

Review

Clinical review: Impact of emergency department care on intensive care unit costs

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Abstract

Critical care is both expensive and increasing. Emergency department (ED) management of critically ill patients before intensive care unit (ICU) admission is an under-explored area of potential cost saving in the ICU. Although limited, current data suggest that ED care has a significant impact on ICU costs both positive and negative. ICU practices can also affect the ED, with a lack of ICU beds being the primary reason for ED overcrowding and ambulance diversion in the USA. Earlier application in the ED of intensive therapies such as goal-directed therapy and noninvasive ventilation may reduce ICU costs by decreasing length of stay and need for admission. Future critical care policies and health services research should include both the ED and ICU in their analyses.

Keywords cost, critical care, emergency department, emergency medicine, intensive care, intensive care unit

Introduction

The cost of critical care is widely recognized as both expensive and increasing [1,2]. Government and private organizations have devoted considerable effort to devising cost control strategies for intensive care units (ICUs) [3,4]. One under-explored area of potential cost saving is how critically ill patients are managed in the emergency department (ED). Specifically, what impact does initial ED care of critically ill patients have on downstream ICU costs? There are surprisingly few data with which to address this question, but we examine what is available.

Critical care delivery in the emergency department

It is first important to recognize that a significant amount of critical care is already performed in the ED. In the 2001 US National Hospital Ambulatory Medical Care Survey [5], 19.2% of all ED patients were classified as emergent (patients who should be seen within 15 min), and over 992,000 patients were admitted to an ICU through an ED. The average ICU bed wait time in this survey was slightly

over 4 hours. Furthermore, there is evidence that the amount of critical illness in EDs is increasing. Lambe and coworkers [6] reported that, in Californian EDs, critical visits increased by 59% between 1990 and 1999, whereas nonurgent visits actually decreased by 8%. Several US single-center studies have also documented the extent of critical care delivery in EDs. Fromm and coworkers [7] reported that, during a 1-year study period in a teaching hospital, 154 patient-days of ED critical care were provided, with ED length of stays (LOSs) for these patients of up to nearly 11 hours. Nguyen and colleagues [8] estimated that an even greater amount of critical care, 464.4 patient-days, was provided annually in their large urban teaching hospital. Similarly, Nelson and coworkers [9] examined the amount of critical care provided in their urban hospital's ED and ICUs during a 3-month study, and found that 15% of all critical care was performed in the ED. Finally, Varon and coworkers [10] and Svenson and colleagues [11] reported that critically ill patients spent several hours in the ED before transfer to an ICU, and that critical care procedures were commonly performed in the ED.

ED = emergency department; EGDT = early goal-directed therapy; ICU = intensive care unit; LOS = length of stay; NIPPV = noninvasive positive pressure ventilation.

Does suboptimal emergency department care increase intensive care unit cost?

ED-specific data are limited, but research on related areas sheds some light on this question. McQuillan and coworkers [12] conducted a confidential inquiry into the quality of ward care before ICU admission of 100 consecutive adult patients in two UK hospitals and found several areas of concern. Based on methodology used in previous UK confidential inquiries, the authors performed structured interviews of both the ward team and the intensive care team. Emphasis was placed on the recognition and management of abnormalities in five main categories: airway, breathing, circulation, oxygen therapy and monitoring. Interview data were anonymized and sent to two intensivists, who then assessed the quality of care before ICU admission, the appropriateness and timeliness of the ICU admission, and adequacy of management in the five main categories. The assessors agreed that over half of the patients ($n = 54$) received suboptimal care. Of these 54 patients, 69% were deemed to have been admitted to the ICU late, and in 53.5% it was concluded that their suboptimal care definitely or probably contributed to morbidity or mortality.

Over a 1-year period, Gray and colleagues [13] examined all patients transferred from 29 EDs within a defined UK regional health authority to an ICU of a different hospital. They also found areas of concern. Despite national UK guidelines for transport of the critically ill [14], only 44% of ventilated patients had end-tidal carbon dioxide monitoring and 78% had invasive blood pressure monitoring. Critical incidents, although not specifically defined by the authors, occurred in 15% of the patients during transport. That study used a prospective observational design and it did not look for associations between absence of monitoring and critical incidents.

Han and coworkers [15] recently conducted a 9-year retrospective cohort study of 91 pediatric patients who presented to local community hospitals with septic shock and who required transport to the Children's Hospital of Pittsburgh. They found that each additional hour of persistent shock was associated with a greater than twofold increase in mortality. Furthermore, resuscitation practice was consistent with American College of Critical Care Medicine Pediatric Advanced Life Support guidelines [16] in only 30% of patients. A higher mortality rate was observed in those patients who were not resuscitated consistent with the guidelines (38% versus 8%).

