternate approach to stratifying on death in the ICU is to apply standard survival analysis methods, such as Kaplan–Meier estimates, log rank tests, and Cox proportional hazards regression models. However, in many cases, these analyses ignore death, leading to uncertainty regarding whether the effect of a palliative or end-of-life care intervention on LOS was attributable to shortening the time to death, increasing the number of deaths, or reducing LOS among survivors. Some investigators censor LOS at the time of death for those who die in the ICU. However, for such approaches to yield interpretable results requires that censoring is not informa-

tive.[30] This is a problematic assumption, as patients' acuities and comorbid conditions are related to both their probability of dying and their LOS if they survive. Thus, the probability of censoring may be time dependent, and thus introduce bias even in randomized trials.[31]

A third approach to analyzing ICU LOS in studies of palliative care or similar interventions is to create a new outcome variable that takes the value of the observed LOS for those who leave the ICU alive and some prespecified value for those who die in the ICU. For example, the value for those who die in the ICU could be specified as the longest observed LOS (worst outcome), or some long but submaximal LOS, thereby accounting for the possibility that extremely long ICU LOS may be considered by some patients to be a fate worse than death. Nonparametric methods, such as Wilcoxon–Mann–Whitney tests, may then be used to compare the distributions of LOS outcomes under treatment and control because the exact numerical value of the new variable for those who died in the ICU does not matter, only its rank or "placement" in the observed data matters. As noted by Lin et al.,[30] this approach does not violate any of the statistical assumptions embedded in other analytic approaches. This approach should be specified *a priori* in studies employing it, and ideally would quantify the range of LOS values that death could assume based on studies of patients' preferences because the "right" ranking of death depends on how patients value the avoidance of long ICU LOS relative to death.

Alternatively, investigators can propose to "place" death in the ICU at a range of values on the LOS distribution and evaluate the degree to which the conclusions are sensitive to this ranking. Thus, although it may be unknowable how certain patients value long ICU lengths of stay relative to death, investigators can specify the range of such potential valuations over which the conclusions of the primary analysis would still apply. Because palliative care interventions are more likely to be beneficial by reducing lengths of stay than by saving lives, the sensitivity of the results to where death in the ICU is ranked on the LOS distribution is likely to be small. However, if a palliative care intervention were to increase ICU mortality, then appropriately accounting for preferences between long ICU stays and death will be essential.

A potential problem with each of these approaches is that deaths outside of the ICU are not accounted for. For example, consider a randomized trial comparing a palliative care intervention with usual care. Patients in the intervention group may leave the ICU sooner, and more commonly leave the ICU alive, if the intervention encourages earlier adoption of hospice care. Although this might be a beneficial effect from patients' perspectives, it would be wrong to conclude—as the foregoing approaches might—that the intervention saved lives. Its benefit would be in changing the circumstances, location, and nature of dying.

This highlights the potential value of studies in which patients can be followed for some time after leaving the ICU alive. In such cases, analyses that model the time alive and not in the ICU for some prespecified time after randomization (i.e., 28 or 60 days) become possible. This approach is analogous to outcomes such as "ventilator-free days"[32] or "ICU-free days".[33] Greater values of this outcome (time alive and not in ICU during some prespecified time after randomization) are better. For example, a patient who left the ICU after 3 days and was still alive 28 days after randomization would have an outcome of 25 days, a patient who left

the ICU after 20 days and was still alive 28 days after randomization would have an outcome of 8 days, a patient who left the ICU after 3 days and died outside the ICU 11 days after randomization would also have an outcome of 8 days, and a patient in the ICU the entire prespecified time of 28 days and a patient who died in the ICU at any time within 28 days of randomization would both have an outcome of 0 days. This approach is simple and provides more information about the effect of treatment on mortality. However, by not distinguishing between patients who die in the ICU on day 3 and patients who die in the ICU on day 28, these approaches fail to account for the fact that patients may value these outcomes quite differently. This is particularly important with regard to palliative care interventions because such interventions may work precisely by reducing duration of life support for those who will die regardless, which could be viewed by many patients, families, and society as beneficial.

