Review Article

Staffing and workforce issues in the pediatric intensive care unit

Derek S. Wheeler[1,2], Maya Dewan[1,2], Andrea Maxwell[1,2], Carley L. Riley[1,2], Erika L. Stalets[1,2]

[1]Division of Critical Care Medicine, Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA; [2]Department of Pediatrics, University of Cincinnati College of Medicine, Cincinnati, OH, USA

Contributions: (I) Conception and design: DS Wheeler; (II) Administrative support: None; (III) Provision of study materials or patients: None; (IV) Collection and assembly of data: None; (V) Data analysis and interpretation: None; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Derek S. Wheeler, MD, MMM, MBA. Cincinnati Children's Hospital Medical Center, 3333 Burnet Avenue, Cincinnati, OH 45229-3039, USA. Email: Derek.Wheeler@cchmc.org.

Abstract: The health care industry is in the midst of incredible change, and unfortunately, change is not easy. The intensive care unit (ICU) plays a critical role in the overall delivery of care to patients in the hospital. Care in the ICU is expensive. One of the best ways of improving the value of care delivered in the ICU is to focus greater attention on the needs of the critical care workforce. Herein, we highlight three major areas of concern—the changing model of care delivery outside of the traditional four walls of the ICU, the need for greater diversity in the pediatric critical care workforce, and the widespread problem of professional burnout and its impact on patient care.

Keywords: Diversity; intensive care unit staffing (ICU staffing); workforce; care continuum; models of care; burnout; intensive care unit without walls (ICU without walls)

Submitted Aug 19, 2018. Accepted for publication Sep 05, 2018.
doi: 10.21037/tp.2018.09.05
View this article at: http://dx.doi.org/10.21037/tp.2018.09.05

"*The best possible care of critically ill patients can be rendered when physicians of various specialties, nurses, and allied health professionals join forces and treat problems together.*" ——Ake Grenvik

Introduction

The authors Spiegelman and Berrett, who also happen to be health care administrators and passionate advocates for patient-centered care, recently wrote a book entitled "*Patients come second: leading change by changing the way you lead*" (1). Spiegelman and Berrett make a fairly convincing argument that by focusing on the physical, mental, and spiritual well-being of their providers, nurses, and employees, health care organizations improve the quality of patient care and the patient experience. In other words, by placing "patients second" and "employees first", these organizations actually do provide patient- and family-centered care.

The health care industry is in the midst of incredible change, and unfortunately, change is not easy. Society, in general, is changing as well. Physicians, nurses, and allied health professionals are starting to feel the effects of all of this change, and in many cases, these effects adversely impact the care that the physicians, nurses, and allied health professionals provide. The specialty of critical care medicine [and here and throughout the rest of this article, we will take the approach followed by the Society of Critical Care Medicine that "critical care medicine" encompasses all of the surgical and medical disciplines that practice in the intensive care unit (ICU) environment, as well as critical care nursing, respiratory therapy, and clinical pharmacy (2)] is not immune to these changes. Indeed, in many cases, our specialty is at the forefront of change.

There have been a number of articles and position statements discussing staffing and workforce issues in critical care medicine. For example, the American College of Critical Care Medicine Task Force on Models of Critical

Care published an updated position statement describing a number of key elements for the ideal model of critical care delivery (3). The Task Force made the following recommendations:

(I) "*An intensivist-led, high-performing, multidisciplinary team dedicated to the ICU is an integral part of effective care delivery*."

(II) "*Process improvement is the backbone of achieving high-quality ICU outcomes*."

(III) "*Standardized protocols including care bundles and order sets to facilitate measurable processes and outcomes should be used and further developed in the ICU setting*."

(IV) "*Institutional support for comprehensive quality improvement programs as well as tele-ICU programs should be provided*."

Notably, the Task Force reviewed the available evidence on 24/7 in-house attending coverage and concluded that the data was not sufficiently conclusive to make a recommendation for or against this practice. Since the publication of this position statement, the American Thoracic Society's Ad Hoc Committee on ICU Organization conducted a systematic review and meta-analysis of the effect of nighttime intensivist staffing on mortality and length of stay in ICU patients. While the committee was focused primarily on adult ICUs, they did review the available literature on 24/7 staffing in pediatric ICUs too. The committee concluded that there is no evidence to suggest that nighttime intensivist staffing is associated with reduced mortality in critically ill patients in the ICU (4). While mortality is certainly an essential outcome, it is by no means the only outcome of interest, and other studies have suggested improvements in outcomes such as duration of mechanical ventilation, incidence of medical errors, and ICU length of stay (5-7). Regardless of the evidence, a number of pediatric intensive care units (PICUs) in large academic children's hospitals are moving towards 24/7 inhouse attending coverage (i.e., nighttime intensivist staffing) (8,9), largely at the behest of hospital administrations. What is often lost in the multiple discussions on 24/7 inhouse attending coverage, which is perhaps more germane to the present discussion, is the impact of 24/7 inhouse attending coverage on the providers. We will discuss these issues further below.