Although these studies did not examine economic impact, it is possible that the morbidity they noted resulted in increased cost. This is partly borne out by a study conducted by Teres and colleagues [17] that examined the effect of severity of illness at ICU admission on resource use in 2434 patients with sepsis in 57 ICUs in the USA. They found that, in survivors, increasing severity of illness was associated with

an increased mean ICU LOS, but that among nonsurvivors the sickest patients had the shortest LOS. A likely interpretation of this finding is that these severely ill patients died sooner in the ICU, thus reducing their LOS. Higgins and coworkers [18] examined records from 10,900 patients in 34 ICUs in the USA and tried to elucidate early indicators of prolonged LOS in the ICU. The authors found that severity of illness partially accounted for high LOS, but more importantly they also concluded that longer ward stays before ICU admission were associated with increased LOS in the ICU. They could not determine whether this association was due to overly strict ICU admission criteria, suboptimal ward care, or other reasons, but they speculated that reducing pre-ICU LOS by identifying ward patients before they decompensated might reduce ICU costs. The effect of ED care on ICU LOS was not considered in that study, but it is quite possible that an analogous relationship exists.

Does optimal emergency department care decrease intensive care units costs?

Decreased need for intensive care unit admission

One of the founders of critical care, Dr Ake Grenvik, wrote in the preface of the *Textbook of Critical Care* (4th edition) that, 'many critically ill patients no longer need admission to the hospital if the diagnostic work-up and treatment may be completed in an ED short-term ICU' [19]. A retrospective Austrian study conducted by Bur [20] of a 2-year period of ED visits supports this statement. Of 1498 patients who presented with unstable life-threatening emergencies to their ED for treatment, only 37% were ultimately admitted to an ICU, whereas 38% were admitted to a ward and 2% were able to be discharged. Similar numbers were seen with patients who were stable but needed immediate care, leading the authors to conclude that, 'providing acute and immediate care in our ED saves both ICU and open ward facilities'. Nguyen and colleagues [8] quantified the impact of ED care on 81 critically ill patients and showed that the greatest rate of physiologic improvement, as measured by Acute Physiology and Chronic Health Evaluation II, Simplified Acute Physiology Score II and Multiple Organ Dysfunction Score, occurred during the ED stay (mean ED LOS of 5.9 ± 2.7 hours). This resulted in 11% of these patients being 'downgraded' to a non-ICU bed after ED care, despite having initially been accepted to the ICU. Similarly, in the study conducted by Nelson and coworkers [9], 10% of patients receiving critical care in their ED were admitted to a non-ICU bed. The natural counterpoint is the potential for a critically ill patient to be inappropriately sent to a ward after temporary improvement in the ED. These studies did not specifically look at this issue, which should be addressed in future research.

Decreased level of care needed in the intensive care unit

In patients who still require ICU admission, some data suggest that early, optimal ED care may decrease the level of care needed in the ICU. Rivers and coworkers [21] showed that early goal-directed therapy (EGDT) for severe sepsis and

septic shock, performed in the ED before ICU admission, reduced not only mortality but also the need for mechanical ventilation and pulmonary artery catheter use. Similarly, noninvasive positive pressure ventilation (NIPPV) for acute respiratory failure may not only improve outcome [22,23] but also reduce ICU costs. Giacomini [24] conducted a prospective uncontrolled trial of short-term NIPPV in 58 ED patients with acute cardiogenic pulmonary edema, hypoxia, and severe respiratory distress. Intubation and ICU admission were avoided in 43 patients (74%).

Decreased intensive care unit length of stay

Optimal ED care may also reduce ICU LOS. The average daily cost for an ICU bed has been estimated at US\$2573 [25], although it has been noted that resource consumption, and therefore cost, is highest during the first days in the ICU [26]. Rivers and coworkers [21] showed that EGDT reduces hospital LOS in survivors, while a large body of evidence supports the ability of NIPPV to reduce the need for intubation and LOS in the ICU in patients with chronic obstructive pulmonary disease [27]. A business plan conducted at Henry Ford Hospital in Detroit, Michigan, showed that EGDT saved US\$11.5 million and 3800 patient-days annually [28]. These savings allowed the high acuity area of the Henry Ford ED to be upgraded in space, equipment, and personnel. Preliminary work at the University of Pittsburgh on a formal cost-effectiveness analysis suggests that EGDT is extremely cost-effective over a wide range of assumptions [29].

How does the intensive care unit affect the emergency department?