In summary, LOS is an important but complicated outcome. The best way to analyze LOS will depend on the proposed mechanism of the intervention, the study population, and the research question. Additional research is needed to explore the pros and cons of the approaches we have described.

Variation in Cost by Day of Stay in the ICU and Marginal Difference between ICU Days and Acute Care Floor Days

For interventions that demonstrate a reduction in ICU LOS, the cost implications are heavily contingent upon where in the ICU stay the days are saved. This is because significant variability in cost exists by day of the stay in the ICU. By looking at patterns of daily costs in the ICU, several studies have found that costs are highest on admission day and then decline dramatically and stabilize after days 2–3.[34–38] One study developed a weighted ICU day as a measure of resource utilization, in which admission day was weighted 4×that of following days.[36] Another study found a similar pattern when looking at patients who were ventilated for more than 48 hours.[35] A sample of over 650,000 seriously ill patients in the ICUs of community hospitals also demonstrated this pattern of admission day being the most expensive with decreasing costs on subsequent days and levels stabilizing after day 2.[37]

Interestingly, a recent study looking at patterns of costs across various ICU settings found that higher day 1 costs were not found in patients admitted to medical/nonsurgical ICUs.[39] This suggests that careful examination of the patterns of daily costs and where in the ICU stay days are being reduced is needed. Simply documenting the reduction in ICU days does not accurately reflect the degree of savings, especially since days reduced are generally at the end of an ICU stay. Consequently, multiplying the average cost of an ICU day by the number of days saved will be misleading. Prior investigators have excluded the costs of the first two ICU days as a conservative approach to calculating costs,[40] although we do not recommend this approach since these are important ICU days, especially when the length of ICU stay is relatively short.

Many studies evaluating the effect of palliative care-type interventions have noted a reduction in ICU LOS for decedents.[9,10,27] In this situation, cost shifting does not occur since the decedent's care is not transferred elsewhere. Conversely, for patients who survive to ICU discharge and are transferred to the acute care floor (any non-ICU acute care

bed, including surgical, medical, obstetric, etc.), it is essential that cost shifting be taken into consideration. For the hospital perspective, assuming total hospital LOS is not affected by earlier ICU discharge, this is addressed by using the marginal difference between the last day in the ICU and the first day on the acute care floor to accurately estimate savings attributable to reducing ICU LOS.

On the other hand, if discharge from the ICU one day earlier leads to a one day reduction in total hospital LOS, the cost reduction would be the sum of the marginal difference between the last day in the ICU and first day on the acute care floor plus the cost of the final foregone floor day. As a result of the variation in costs by day of stay in the ICU, replacing ICU days later in the course of an ICU stay with acute care floor days may not result in dramatic savings[35] on a per-patient basis in the short term.

As a result of this variation in cost by day of stay in the ICU and the marginal difference between terminal ICU days and acute care floor days, the most accurate way to estimate the effect of palliative care interventions on ICU costs is to source primary cost data as the outcome of interest, rather than calculating costs through LOS effect estimates. Furthermore, obtaining a broader perspective that includes the post-ICU course is important to capture the effect of cost shifting. If primary cost data are not available, then factoring in the difference in costs by day of stay is needed to prevent misleading results.

Breaking Down Costs from the Hospital Perspective and Selecting a Time Horizon

The vast majority of studies reporting on hospital and ICU costs use total costs as the outcome of interest.[41] Demonstrating reductions in total costs, however, can be misleading, since not all types of costs will be affected in the same way with an intervention. While terminology may differ based on the costing system, there are generally three categories of cost to account for—indirect costs, direct fixed costs, and direct variable costs. Indirect costs represent costs that the hospital incurs irrespective of patient volume; examples include building maintenance and administrative salaries that are apportioned to all billing sectors of the hospital. Direct fixed costs represent costs that the hospital incurs to have an ICU of a particular size but are irrespective of ICU patient volume; examples can include staff salaries and equipment such as mechanical ventilators. Direct variable costs are costs that fluctuate with patient volume, characteristics, and intensity of treatment; examples include laboratories, supplies, and drugs.[42]