The Society of Critical Care Medicine also published a statement on the ideal intensivist/patient staffing ratios. The available literature on what is the optimal intensivist/staffing ratio for safe and effective care is rather limited. There is no question that proper staffing ratios can have significant impact on non-direct patient care activities such as teaching (both informally at the bedside, as well as during traditional ICU rounds). In addition, large caseloads may adversely impact patient flow both into and out of the ICU. Finally, inadequate staffing ratios can lead to burnout (see below) and turnover. The Task Force on ICU Staffing concluded that an intensivist/patient ratio greater than 1:14 (i.e., more patients) adversely impacts education, staff well-being, and patient care (10).

With brevity in mind, we will refrain from discussing issues such as the use of advanced practice nurses and physician assistants in the PICU (11), PICU nurse staffing (12-15), the impact of multidisciplinary rounds on ICU outcomes (16-18), the rise of subspecialty ICUs and how (19) they impact care delivery and outcomes (20-24), or the looming shortage of PICU physicians (25-27). There is already a vast literature on these topics that would be difficult to improve upon. Rather, we believe that there are a number of important issues pertaining to ICU staffing and the ICU workforce that have not been adequately addressed in the literature. We will highlight three key "stress points" for the practicing pediatric intensivist in today's health care environment. First, we will highlight the evolving model of pediatric critical care delivery and the concept of the "ICU without walls". Next, we will review some of the more important issues pertaining to diversity (or lack thereof) in the pediatric ICU workforce. Finally, we will close with a brief discussion on the important issue of professional burnout.

"Four walls does not an ICU make"

Historically, the ICU was viewed primarily in geographical terms, i.e., the ICU was a specific location in the hospital, usually located in close proximity to the emergency department (ED) and operating room (OR) suites. Critically ill or injured patients were admitted to the ICU when they required intensive monitoring and minute-by-minute care by trained physicians, nurses, and allied health professionals. In other words, critical care medicine, as a unique and independent specialty, was practiced within the four walls of the ICU. ICUs first developed in response to the global polio epidemic—patients requiring long-term mechanical ventilator assistance were cohorted together in separate units or wings of the hospital (25). Keeping these patients together, in one geographic location, optimized staffing efficiency, minimized disruptions in the supply chain (medical equipment and supplies, as well as medications, could be delivered to one location of the hospital as opposed

to multiple locations distributed throughout the hospital), and facilitated the development of the expertise for physicians and nurses to provide safe and effective care. The specialty of critical care medicine gradually evolved over time as a result of this relative isolation from the rest of the hospital – the four walls of the ICU served as an "incubator", if you will, for the evolution of critical care medicine as its own unique discipline (28).

As the specialty of critical care medicine has evolved over time, it is clear that there is so much more, in terms of the delivery of critical care medicine that occurs outside the four walls of the ICU (28-33). First and foremost, what happens "inside" the four walls of the ICU, in terms of the quality of care, safety, patient and family experience, and flow/capacity management partially depends on what happens "outside" the four walls of the ICU. The different microsystems (34,35) of care delivery (acute care ward, emergency department, ICU, operating room, step-down or intermediate ICU, and rehabilitation unit) are all functionally linked and mutually dependent upon each other—operations cannot be optimized solely in one microsystem without potentially impacting operations in another microsystem. As Dr. Peter McQuillan stated over 20 years ago, "*the greatest impact on the outcome for intensive care units may come from improvements in the input to intensive care*, *particularly in the quality of acute care*..." (36). Rapid response systems have developed largely in response to the need to extend the delivery of critical care medicine beyond the four walls of the ICU (37).

Second, as critically ill children recover from their illness, significant organ dysfunction frequently persists, leading to chronic and often complex medical issues, as well as technology-dependence (e.g., ventilator-dependence and/or dialysis-dependence) (38-42). Rather than viewing critical care delivery as separate and distinct from post-ICU recovery and rehabilitation, a number of centers have started working closely with specialists in physical medicine and rehabilitation to improve long-term recovery and quality of life (43-46). Pediatric critical care medicine is no longer practiced in isolation. Instead, pediatric critical illness lies along a continuum that (often) starts in the ambulatory setting and, for some patients at least, never really ends (42,45,47).

There is one final trend that has forced a re-design of the model of critical care delivery to incorporate care that occurs outside the four walls of the ICU, and it has everything to do with money. Hospital care is expensive. Over the last several years, more patients are cared for in the ambulatory setting. Ambulatory surgery centers have popped up all over the country. Home health care services have re-engineered care in ways previously unimagined. As a result, hospitals have either closed or merged with larger hospital systems, and the number of hospital beds has decreased. At the same time, the number of ICU beds around the country have increased (48-50). From 2000 to 2010, the number of acute care beds decreased by 2.2%, while the number of critical care beds increased by 17.8% (48). Most of this growth has occurred in large academic medical centers in urban settings (49,50).