As with all hospital areas, the relationship between the ED and ICU is a mutual one, with each affecting the other in a continuous feedback loop. First, ED overcrowding is directly related to lack of ICU bed space. In the USA the primary reason for both ED overcrowding and ED 'diversion' (wherein an ED is forced to turn away ambulances because of the hospital's lack of capacity) is a lack of ICU beds [5,30,31]. Second, ED overcrowding has a negative impact on patient care. Perhaps most importantly, overcrowding leads to a ballooning in patient–nurse ratios because, unlike ICUs, EDs have no set patient–nurse ratios. In a widely quoted 2002 article published in *JAMA*, Aiken and coworkers [32] reported that higher patient–nurse ratios were associated with increased mortality in ward patients. As Church previously noted [33], a similar relationship might exist for ED patients as well. A lack of inpatient beds has also been shown to increase ED LOS for admitted patients [34], which in turn has been associated with a delay in nurse implementation of orders for critically ill patients, both in the ED and upon arrival in the ICU [35].

Finally, in the UK study conducted by Gray and coworkers [13] the second most commonly noted reason for transfer of critically ill ED patients to a referral hospital was a lack of an

available bed in the first hospital's ICU. Those investigators emphasized that transfers for such nonclinical reasons should ideally be the most stable patient requiring critical care, but that this is probably not the case for ED patients who have just begun their course of care. Optimal management of critically ill patient transfers have therefore become a major issue, not only for the ICU [36] but also for the ED [37]. Clearly, then, the link between the ED and ICU is a mutual one, with actions in one area having a significant impact on the other.

Implications for controlling the cost of critical care

The paucity of data regarding the impact of ED care of critically patients on ICU costs represents a challenge and opportunity for health services research. Many questions need to be explored, recognizing that the ICU does not operate in isolation. Medical emergency response teams and critical care outreach have been shown to have a positive impact on care and, potentially, on the cost of ward patients [38–40]. Should these concepts be extended to EDs as well, above and beyond existing early intervention models for stroke, myocardial infarction, and trauma? How should the ED and ICU be more closely operationally aligned, as suggested by recent papers from the UK [41,42], Canada [43], the USA [44] and Australia [45]? Also, what is the best way to spend the 'critical care budget'? If early ED care can save ICU costs, should health care budgets be adjusted accordingly?

As we pursue formal health services research answers to these questions, practical steps forward can be made today. Hospital finance committees considering the cost of critical care should look beyond the ICU, and examine how ED care, ED–ICU transfer times, delay in reaching ICU consultants, and other issues affect efficiency and cost at their institution. Whenever possible, the ED and ICU should jointly decide upon issues of mutual interest and responsibility. For example, there would be less benefit, financial or physical, to starting protocols such as postcardiac arrest hypothermia or EGDT if both the ED and ICU do not agree to follow these protocols strictly. Unfortunately, many clinical guidelines have been produced with minimal involvement from the ED, which unsurprisingly has contributed to difficulty in changing ED practice. Future critical care initiatives should involve the ED and other potential stakeholders. The inclusion of the American College of Emergency Physicians in the Surviving Sepsis Campaign is a positive step in the right direction.

Perhaps the most important step is for all of us who care for critically ill patients to hearken back to the ideals of the late Dr Peter Safar, who envisioned critical care as a seamless process that crossed artificial organizational boundaries. In 1974, Dr Safar wrote that, 'the most sophisticated intensive care often becomes unnecessarily expensive terminal care when the pre-ICU system fails' [46]. Three decades later these words still ring true.

Conclusion

Critical care is often performed in the ED, such that there is a mutual link between the ED and the ICU. The available data strongly suggest that ED care of critically ill patients can affect ICU costs, both positively and negatively. More proximal delivery of critical care in the ED, before ICU admission, may decrease downstream ICU costs and yield significant system savings. Conversely, ICU practices can also have an impact on the ED. Optimizing the cost-effectiveness of critical care should involve both the ED and ICU. Future research should examine the effect of ED interventions on subsequent ICU costs as well as on patient outcomes. Most importantly, critical care must be seen as a continuum of care so that maximum patient benefit may be achieved and hospital costs minimized.

Competing interests

The author(s) declare that they have no competing interests.