It is estimated that direct variable costs comprise roughly 20% of total ICU costs, with the remainder being direct fixed or indirect costs.[35,43,44] Thus, from the hospital perspective in the short-term, under volume-based fee-for-service (FFS) reimbursement, open beds have complicated economic implications because hospitals must continue to pay direct fixed and indirect costs irrespective of occupancy. Consequently, reporting the effect of interventions on ICU costs necessitates breaking down the cost outcome by indirect, direct fixed, and direct variable components. If investigators are unable to obtain primary cost data broken down into components, at the very minimum, estimates based on the literature of ICU cost components and discussion of the limitations in using total costs are warranted.

One of the reasons that breaking down costs into three categories is important is to help understand the cost savings

from the hospital perspective under different time horizon assumptions. The time horizon over which the effect of an intervention is being measured is an important factor for understanding the scale of cost savings. For example, over a short time horizon, changes in savings are likely to be most accurately reflected as changes in direct variable costs as these are costs that are sensitive to patient volume and individual patient characteristics such as severity of illness, whereas direct fixed and indirect costs are paid irrespective of patient volume and cannot be saved.

Conversely, over a very long time horizon, direct fixed costs can contribute to cost savings. This is because over a long enough time horizon, direct fixed costs—and potentially even indirect costs—can become variable.[8] For example, nursing staffing comprises an estimated 40% of total ICU costs[45] and is considered a fixed cost to the hospital as salaries are generally paid irrespective of patient volume. However, over a long time horizon, interventions that reduce bed occupancy may result in bed closures and the number of ICU nurses a hospital employs, leading to a reduction in direct fixed costs. Alternatively, such interventions may also reduce the rate of growth in ICU beds, which may also reduce healthcare costs over the long time horizon. Thus, the degree of cost savings realized in the ICU depends on the time horizon selected for the economic evaluation.

The Role of the Payment Model in Economic Evaluations from the Hospital and Healthcare System Perspective

Another reason to break costs into the three aforementioned categories is to understand the incentive hospitals and healthcare systems face to realize cost saving. Hospitals in the United States have traditionally been shielded from the incentive to cut costs because of the prevalence of FFS, also known as indemnity insurance plans, in the health insurance arena. These plans reimburse hospitals for their volume of services, regardless of their impact on patient outcomes. Thus, hospitals only had a financial incentive to limit use of services if the reimbursement amount was lower than the direct variable cost.

Experts agree that the FFS system is, at least in part, responsible for the soaring healthcare costs in the United States.[46–49] Efforts are underway to change how providers are paid, shifting the emphasis away from volume and toward value. In 2012, almost no Medicare payments were attached to value; under the Affordable Care Act, Medicare has planned to shift 50% of its payments to such programs by 2018.[50] While the future of the ACA remains uncertain, the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA), is not. MACRA ended the sustainable growth rate formula for physicians participating in Medicare Part B, and provides financial incentives to enroll in one of two value-based payment plans starting in 2017. The creation of Accountable Care Organizations (ACOs), a new payment and delivery model in which providers agree to collectively take responsibility for the quality and total healthcare costs for a population of patients, are one way in which healthcare systems are trying to improve healthcare and lower costs. ACOs participating in the Medicare Shared Saving Program are able to retain 50–60% of realized savings. More than 500 ACOs are currently being funded by the private, public, and combined sectors.[51]

Table 1 outlines the characteristics of the most popular value-based reimbursement plans.