Unfortunately, far less has been published about trends in the supply of acute care beds and ICU beds at children's hospitals in the United States. Two surveys conducted in 2003 and 2004, respectively, estimated that there are about 350 PICUs in the United States, though over half of them are smaller units with less than 8 beds (51). There were slightly over 4,000 PICU beds at that time (8), clearly far less than the estimated 67,357 adult critical care beds and 20,000 neonatal intensive care beds (52-54). However, here is perhaps one instance when it is acceptable to extrapolate from adult data—the trend in pediatrics is to provide more care in the ambulatory setting versus the inpatient setting, as it is far less expensive. Overall then, patients admitted to the hospital are sicker and more complex than they were in the past, which has encouraged both the growth in the number of hospitalists (55,56) as well as the "ICU without walls" concept (28).

These changing models of care delivery will undoubtedly impact pediatric critical care providers. As patients become more complex (in terms of the number of chronic medical conditions that they have), the burden of documentation, data retrieval, and communication (with patients, families, and other providers) will increase (57-59). The ICU physician, as the "care quarterback" for these complex patients in the ICU, will have to assume an even greater role in the coordination of care between multiple subspecialty physicians. Capacity constraints and changes in care delivery models will increasingly pull the ICU physician outside of the ICU, placing additional strain on the ICU team (60). Finally, the greater number and utilization of ICU beds in the hospital, the push for 24/7 inhouse attending coverage, and the move to deliver critical care along the care continuum outside the four walls of the ICU will require greater numbers of ICU physicians in the future at a time when ICU physicians may be in short supply (61,62). All of these factors will have to be addressed in the very near future.

Diversity issues in the pediatric ICU workforce

There is an urgent need for greater diversity, with respect to gender, race, ethnicity, and sexual orientation in the U.S. health care workforce. While society, in general, is becoming more diverse, the same cannot be said of American medicine (63,64). For example, women currently comprise 36.7% of all physicians (which is certainly less than the percentage of females in the general population), while blacks and Hispanic/Latinos comprised only 4.2% and 4.6%, respectively, of physicians (compared to 13% and 17% of the general population) (65). American Indian, Alaskan Native, Native Hawaiian, and Pacific Islanders (which collectively, with blacks and Hispanic/Latinos historically define the "underrepresented minorities" in medicine) are represented even less (63,65,66). Less is known about LGBT physicians in the workforce, though one survey of pediatric department chairs in U.S. medical schools found that only 0.4% of faculty physicians were LGBT (67). Pediatrics is doing better, particularly from a gender diversity standpoint, compared to other medical subspecialties, with women comprising 73% of residents, 64% of clinical fellows, and 54% of faculty in the same survey (67). Based upon the most recent American Board of Pediatrics workforce data, slightly over 40% of all certified pediatric critical care physicians are women, though 60% of 1st year pediatric critical care medicine fellows in 2017 were women (68).

There are a number of reasons why diversity in the physician workforce is important. Communication between patient and physician is better when they have similar backgrounds (patient-provider demographic concordance) (69,70). Providers from underrepresented minority groups are more likely to practice in underserved areas (66,71). Research scholarship generated by diverse research teams tends to be higher quality and more impactful (72,73). Finally, at least one study has shown that elderly patients in the hospital that are treated by female physicians have lower mortality and readmission rates compared to those who are treated by male physicians (74).

Unfortunately, despite the real benefits to a diverse physician workforce, disparities (and in some cases, outright discrimination) are evident, especially in regards to gender. For example, a 2016 survey found that 30% of female physicians had experienced sexual harassment (75). Women are less likely to be introduced as "doctor" at grand rounds (76). Women are less likely to be listed as first authors in top tier journals (73), less likely to be invited to speak at major conferences (77), and less likely to be included on expert guideline consensus panels (78). There are fewer women in hospital and department leadership positions (64), even in pediatrics (67). There are fewer women professors compared to men (64,79). Women receive less research start-up funding than their male colleagues (73,80). Perhaps most concerning, despite all of the attention on gender parity in the last few years, there is a significant gender pay gap in medicine.

The writer, Collins, in a recent article in the *New Yorker* (81), stated that "equal pay" and the "gender pay gap" are not one and the same. "Gender pay gap" refers to the difference between the men's average earnings and the women's average earnings. So, a hospital or medical school could pay men and women equally and still have a significant gender pay gap, particularly if most of the women are at the assistant or associate professor level (earning the same as their male peers at a similar academic rank) and most of the men are at the associate professor or professor level. The gender pay gap is made even worse if most of the physicians in leadership positions are men. Even after accounting for these kinds of differences in faculty rank, women are paid much less (on average, $19,878 after adjusting for specialty, institution, and faculty rank) than their male counterparts (82).