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References

- Halpern NA, Bettes L, Greenstein R: **Federal and nationwide intensive care units and healthcare costs: 1986–1992.** *Crit Care Med* 1994, **22**:2001-2007.
- Angus DC, Kelley MA, Schmitz RJ, White A, Popovich JJ: **Current and projected workforce requirements for care of the critically ill and patients with pulmonary disease: Can we meet the requirements of an aging population?** *JAMA* 2000, **284**:2762-2770.
- Sachdeva RC: **Intensive care: a cost effective option for developing countries?** *Indian J Pediatr* 2001, **68**:339-342. (Erratum appears in *Indian J Pediatr* 2001, **68**:404.)
- Apolone G, Melotti RM, Repetto F, Iapichino G: **Cost containment: Europe. Italy.** *New Horiz* 1994, **2**:350-356.
- McCaig L, Burt C: *National Hospital Ambulatory Medical Care Survey: 2001 Emergency Department Summary. Advance Data from Vital and Health Statistics, Centre for Disease Control and Prevention, National Centre for Health Statistics, 2003 Report No 335.*
- Lambe S, Washington DL, Fink A, Herbst K, Liu HH, Fosse JS, Asch SM: **Trends in the use and capacity of California's emergency departments, 1990–1999.** *Ann Emerg Med* 2002, **39**:389-396.
- Fromm RE Jr, Gibbs LR, McCallum WG, Niziol C, Babcock JC, Gueler AC, Levine RL: **Critical care in the emergency department: a time-based study.** *Crit Care Med* 1993, **21**:970-976.
- Nguyen HB, Rivers EP, Havstad S, Knoblich B, Ressler JA, Muzzin AM, Tomlanovich MC: **Critical care in the emergency department: A physiologic assessment and outcome evaluation.** *Acad Emerg Med* 2000, **7**:1354-1361.
- Nelson M, Waldrop RD, Jones J, Randall Z: **Critical care provided in an urban emergency department.** *Am J Emerg Med* 1998, **16**:56-59.
- Varon J, Fromm RE, Levine RL: **Emergency department procedures and length of stay for critically ill medical patients.** *Ann Emerg Med* 1994, **23**:546-549.
- Svenson J, Besinger B, Stapczynski JS: **Critical care of medical and surgical patients in the ED: Length of stay and initiation of intensive care procedures.** *Am J Emerg Med* 1997, **15**:654-657.
- McQuillan P, Pilkington S, Allan A, Taylor B, Short A, Morgan G, Nielsen M, Barrett D, Smith G, Collins CH: **Confidential inquiry into quality of care before admission to intensive care.** *BMJ* 1998, **316**:1853-1858.
- Gray A, Gill S, Airey M, Williams R: **Descriptive epidemiology of adult critical care transfers from the emergency department.** *Emerg Med J* 2003, **20**:242-246.
- Intensive Care Society: *Guidelines for the Transport of the Critically Ill Adult.* London: Intensive Care Society; 2002.
- Han YY, Carcillo JA, Dragotta MA, Bills DM, Watson RS, Westerman ME, Orr RA: **Early reversal of pediatric-neonatal septic shock by community physicians is associated with improved outcome.** *Pediatrics* 2003, **112**:793-799.
- Carcillo JA, Fields AI, Task Force Committee Members: **Clinical practice parameters for hemodynamic support of pediatric and neonatal patients in septic shock.** *Crit Care Med* 2002, **30**:1365-1378.
- Teres D, Rapoport J, Lemeshow S, Kim S, Akhras K: **Effects of severity of illness on resource use by survivors and nonsurvivors of severe sepsis at intensive care unit admission.** *Crit Care Med* 2002, **30**:2413-2419.
- Higgins TL, Mcgee WT, Steingrub JS, Rapoport J, Lemeshow S, Teres D: **Early indicators of prolonged intensive care unit stay: Impact of illness severity, physician staffing, and pre-intensive care unit length of stay.** *Crit Care Med* 2003, **31**:45-51.
- Grenvik A, Ayres SM, Holbrook PR, Shoemaker WC. *Textbook of Critical Care*, 4th edn. Philadelphia: W.B. Saunders Company; 2000.
- Bur A: **The emergency department in a 2000-bed teaching hospital: saving open ward and intensive care facilities.** *Eur J Emerg Med* 1997, **4**:19-23.
- Rivers E, Nguyen B, Havstad S, Ressler J, Muzzin A, Knoblich B, Peterson E, Tomlanovich M, for the Early Goal-Directed Therapy Collaborative Group: **Early goal-directed therapy in the treatment of severe sepsis and septic shock.** *N Engl J Med* 2001, **345**:1368-1377.
- Evans TW, Albert RK, Angus DC, Bion JF, Chiche J-D, Epstein SK, Fagon JY, Ranieri M, Sznajder JI, Torres A, et al.: **International Consensus Conferences in Intensive Care Medicine: noninvasive positive pressure ventilation in acute respiratory failure.** *Am J Respir Crit Care Med* 2001, **163**:283-291.
- Crane SD, Elliott MW, Gilligan P, Richards K, Gray AJ: **Randomised controlled comparison of continuous positive airways pressure, bilevel non-invasive ventilation, and standard treatment in emergency department patients with acute cardiogenic pulmonary oedema.** *Emerg Med J* 2004, **21**:155-161.
- Giacomini: **Short-term noninvasive pressure support ventilation prevents ICU admittance in patients with acute cardiogenic pulmonary edema (vol 123, pg 2057, 2003).** *Chest* 2003, **124**:1181.
- Rahim MT, Milbrandt EB, Dremsizov TT, Kersten A, Linde-Zwirble WT, Watson RS, Clermont G, Angus DC: **Pricing critical care: an updated Russell equation [abstract].** *Crit Care Med* 2004, **Suppl 1**:P76.
- Taheri PA, Butz DA, Greenfield LJ: **Length of stay has minimal impact on the cost of hospital admission.** *J Am Coll Surg* 2000, **191**:123-130.
- Liesching T, Kwok H, Hill NS: **Acute applications of noninvasive positive pressure ventilation.** *Chest* 2003, **124**:699-713.
- Rivers EP, Nguyen HB, Huang DT, Donnino MW: **Critical care and emergency medicine.** *Curr Opin Crit Care* 2002, **8**:600-606.
- Huang DT, Angus DC, Dremsizov TT, Rivers EP, Clermont G: **Cost-effectiveness analysis of early goal-directed therapy in the treatment of severe sepsis and septic shock [abstract].** *Crit Care* 2003, **Suppl 2**:S116.
- American Hospital Association, The Lewin Group: *Emergency Department Overload: A Growing Crisis. The Results of the AHA Survey of Emergency Department (ED) and Hospital Capacity, 2002* [http://www.hospitalconnect.com/aha/press_room-info/content/EdoCrisisSlides.pdf].
- United States General Accounting Office: *Hospital Emergency Departments: Crowded Conditions Vary Among Hospitals and Communities.* Report to the Ranking Minority Member, Committee on Finance, US Senate. 2003, GAO-03-460.
- Aiken LH, Clarke SP, Sloane DM, Sochalski J, Silber JH: **Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction.** *JAMA* 2002, **288**:1987-1993.
- Church A: **Critical care and emergency medicine.** *Crit Care Clin* 2003, **19**:271-278.
- Forster AJ, Stiell I, Wells G, Lee AJ, van Walraven C: **The effect of hospital occupancy on emergency department length of stay and patient disposition.** *Acad Emerg Med* 2003, **10**:127-133.