These alternative payment models have varying degrees of financial incentive for hospitals to cut costs. Bundled payment

TABLE 1. SUMMARY OF DIFFERENT REIMBURSEMENT PLANS AND KEY OPPORTUNITIES FOR PALLIATIVE CARE INTERVENTIONS IN THE ICU

Reimbursement system[a]	Description	Opportunities for palliative care from the hospital perspective
Fee-for-service	Each service is paid for separately, and payment depends on the quantity of services provided. For example each office visit, laboratory test, or procedure will be paid for separately.	Provided hospital costs are greater than reimbursement, palliative care can have a key role in reducing unwanted intensity of care and corresponding costs.
Bundled payment	Reimbursement is based on an episode of care. The most common example of this is "global surgery periods," where reimbursement for a particular surgery is bundled–including preoperative, operative, and the postoperative period.	Provided hospital costs are greater than reimbursement, palliative care can have a key role in reducing unwanted intensity of care and corresponding costs.
Hospital value-based purchasing	This program rewards acute care hospitals based on quality of care provided. It factors in adherence to best clinical practices and patients' experiences of care during the admission. Incentive payments to hospitals are determined by performance on selected quality measures and improvements made in quality measures.	Palliative care can have a key role in improving the quality of care delivered.
Capitated payment	Reimbursement based on payment per person, rather than per service provided, irrespective of actual utilization. In this model, each health plan is paid a prospective capitation payment.	Palliative care can have an important role in managing high-cost patients with serious illness and multimorbidity.

[a]Reference: https://www.cms.gov

plans reimburse hospitals per episode of care, as opposed to per-item treatment costs. The larger bundle of goods on which hospitals are reimbursed make it more likely that the reimbursement is lower than the direct variable costs incurred with ICU care, and ICU stays are not always part of the treatment plan for the particular bundle. Under value-based purchasing, hospitals are reimbursed much like in a bundled payment plan, but face additional rewards or penalties tied to maintaining or increasing quality of care. To the extent that lower ICU usage and/or shorter ICU stays are included as quality measures,[52] hospitals have additional financial incentive to adopt interventions that curb nonbeneficial ICU stays. Finally, under capitated payment systems, hospitals or healthcare systems are reimbursed per patient, regardless of utilization. Hospitals under capitated systems have the strongest financial incentive to minimize costs for a given quality, since their income is predetermined by the number of covered lives. All costs related to the provision of care for these individuals are borne by the hospital or healthcare system. In other words, these hospitals and healthcare systems are responsible for the full marginal cost of all treatment decisions.

Reducing volume-based FFS reimbursement and increasing value-based purchasing has important implications for palliative care interventions in the ICU and elsewhere.[53] These interventions have the potential to improve quality of life and quality of dying for seriously ill patients, while simultaneously reducing unwanted or nonbeneficial aggressive, costly care. Consequently, incentives for hospitals and healthcare systems to expand these programs that can improve quality and reduce costs are likely to increase as we move toward value-based purchasing of healthcare.

Conclusion

Intensive care utilization at the end-of-life is increasing in the United States, despite evidence suggesting that this type of aggressive care is not consistent with values and preferences of most patients during the terminal phase of illness.[54] Palliative care interventions improve communication between medical teams, patients, and their families—helping to ensure that patients receive the care they want as they face serious illness. In addition to improving quality of care, to understand the *value* of palliative care, we must also understand the economic impact of these interventions. Understanding and assessing the effect on ICU utilization and costs from the hospital and healthcare system perspectives, however, can be challenging.

In this article, we have highlighted some of these challenges and recommendations to address these challenges (summary provided in Table 2). In particular, the move away from volume-based FFS reimbursement and toward value-based purchasing has important implications for palliative care interventions. These interventions have the potential to improve quality of life and quality of dying for seriously ill patients, while simultaneously reducing unwanted or nonbeneficial costly care, both metrics which now are financially rewarded. Consequently, hospitals and healthcare systems have increased incentives to adopt new palliative care interventions and expand palliative care programs that improve quality and reduce costs. This represents an opportunity for clinicians, researchers, and administrators interested in improving palliative care in the ICU. In an era focused on cost containment and transition from FFS to the value-based reimbursement environment, robust economic evaluations are needed to guide resource allocation.