Gender disparities have significant costs. Women physicians are at a greater risk for professional burnout (see below) compared to their male colleagues (73,83,84). Women physicians are less satisfied with work-life integration, mentoring relationships and support, career-advancement opportunities, recognition, and salary, all of which worsen career satisfaction (85). If women are less satisfied with their careers, they may be more likely to leave medicine (86,87), which will only worsen the lack of gender diversity in the physician workforce, particularly in more senior or leadership roles. Burnout and lower levels of career satisfaction can also adversely impact physician health and potentially worsen patient care (85).

Increasing workforce diversity will require a multi-faceted approach that emphasizes both recruitment and retention (66). Recruitment efforts will have to begin early, e.g., during the undergraduate and medical school years, in order to establish an appropriate pipeline of diverse providers. The field of pediatrics, and the subspecialty of pediatric critical care medicine, are already well-positioned in this regard. Retention efforts will have to focus on eliminating discriminatory behaviors, policies, and procedures, such as the gender pay gap, as well as the unconscious behaviors and attitudes that adversely impact diversity in the workforce.

Professional burnout

The psychiatrist Freudenberger was the first to use the term "burnout" in the psychology literature in 1974 (88). He used the term to describe a constellation of signs and symptoms of emotional and physical exhaustion resulting from excessive work demands that he observed in volunteer staff working at a free clinic for drug addicts. He stated that the burned-out worker "looks, acts, and seems depressed". Interest in occupational stress and burnout grew in the social sciences literature, and the term was used in the title of a 1961 Graham Greene novel (*A Burnt-Out Case*) about a doctor working with leprosy patients in the Belgian Congo. So, while burnout is not exclusive to health care workers, it was first described in both the medical literature and lay press in clinicians. The psychologist, Christina Maslach developed and validated the Maslach Burnout Inventory (MBI), which characterizes burnout as a clinical syndrome consisting of emotional exhaustion, depersonalization, and a reduced sense of personal accomplishment. Today, the MBI is one of the most widely used assessment tools for measuring burnout and has been used in a number of different occupations.

There has been a virtual explosion of literature pertaining to burnout in health care workers over the course of the last 5–10 years. Whether clinicians are more burned-out now than they were in the past is not definitively known. There may have been a stigma associated with burnout in the past that precluded accurate measures of prevalence. For example, clinicians are expected to be resilient, to seek and attain perfection, and to work long hours without rest. Physicians aren't supposed to complain of things like emotional exhaustion, depersonalization, or a sense of failure. Indeed, physicians aren't even supposed to make (or even worse, acknowledge) mistakes. Anecdotally, a number of older physicians continue to roll their eyes whenever the topic of burnout is discussed—this is unfortunate and problematic.

The most recent studies suggest that burnout is not only more common in physicians compared to other professions in the U.S. (83,84), it is getting worse not better (89). More than half of all U.S. physicians are experiencing burnout (89). While all physicians, regardless of age, gender, specialty, or career stage experience burnout, physicians at the mid-career stage appear to be at the greatest risk (90). Female physicians appear to be at a greater risk compared to male physicians (91,92). While there are a number of key drivers of burnout, loss of autonomy (particularly when the hospital administration makes decisions that affect physician's work lives without any input from the physicians), administrative/clerical burden, the electronic health record, and excessive work demands, in particular adversely impact work-life balance (93-96).

Approximately one-half of critical care physicians experience burnout (97-99). Nearly half of the pediatric critical care physicians responding to one survey reported high burnout in at least one of the three subscales of the MBI (100). The typical job stresses experienced by providers working in the ICU environment on even a normal day may increase the risk of burnout in critical care physicians (97,101). Night call responsibilities (i.e., 24/7 inhouse attending coverage) have been cited as one factor that can drive burnout among critical care physicians (97,98,102). However, while 57% of pediatric critical care physicians expressed concern that 24/7 inhouse attending coverage increased burnout risk, there was no association between coverage model (inhouse versus home night call coverage) and MBI results in a recently published study involving 1,323 pediatric critical care physicians (both attendings and fellows). Moreover, almost 80% of the pediatric critical care physicians stated that they would prefer to work at an institution with inhouse attending coverage, as it was better for patient care and quality of life (9). There are fewer studies on the prevalence of burnout in critical care nurses, though one study suggested that at least 1/3 of nurses working in the ICU experience serious burnout (103).

The consequences of burnout are important to consider. Burned out physicians are at a greater risk for depression, substance abuse, and suicide. Burnout increases the number of "sick days" and staff turnover among both physicians and nurses. Finally, burnout has been associated with worse patient outcomes (95,98,102). Given all of the ongoing changes in models of critical care delivery discussed above, some of which may contribute to burnout, as well as the fact that the lack of diversity in the workforce also contributes to burnout, pediatric critical care medicine, as a specialty will have to find meaningful ways of addressing burnout. Unfortunately, addressing burnout is not easy, though initiatives focused on both the individual physician and organization are usually the most successful (95,104-106).