35. Clark K, Normile LB: **Delays in implementing admission orders for critical care patients associated with length of stay in emergency departments in six mid-atlantic states.** *J Emerg Nursing* 2002, **28**:489-495.
36. Warren J, Fromm RE Jr, Orr RA, Rotello LC, Horst HM: **Guidelines for the inter- and intrahospital transport of critically ill patients.** *Crit Care Med* 2004, **32**:256-262.
37. Gray A, Bush S, Whiteley S: **Secondary transport of the critically ill and injured adult.** *Emerg Med J* 2004, **21**:281-285.
38. Bright D, Walker W, Bion J: **Clinical review: outreach – a strategy for improving the care of the acutely ill hospitalized patient.** *Crit Care* 2004, **8**:33-40.
39. Ball C, Kirkby M, Williams S: **Effect of the critical care outreach team on patient survival to discharge from hospital and readmission to critical care: non-randomised population based study.** *BMJ* 2003, **327**:1014-1016A.
40. Buist MD, Moore GE, Bernard SA, Waxman BP, Anderson JN, Nguyen TV: **Effects of a medical emergency team on reduction of incidence of and mortality from unexpected cardiac arrests in hospital: preliminary study.** *BMJ* 2002, **324**:387-390.
41. Nightingale P: **Improving the care of the seriously ill patient: the interface between the accident and emergency department and critical care areas.** *Emerg Med J* 2001, **18**:326-327.
42. Brown T: **Emergency physicians in critical care: a consultant's experience.** *Emerg Med J* 2004, **21**:145-148.
43. Melanson P: **Critical care medicine as a subspecialty of emergency medicine.** *CJEM* 2000, **2**:258-261.
44. Gunn S, Grenvik A: **Emergency medicine and critical care certification.** *Acad Emerg Med* 2002, **9**:322-323.
45. Hore CT, Lancashire W, Roberts JB, Fassett R: **Integrated critical care: an approach to specialist cover for critical care in the rural setting.** *Med J Aust* 2003, **179**:95-97.
46. Safar P: **Critical care medicine: quo vadis?** *Crit Care Med* 1974, **2**:1-5.