TABLE 2. SUMMARY OF CHALLENGES TO CONSIDER AND RECOMMENDATIONS WHEN EVALUATING THE ECONOMIC IMPACT OF PALLIATIVE AND END-OF-LIFE CARE INTERVENTIONS ON ICU COSTS AND UTILIZATION

Challenge to consider	Rationale	Recommendations
ICU LOS as an outcome measure	This outcome measure is often reported stratified by death in the ICU, which is determined after randomization. Stratifying on a postrandomization variable may introduce bias.	Consider alternate approaches such as (a) creating a new outcome variable that takes the value of the observed LOS for those who leave the ICU alive and a prespecified value for those who die in the ICU, (b) modeling the time alive and not in the ICU for some prespecified time after randomization
Variation in cost by day of stay and marginal difference between ICU days and acute care floor days	ICU costs are not the same on all days of a stay. Using the average cost of an ICU day and multiplying it by LOS does not accurately reflect costs for a particular number of days in the ICU.	1. Obtain primary cost/day if possible, rather than calculating costs based on LOS. 2. If unable to obtain primary cost data, use published estimates of variation in costs by day of stay from the literature (37, 38, 40)
Breaking down costs from hospital perspective	Reporting total cost savings does not accurately reflect potential savings from the hospital perspective	1. When able to obtain primary cost data, break down reporting of costs into indirect, direct fixed and direct variable components. 2. If unable to obtain components of costs, consider using percentage estimates from the literature as a discussion point (37, 40).
Selecting a time horizon	Degree of potential savings depends on the time horizon that is being considered.	1. When selecting a short time horizon, savings should reflect direct variable costs. 2. When selecting a long time horizon, savings can reflect both direct variable costs and discussion of potential direct fixed costs than can be saved.

LOS, Length of stay.

Author's Contributions

All authors made substantial contributions to the design of the work; AND participated in revising it critically; AND provided final approval of the version to be published; AND agree to be accountable for the work.

Acknowledgment

Author Disclosure Statement

The authors all attest that they do not have any potential or actual personal or financial involvement with any company or organization with financial interest in the subject matter.