Conclusions

One of the best ways of improving the care of critically ill children in the ICU is to focus on strengthening the pediatric critical care workforce (1). Herein we highlighted

three of the major issues that are impacting the field of pediatric critical care medicine in a number of ways—the changing model of care delivery outside of the traditional four walls of the ICU, the need for greater diversity in the pediatric critical care workforce, and the widespread problem of professional burnout and its impact on patient care. Further work is required to determine how the field of pediatric critical care medicine can best address these important issues.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

References

1. Spiegelman P, Berrett B. Patients Come Second: Leading Change by Changing the Way You Lead. Austin, TX: Greenleaf Book Group, LLC, 2013.
2. Brilli RJ, Spevetz A, Branson RD, et al. Critical care delivery in the intensive care unit: Defining clinical roles and the best practice model. Crit Care Med 2001;29:2007-19.
3. Weled BJ, Adzhigirey LA, Hodgman TM, et al. Critical care delivery: The importance of process of care and ICU structure to improved outcomes: An update from the American College of Critical Care Medicine Task Force on Models of Critical Care. Crit Care Med 2015;43:1520-5.
4. Kerlin MP, Adhikari NK, Rose L, et al. An Official American Thoracic Society systematic review: The effect of nighttime intensivist staffing on mortality and length of stay among intensive care unit patients. Am J Respir Crit Care Med 2017;195:383-93.
5. Nishisaki A, Pines JM, Lin R, et al. The impact of 24-hr, in-hospital pediatric critical care attending physician presence on process of care and patient outcomes. Crit Care Med 2012;40:2190-5.
6. Gupta P, Rettiganti M, Jeffries HE, et al. Association of 24/7 in-house intensive care unit attending physician coverage with outcomes in children undergoing heart operations. Ann Thorac Surg 2016;102:2052-61.
7. Gupta P, Rettiganti M, Rice TB, et al. Impact of 24/7 in-hospital intensivist coverage on outcomes in pediatric intensive care: A multicenter study. Am J Respir Crit Care Med 2016;194:1506-13.
8. Odetola FO, Clark SJ, Freed GL, et al. A national survey of pediatric critical care resources in the United States. Pediatrics 2005;115:e382-6.
9. Rehder KJ, Cheifetz IM, Markovitz BP, et al. Survey of in-house coverage by pediatric intensivist: Characterization of 24/7 in-hospital pediatric critical care faculty coverage. Pediatr Crit Care Med 2014;15:97-104.
10. Ward NS, Afessa B, Kleinpell R, et al. Intensivst/patient ratios in closed ICUs: A statement from the Society of Critical Care Medicine Taskforce on ICU Staffing. Crit Care Med 2013;41:638-45.
11. Kleinpell RM, Ely EW, Grabenkort R. Nurse practitioners and physician assistants in the intensive care unit: An evidence-based review. Crit Care Med 2008;36:2888-97.
12. Bray K, Wren I, Baldwin A, et al. Standards for nurse staffing in critical care units determined by: The British Association of Critical Care Nurses, The Critical Care Networks National Nurse Leads, Royal College of Nursing Critical Care and In-flight Forum. Nurs Crit Care 2010;15:109-11.
13. Numata Y, Schulzer M, van der Wal R, et al. Nurse staffing levels and hospital mortality in critical care settings: Literature review and meta-analysis. J Adv Nurs 2006;55:435-48.
14. Carayon P, Gurses AP. A human factors engineering conceptual framework of nursing workload and patient safety in intensive care units. Intensive Crit Care Nurs 2005;21:284-301.
15. Baird J, Rehm RS, Hinds PS, et al. Do you know my child? Continuity of nursing care in the pediatric intensive care unit. Nurs Res 2016;65:142-50.
16. Kane SL, Weber RJ, Dasta JF. The impact of critical care pharmacists on enhancing patient outcomes. Intensive Care Med 2003;29:691-8.
17. Horn E, Jacobi J. The critical care clinical pharmacist: Evolution of an essential team member. Crit Care Med 2006;34:S46-51.
18. Kim MM, Barnato AE, Angus DC, et al. The effect of multidisciplinary care teams on intensive care unit mortality. Arch Intern Med 2010;170:369-76.
19. McCredie VA, Alali AS, Scales DC, et al. Impact of ICU structure and processes of care on outcomes after severe traumatic brain injury: A multicenter cohort study. Crit Care Med 2018;46:1139-49.
20. Balachandran R, Nair SG, Gopalraj SS, et al. Dedicated pediatric cardiac intensive care unit in a developing country: Does it improve the outcome? Ann Pediatr Cardiol

