Integrating the Institute of Medicine's six quality aims into pediatric critical care: Relevance and applications

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The Institute of Medicine's report *Crossing the Quality Chasm* recommends "six aims for improvement." The aims are safety, effectiveness, equity, timeliness, patient-centeredness, and efficiency. This review focuses on the quality of care information relevant to the Institute of Medicine's six aims to assess their relevance, potential impact, and affect on pediatric critical care practice. It is concluded that if the care for pediatric intensive care patients is to be fundamentally improved, an understanding of the current care environment, the existing evidence base, the opportunities for improvement, and the documentation of the improvements needs to be realized. The Institute of Medicine's six aims provide a useful framework to advance the quality of care in this pediatric subspecialty and perhaps others. (Pediatr Crit Care Med 2005; 6:264–269)

Key Words: quality; safety; intensive care; critical care; children; pediatrics; efficiency; outcomes

The importance of understanding the components of quality has been recognized for about 30 yrs, with increasing attention being paid to this issue over time. The most recent attempt to characterize health care quality and the prevailing paradigm for evaluating the provision of clinical services is detailed in the Institute of Medicine's (IOM) report *Crossing the Quality Chasm* (1). The document recommends "six aims for improvement." The aims are safety, effectiveness, equity, timeliness, patient-centeredness, and efficiency. These aims are intended to identify the fundamental domains that need to be addressed to improve the health care services delivered to individuals and populations. For pediatric patients, this includes an imperative that addresses the current understanding of the care that is delivered, the existing evidence base, the opportunities available to improve that care, and the documentation of specific performance indicators (2).

Despite the national attention focused on these aims, little has been written to evaluate their relevance or to consider how they would be operationalized in a single subspecialty.

Recently, the Institute for Healthcare Improvement has adapted the IOM model into their "Idealized Design of the ICU" (3), emphasizing the potential relevance of the IOM aims to a single subspecialty. This review will focus on the quality of care information relevant to the IOM's six aims to assess their relevance, potential impact, and affect on pediatric critical care practice.

Understanding the System of Care

The conceptual framework for this review is shown in Figure 1, which presents the concept of the IOM's recommendations adapted to intensive care units (ICUs). In this model, the ICU is a microsystem that operates in series with other microsystems to deliver health care (4). The hospital or health care system is seen as a macrosystem. Issues of timeliness, efficiency, effectiveness, safety, equity, and patient centeredness relate to both the macrosystem and the microsystem.

The efficacy of macrosystem-level interventions in improving quality at the microsystem level is difficult to assess. However, improvements at the microsystem level can often be easily measured and incrementally lead to overall macrosystem improvements (Fig. 2) (4). Reducing variability in organizational structure and reducing variability in the patient care process are two strategies to improve clinical outcomes and enhance health care quality in the ICU (Fig. 2) (5, 6). An example of reducing variability in structure is the use of ICU physician directors and the 24-hr intensivist model of coverage (5, 6). Opportunities to reduce variability in process can be achieved with clinical practice guidelines or pathways. In addition, cultural issues are important to providing a pediatric ICU (PICU) environment that promotes quality generally and patient safety more specifically. Providers need to believe that the provision of quality health care is aligned with the goals of their unit and their organization (7). Furthermore, a blame-free environment is a very important method of learning about opportunities to improve quality through reports by providers (7–9).

Safety

The IOM's report on medical errors and patient safety brought considerable attention to the problem of iatrogenic injury suffered by hospitalized patients (10). The increasing focus on improving patient safety through reducing medical errors and adverse events in the high-risk PICU environment is palpable (11–13). We need to design better interventions to reduce adverse occurrences and improve our understanding of the types of errors and the circumstances within the environment of care that contribute to these errors.