References

1. Halpern NA, Pastores SM: Critical care medicine in the United States 2000–2005: An analysis of bed numbers, occupancy rates, payer mix, and costs. Crit Care Med 2010;38:65–71.
2. Pastores SM, Dakwar J, Halpern NA: Costs of critical care medicine. Crit Care Clin 2012;28:1–10.v.
3. Wallace DJ, Angus DC, Seymour CW, et al.: Critical care bed growth in the United States. A comparison of regional and national trends. Am J Respir Crit Care Med 2015;191:410–416.
4. Khandelwal N, Kross EK, Engelberg RA, et al.: Estimating the effect of palliative care interventions and advance care planning on ICU utilization: A systematic review. Crit Care Med 2015;43:1102–1111.
5. Meier DE, Beresford L: Palliative care cost research can help other palliative care programs make their case. J Palliat Med 2009;12:15–20.
6. May P, Normand C, Morrison RS: Economic impact of hospital inpatient palliative care consultation: Review of current evidence and directions for future research. J Palliat Med 2014;17:1054–1063.
7. Luce JM, Rubenfeld GD: Can health care costs be reduced by limiting intensive care at the end of life? Am J Respir Crit Care Med 2002;165:750–754.
8. Curtis JR, Engelberg RA, Bensink ME, Ramsey SD: End-of-life care in the intensive care unit: Can we simultaneously increase quality and reduce costs? Am J Respir Crit Care Med 2012;186:587–592.
9. Schneiderman LJ, Gilmer T, Teetzel HD: Impact of ethics consultations in the intensive care setting: A randomized, controlled trial. Crit Care Med 2000;28:3920–3924.
10. Schneiderman LJ, Gilmer T, Teetzel HD, et al.: Effect of ethics consultations on nonbeneficial life-sustaining treatments in the intensive care setting: A randomized controlled trial. JAMA 2003:1166–1172.
11. Lautrette A, Darmon M, Megarbane B, et al.: A communication strategy and brochure for relatives of patients dying in the ICU. N Engl J Med 2007;356:469–478.
12. Bakitas M, Lyons KD, Hegel MT, et al.: Effects of a palliative care intervention on clinical outcomes in patients with advanced cancer: The Project ENABLE II randomized controlled trial. JAMA 2009:741–749.
13. Cheung W, Aggarwal G, Fugaccia E, et al.: Palliative care teams in the intensive care unit: A randomised, controlled, feasibility study. Crit Care Resusc 2010:28–35.
14. Curtis JR, Nielsen E, Treece P, et al.: Integrating palliative and critical care: Randomized trial of a quality improvement intervention. Crit Care Med 2009;37:A388.
15. Curtis JR, Nielsen EL, Treece PD, et al.: Effect of a quality-improvement intervention on end-of-life care in the intensive care unit: A randomized trial. Am J Respir Crit Care Med 2011;183:348–355.
16. Andereck WS, McGaughey JW, Schneiderman LJ, et al.: Seeking to reduce nonbeneficial treatment in the ICU: An exploratory trial of proactive ethics consultation. Crit Care Med 2014;42:824–830.
17. Dowdy MD, Robertson C, Bander JA: A study of proactive ethics consultation for critically and terminally ill patients with extended lengths of stay. Crit Care Med 1998;26:252–259.
18. Campbell ML, Guzman JA: A proactive approach to improve end-of-life care in a medical intensive care unit for patients with terminal dementia. Crit Care Med 2004;32:1839–1843.
19. Lilly CM, Sonna LA, Haley KJ, Massaro AF: Intensive communication: Four-year follow-up from a clinical practice study. Crit Care Med 2003;31:S394–S399.
20. Penrod JD, Deb P, Luhrs C, et al.: Cost and utilization outcomes of patients receiving hospital-based palliative care consultation. J Palliat Med 2006;9:855–860.
21. Penrod JD, Deb P, Dellenbaugh C, et al.: Hospital-based palliative care consultation: Effects on hospital cost. J Palliat Med 2010;13:973–979.
22. Norton SA, Hogan LA, Holloway RG, et al.: Proactive palliative care in the medical intensive care unit: Effects on length of stay for selected high-risk patients. Crit Care Med 2007;35:1530–1535.
23. Mosenthal AC, Murphy PA, Barker LK, et al.: Changing the culture around end-of-life care in the trauma intensive care unit. J Trauma 2008;64:1587–1593.
24. Shelton W, Moore CD, Socaris S, et al.: The effect of a family support intervention on family satisfaction, length-of-stay, and cost of care in the intensive care unit. Crit Care Med 2010;38:1315–1320.
25. Daly BJ, Douglas SL, O'Toole E, et al.: Effectiveness trial of an intensive communication structure for families of long-stay ICU patients. Chest 2010:1340–1348.
26. McAdam JL, Dracup KA, White DB, et al.: Symptom experiences of family members of intensive care unit patients at high risk for dying. Crit Care Med 2010;38:1078–1085.
27. Curtis JR, Treece PD, Nielsen EL, et al.: Randomized trial of communication facilitators to reduce family distress and intensity of end-of-life care. Am J Respir Crit Care Med 2016;193:154–162.
28. Rosenbaum PR: The consequences of adjustment for a concomitant variable that has been affected by the treatment. J Roy Stat Soc A Stat 1984;147:656–666.
29. May P, Garrido MM, Cassel JB, et al.: Using length of stay to control for unobserved heterogeneity when estimating treatment effect on hospital costs with observational data: Issues of reliability, robustness, and usefulness. Health Serv Res 2016;51:2020–2043.
30. Lin W, Halpern SD, Prasad Kerlin M, Small DS.: A "placement of death" approach for studies of treatment effects on ICU length of stay. Stat Methods Med Res 2017;26:292–311.
31. Aalen OO, Cook RJ, Roysland K: Does Cox analysis of a randomized survival study yield a causal treatment effect? Lifetime Data Anal 2015;21:579–593.

32. Schoenfeld DA, Bernard GR, Network A: Statistical evaluation of ventilator-free days as an efficacy measure in clinical trials of treatments for acute respiratory distress syndrome. Crit Care Med 2002;30:1772–1777.

33. Young P, Saxena M, Bellomo R, et al.: Acetaminophen for fever in critically ill patients with suspected infection. N Engl J Med 2015;373:2215–2224.