2011;4:122-6.
21. Burstein DS, Jacobs JP, Li JS, et al. Care models and associated outcomes in congenital heart surgery. Pediatrics 2011;127:e1482-9.
22. Eldadah M, Leo S, Kovach K, et al. Influence of a dedicated paediatric cardiac intensive care unit on patient outcomes. Nurs Crit Care 2011;16:281-6.
23. Lott JP, Iwashyna TJ, Christie JD, et al. Critical illness outcomes in specialty versus general intensive care units. Am J Respir Crit Care Med 2009;179:676-83.
24. Gupta P, Beam BW, Noel TR, et al. Impact of preoperative locatio on outcomes in congenital heart surgery. Ann Thorac Surg 2014;98:896-903.
25. Riley C, Poss WB, Wheeler DS. The evolving model of pediatric critical care delivery in North America. Pediatr Clin North Am 2013;60:545-62.
26. Radabaugh CL, Ruch-Ross HS, Riley CL, et al. Practice patterns in pediatric critical care medicine: Results of a workforce survey. Pediatr Crit Care Med 2015;16:e308-12.
27. Wheeler DS. A changing workforce for the changing needs of critically ill children in the United States and Canada. Pediatr Crit Care Med 2015;16:791-2.
28. Hillman K. Critical care without walls. Curr Opin Crit Care 2002;8:594-9.
29. Clark M, Cushman L, Carlson TA. Interventional recovery outside the walls of an intensive care environment. Crit Care Nurs Q 1997;19:42-7.
30. Dawson D, McEwen A. Critical care without walls: The role of the nurse consultant in critical care. Intensive Crit Care Nurs 2005;21:334-43.
31. Flaatten H. The intensive care unit, any place with four walls? Acta Anaesthesiol Scand 2007;51:391-2.
32. Durand M, Hutchings A, Black N, et al. "Not quite Jericho, but more doors than there used to be." Staff views of the impact of "modernization" on boundaries around adult critical care services in England. J Health Serv Res Policy 2010;15:229-35.
33. Gordo F, Abella A. Intensive care unit without walls: Seeking patient safety by improving the efficiency of the system. Med Intensiva 2014;38:438-43.
34. Nelson EC, Godfrey MM, Batalden PB, et al. Clinical microsystems, part 1. The building blocks of health systems. Jt Comm J Qual Patient Saf 2008;34:367-78.
35. Nelson EC, Batalden PB, Huber TP, et al. Microsystems in health care: Part 1. Learning from high-performing front-line clinical units. Jt Comm J Qual Improv 2002;28:472-93.
36. McQuillan P, Pilkington S, Allan A, et al. Confidential inquiry into quality of care before admission to intensive care. BMJ 1998;316:1853-8.
37. VandenBerg SD, Hutchison JS, Parshuram CS, et al. A cross-sectional survey of levels of care and response mechanisms for evolving critical illness in hospitalized children. Pediatrics 2007;119:e940-6.
38. Knoester H, Grootenhuis MA, Bos AP. Outcome of paediatric intensive care survivors. Eur J Pediatr 2007;166:1119-28.
39. Czaja AS, Zimmerman JJ, Nathens AB. Readmission and late mortality after pediatric severe sepsis. Pediatrics 2009;123:849-57.
40. Namachivayam P, Taylor A, Montague T, et al. Long-stay children in intensive care: Long-term functional outcome and quality of life from a 20-yr institutional study. Pediatr Crit Care Med 2012;13:520-8.
41. Farris RW, Weiss NS, Zimmerman JJ. Functional outcomes in pediatric severe sepsis: Further analysis of the research severe sepsis and organ dysfunction in children: A global perspective trial. Pediatr Crit Care Med 2013;14:835-42.
42. Aspesberro F, Mangione-Smith R, Zimmerman JJ. Health-related quality of life following pediatric critical illness. Intensive Care Med 2015;41:1235-46.
43. Cameron S, Ball I, Cepinskas G, et al. Early mobilization in the critical care unit: A review of adult and pediatric literature. J Crit Care 2015;30:664-72.
44. Choong K, Foster G, Fraser DD, et al. Acute rehabilitation practices in critically ill children: A multicenter study. Pediatr Crit Care Med 2014;15:e270-9.
45. Herrup EA, Wieczorek B, Kudchadkar SR. Characteristics of postintensive care syndrome in survivors of pediatric critical illness: A systematic review. World J Crit Care Med 2017;6:124-34.
46. Wieczorek B, Burke C, Al-Harbi A, et al. Early mobilization in the pediatric intensive care unit: A systematic review. J Pediatr Intensive Care 2015;2015:129-70.
47. Pinto NP, Rhinesmith EW, Kim TY, et al. Long-term function after pediatric critical illness: Results from the Survivors Outcomes Study. Pediatr Crit Care Med 2017;18:e122-30.
48. Halpern NA, Goldman DA, Tan KS, et al. Trends in critical care beds and use among population groups and medicare and medicaid beneficiaries in the United States: 2000-2010. Crit Care Med 2016;44:1490-9.
49. 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;191:410-6.
50. Wallace DJ, Seymour CW, Kahn JM. Hospital-level

changes in adult ICU bed supply in the United States. Crit Care Med 2017;45:e67-76.
51. Randolph AG, Gonzales CA, Cortellini L, et al. Growth of pediatric intensive care units in the United States from 1995 to 2001. J Pediatr 2004;144:792-8.
52. 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.
53. Halpern NA, Pastores SM, Greenstein RJ. Critical care medicine in the United States 1985-2000: An analysis of bed numbers, use, and costs. Crit Care Med 2004;32:1254-9.
54. Halpern NA, Pastores SM, Thaler HT, et al. Critical care medicine use and cost among Medicare beneficiaries 1995-2000: Major discrepancies between two United States federal Medicare databases. Crit Care Med 2007;35:692-9.
55. Landrigan CP, Conway PH, Edwards S, et al. Pediatric hospitalists: A systematic review of the literature. Pediatrics 2006;117:1736-44.
56. Barrett DJ, McGuiness GA, Cunha CA, et al. Pediatric hospital medicine: A proposed new subspecialty. Pediatrics 2017;139:e20161823.
57. Carayon P, Wetterneck TB, Alyousef B, et al. Impact of electronic health record technology on the work and workflow of physicians in the intensive care unit. Int J Med Inform 2015;84:578-94.
58. Hefter Y, Madahar P, Eisen LA, et al. A time-motion study of ICU workflow and the impact of strain. Crit Care Med 2016;44:1482-9.
59. Clark AV, LoPresti CM, Smith TI. Trends in inpatient admission comorbidity and electronic health data: Implications for resident workload intensity. J Hosp Med 2018;13:570-2.
60. Halpern SD. ICU capacity strain and the quality and allocation of critical care. Curr Opin Crit Care 2011;17:648-57.
61. Halpern NA, Pastores SM, Oropello JM, et al. Critical care medicine in the United States: Addressing the intensivist shortage and image of the specialty. Crit Care Med 2013;41:2754-61.
62. Kahn JM, Rubenfeld GD. The myth of the workforce crisis. Why the United States does not need more intensivist physicians. Am J Respir Crit Care Med 2015;191:128-34.
63. Xierali IM, Castillo-Page L, Zhang K, et al. AM last page: The urgency of physician workforce diversity. Acad Med 2014;89:1192.
64. Lane-Fall MB, Miano TA, Aysola J, et al. Diversity in the emerging critical care workforce: Analysis of demographic trends in critical care fellows from 2004 to 2014. Crit Care Med 2017;45:822-7.
65. Nivet MA, Castillo-Page L. Diversity in the Physician Workforce: Facts & Figures 2014. Washington, DC: Association of American Medical Colleges, 2014.
66. Committee on Workforce Diversity. American Academy of Pediatrics. Enhancing pediatric workforce diversity and providing culturally effective pediatric care: Implications for practice, education, and policymaking. Pediatrics 2013;132:e1105-16.
67. Mendoza FS, Walker LR, Stoll BJ, et al. Diversity and inclusion training in pediatric departments. Pediatrics 2015;135:707-13.
68. American Board of Pediatrics . Workforce Data, 2017-2018. Available online: https://www.abp.org/sites/abp/files/pdf/pediatricphysiciansworkforcedatabook2017-2018.pdf#page=8
69. Cooper LA, Roter DL, Johnson RL, et al. Patient-centered communication, ratings of care, and concordance of patient and physician race. Ann Intern Med 2003;139:907-15.
70. Laveist TA, Nuru-Jeter A. Is doctor-patient race concordance associated with greater satisfaction with care? J Health Soc Behav 2002;43:296-306.
71. Cohen JJ, Gabriel BA, Terrell C. The case for diversity in the health care workforce. Health Aff (Millwood) 2002;21:90-102.
72. Valantine HA, Collins FS. National Institutes of Health addresses the science of diversity. Proc Natl Acad Sci 2015;112:12240-2.
73. Rotenstein LS, Jena AB. Lost Taussigs - The consequences of gender discrimination in medicine. N Engl J Med 2018;378:2255-7.
74. Tsugawa Y, Jena AB, Figueroa JF, et al. Comparison of hospital mortality and readmission rates for medicare patients treated by male vs female physicians. JAMA Intern Med 2017;177:206-13.
75. Jagsi R. Sexual harassment in medicine - #MeToo. N Engl J Med 2018;378:209-11.
76. Files JA, Mayer AP, Ko MG, et al. Speaker introductions at Internal Medicine Grand Rounds: Forms of address reveal gender bias. J Womens Health (Larchmt) 2017;26:413-9.
77. Mehta S, Rose L, Cook D, et al. The speaker gender gap at critical care conferences. Crit Care Med 2018;46:991-6.
78. Mehta S, Burns KE, Machado FR, et al. Gender parity in critical care medicine. Am J Respir Crit Care Med 2017;196:425-9.
79. Jena AB, Khullar D, Ho O, et al. Sex differences in academic rank in US medical schools in 2014. JAMA 2015;314:1149-58.