34. Dasta JF, McLaughlin TP, Mody SH, Piech CT: Daily cost of an intensive care unit day: The contribution of mechanical ventilation. Crit Care Med 2005;33:1266–1271.

35. Kahn JM, Rubenfeld GD, Rohrbach J, Fuchs BD: Cost savings attributable to reductions in intensive care unit length of stay for mechanically ventilated patients. Med Care 2008;46:1226–1233.

36. Rapoport J, Teres D, Zhao Y, Lemeshow S: Length of stay data as a guide to hospital economic performance for ICU patients. Med Care 2003;41:386–397.

37. Khandelwal N, Benkeser DC, Coe NB, Curtis JR: Potential influence of advance care planning and palliative care consultation on ICU costs for patients with chronic and serious illness. Crit Care Med 2016;44:1474–1481.

38. Khandelwal N, Benkeser D, Coe NB, et al.: Patterns of cost for patients dying in the intensive care unit and implications for cost savings of palliative care interventions. J Palliat Med 2016;19:1171–1178.

39. Gershengorn HB, Garland A, Gong MN: Patterns of daily costs differ for medical and surgical intensive care unit patients. Ann Am Thorac Soc 2015;12:1831–1836.

40. Ciemins EL, Blum L, Nunley M, et al.: The economic and clinical impact of an inpatient palliative care consultation service: A multifaceted approach. J Palliat Med 2007;10:1347–1355.

41. Smith S, Brick A, O'Hara S, Normand C: Evidence on the cost and cost-effectiveness of palliative care: A literature review. Palliat Med 2014;28:130–150.

42. Wunsch H, Gershengorn H, Scales DC: Economics of ICU organization and management. Crit Care Clin 2012;28:25–37.v.

43. Roberts RR, Frutos PW, Ciavarella GG, et al.: Distribution of variable vs fixed costs of hospital care. JAMA 1999;281:644–649.

44. Cooke CR: Economics of mechanical ventilation and respiratory failure. Crit Care Clin 2012;28:39–55.vi.

45. Noseworthy TW, Konopad E, Shustack A, et al.: Cost accounting of adult intensive care: Methods and human and capital inputs. Crit Care Med 1996;24:1168–1172.

46. Emanuel EJ, Fuchs VR: The perfect storm of overutilization. JAMA 2008;299:2789–2791.

47. Chernew ME: Reforming payment for health care services. Arch Inter Med 2010;170:1742–1744.

48. Fuchs VR: Eliminating ''Waste'' in health care. JAMA 2009;302:2481–2482.

49. Gosden T, Forland F, Kristiansen IS, et al.: Capitation, salary, fee-for-service and mixed systems of payment: Effects on the behaviour of primary care physicians. Cochrane Database Syst Rev 2000:CD002215.

50. Burwell SM: Setting value-based payment goals—HHS efforts to improve US Health Care. N Engl J Med 2015;372:897–899.

51. Abrams M, Nuzum R, Zezza M, et al.: The Affordable Care Act's payment and delivery system reforms: A progress report at three years. The Commonwealth Fund, May 2015. http://www.commonwealthfund.org/∼/media/files/publications/issue-briefs/2015/may/1816_abrams_aca_reforms_delivery_payment_rb.pdf (last accessed September 25, 2017).

52. National Hospital Quality Measures—ICU. www.jointcommission.org/national_hospital_quality_measures_-_icu (Last Accessed March 18, 2016).

53. Smith G, Bernacki R, Block SD: The role of palliative care in population management and accountable care organizations. J Palliat Med 2015;18:486–494.

54. Teno JM, Gozalo PL, Bynum JP, et al.: Change in end-of-life care for Medicare beneficiaries: Site of death, place of care, and health care transitions in 2000, 2005, and 2009. JAMA 2013;309:470–477.

Address correspondence to:
Nita Khandelwal, MD, MS
Department of Anesthesiology and Pain Medicine
University of Washington
Harborview Medical Center
Seattle, WA 98104

E-mail: khandel@uw.edu