80. Sege R, Nykiel-Bub L, Selk S. Sex differences in institutional support for junior biomedical researchers. JAMA 2015;314:1175-7.
81. Collins L. Letter from London: What Women Want: Equal pay - and how BBC employees got it. The New Yorker 2018:34-43.
82. Jena AB, Olenski AR, Blumenthal DM. Sex differences in physician salary in US public medical schools. JAMA Intern Med 2016;176:1294-304.
83. Dyrbye LN, West CP, Satele D, et al. Burnout among U.S. medical students, residents, and early career physicians relative to the general U.S. population. Acad Med 2014;89:443-51.
84. Shanafelt TD, Boone S, Tan L, et al. Burnout and satisfaction with work-life balance among US physicians relative to the general US population. Arch Intern Med 2012;172:1377-85.
85. Rizvi R, Raymer L, Kunik M, et al. Facets of career satisfaction for women physicians in the United States: A systematic review. Women Health 2012;52:403-21.
86. Guille C, Frank E, Zhao Z, et al. Work-family conflict and the sex differences in depression among training physicians. JAMA Intern Med 2017;177:1766-72.
87. Williams ES, Konrad TR, Scheckler WE, et al. Understanding physicians' intentions to withdraw from practice: The role of job satisfaction, job stress, mental and physical health 2001. Health Care Manage Rev 2010;35:105-15.
88. Freudenberger HJ. Staff burnout. J Social Issues 1974;30:159-65.
89. Shanafelt TD, Hasan O, Dyrbe LN, et al. Changes in burnout and satisfaction with work-life balance in physicians and the general US working population between 2011 and 2014. Mayo Clin Proc 2015;90:1600-13.
90. Dyrbye LN, Varkey P, Boone SL, et al. Physician satisfaction and burnout at different career stages. Mayo Clin Proc 2013;88:1358-67.
91. Linzer M, Harwood E. Gendered expectations: Do they contribute to high burnout among female physicians? J Gen Intern Med 2018;33:963-5.
92. McMurray JE, Linzer M, Konrad TR, et al. The work lives of women physicians results from the physician work life study. The SGIM Career Satisfaction Study Group. J Gen Intern Med 2000;15:372-80.
93. Shanafelt TD, Dyrbe LN, Sinsky C, et al. Relationship between clerical burden and characteristics of the electronic environment with physician burnout and professional satisfaction. Mayo Clin Proc 2016;91:836-48.
94. Shanafelt TD, Gorringe G, Menaker R, et al. Impact of organizational leadership on physician burnout and satisfaction. Mayo Clin Proc 2015;90:432-40.
95. West CP, Dyrbe LN, Shanafelt TD. Physician burnout: Contributors, consequences, and solutions. J Intern Med 2018;283:516-29.
96. Shanafelt TD, Mungo M, Schmitgen J, et al. Longitudinal study evaluating the association between physician burnout and changes in professional work effort. Mayo Clin Proc 2016;91:422-31.
97. Embriaco N, Azoulay E, Barrau K, et al. High level of burnout in intensivist: Prevalence and risk factors. Am J Respir Crit Care Med 2007;175:686-92.
98. Embriaco N, Papazian L, Kentish-Barnes N, et al. Burnout syndrome among critical care healthcare workers. Curr Opin Crit Care 2007;13:482-8.
99. van Mol MM, Kompanje E, Benoit DD, et al. The prevalence of compassion fatigue and burnout among healthcare professionals in intensive care units: A systematic review. PLoS One 2015;10:e0136955.
100. Shenoi AN, Kalyanaraman M, Pillai A, et al. Burnout and psychosocial distress among pediatric critical care physicians in the United States. Crit Care Med 2018;46:116-22.
101. Donchin Y, Seagull FJ. The hostile environment of the intensive care unit. Curr Opin Crit Care 2002;8:316-20.
102. Papazian L, Sylvestre A, Herridge M. Should all ICU clinicians regularly be tested for burnout? Yes. Intensive Care Med 2018. [Epub ahead of print].
103. Poncet MC, Toullic P, Papazian L, et al. Burnout syndrome in critical care nursing staff. Am J Respir Crit Care Med 2007;175:698-704.
104. Shanafelt TD, Noseworthy JH. Executive leadership and physician well-being: Nine organizational strategies to promote engagement and reduce burnout. Mayo Clin Proc 2017;92:129-46.
105. Swensen SJ, Shanafelt T. An organizational framework to reduce professional burnout and bring back joy in practice. Jt Comm J Qual Patient Saf 2017;43:308-13.
106. West CP, Dyrbe LN, Erwin PJ, et al. Interventions to prevent and reduce physician burnout: A systematic review and meta-analysis. Lancet 2016;388:2272-81.

Cite this article as: Wheeler DS, Dewan M, Maxwell A, Riley CL, Stalets EL. Staffing and workforce issues in the pediatric intensive care unit. Transl Pediatr 2018;7(4):275-283. doi: 10.21037/tp.2018.09.05