Medical error classifications have been proposed, and several have been studied

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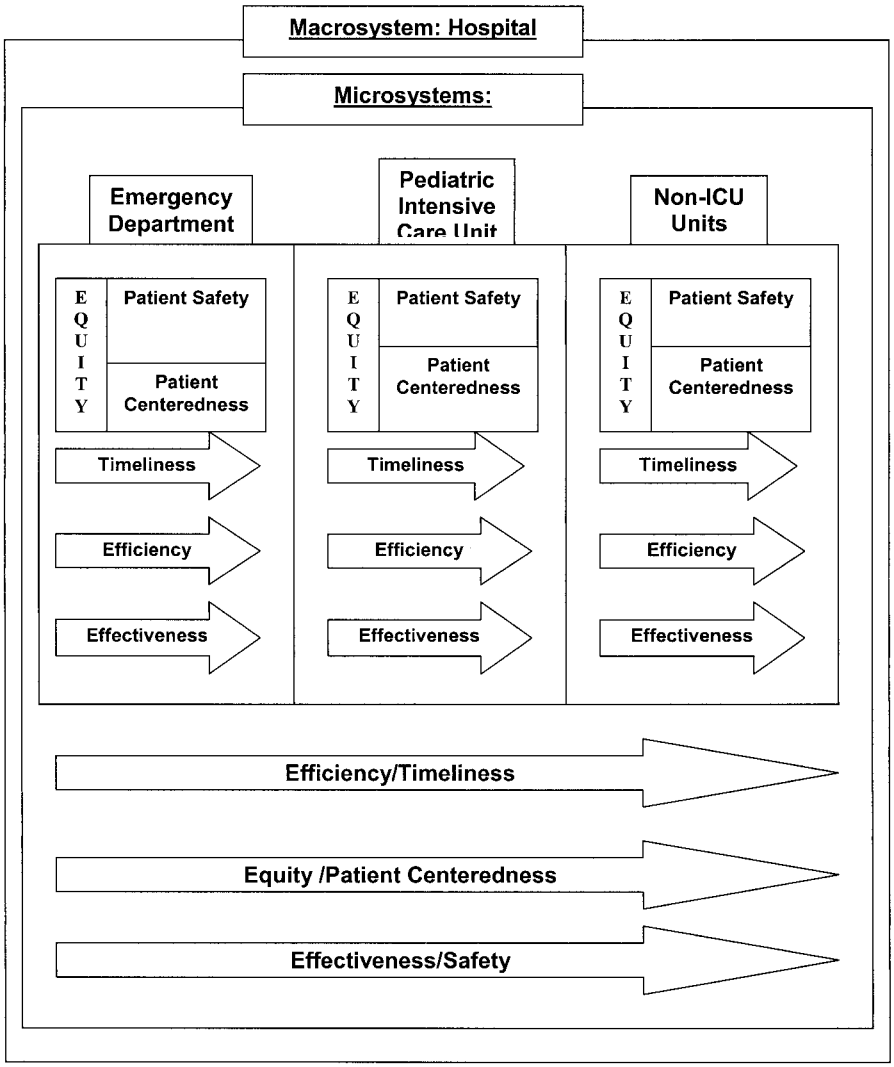

Figure 1. Conceptual model of the relationship of the Institute of Medicine's six aims of quality to the hospital experience of the critically ill pediatric patient. The aims of efficiency, timeliness, and effectiveness are essential to care delivered both within the macro- and microsystems of care and help to bridge the care processes from one microsystem to another. The remaining aims of safety, patient centeredness, and equity are particularly important within each microsystem where the care that is delivered is governed by the care processes within the microsystem. *ICU*, intensive care unit.

in children (14–16). The IOM used the definitions of Brennan and colleagues (14) to categorize medical errors based on diagnosis, treatment, or prevention strategies. Each of these categories has particular relevance for the evaluation of pediatric critical care services.

Diagnostic Errors. Autopsies have been used to detect missed diagnoses that may have had ante mortem clinical relevance (17). In adult ICUs, autopsy studies reveal significant diagnostic changes that could have changed outcome (17). One PICU study identified major diagnostic errors in 5% of patients that could have affected outcome, and an additional 25% of patients had missed, but clinically insignificant, diagnoses (18). Of importance, case discussions such as a traditional mortality and morbidity conferences may provide an opportunity to detect system-level deficiencies and add value to the detection of diagnostic medical errors.

Treatment Errors. Medication errors and adverse drug events are the most common treatment errors in the PICU. A single-site study of all pediatric inpatients found that the rate of medication errors was 5.7% (19). PICUs, where treatment complexity and disease burden are much greater than in non-ICU areas, have more adverse events (19). The potential for error with high-risk drugs such as sedatives, vasoactive infusions, and parenteral nutrition is great (19). In addition, the medications used in the PICU are more complex than in other clinical areas. They often require multiple calculations to achieve the desired concentrations and dosages. One effective strategy to reduce the rate of PICU medication errors is the use of a unit-based pharmacist (20). On average, the clinical ICU pharmacist intervened approximately 35 times per 100 patient days. The most frequent interventions were dosage adjustments (28%) and information provision (26%) (20).

Nosocomial Infection. Acquired infections are an important contributor to PICU morbidity and mortality (21–23). The Joint Commission on Accreditation of Healthcare Organizations now considers nosocomial infection contributing to a patient's death as a reportable sentinel event. A pediatric study estimated that each case of nosocomial bloodstream infection costs an additional $46,000 with increased PICU and hospital stays of 14.6 and 21.1 days, respectively (23). Recent efforts have expanded our knowledge of the incidence, prevalence, risk factors, costs, locations, organisms, and associated factors of nosocomial infections for the critically ill pediatric patient (22). These studies providing directed strategies to reduce nosocomial infection rates have evaluated more stringent infection control policies, the scheduled rotation of prescribed antibiotics, and the use of antibiotic-impregnated central venous catheters (21–23).

Procedures. Practice and outcome variability, both within and between ICUs, is well known (24). Accidental extubation is a common, potentially lethal, and often preventable procedural complication (25). As much as any complication, it demonstrates how variability in the process of care contributes to safety. Despite years of study, there are no standardized, accepted methods (e.g., taping methods, restraint use, sedation protocols) for tube and patient care to minimize this complication.

Prevention. The major component of preventive errors is the failure to provide prophylactic treatment (1). Evidence has accumulated, for example, regarding prophylaxis for stress ulcers, deep venous thrombosis, pressure ulcers, and other adverse ICU occurrences (26). Two recent efforts to address prophylactic care are the PRIMACORP study to determine whether prophylactic milrinone in the pediatric cardiac surgery patient im-

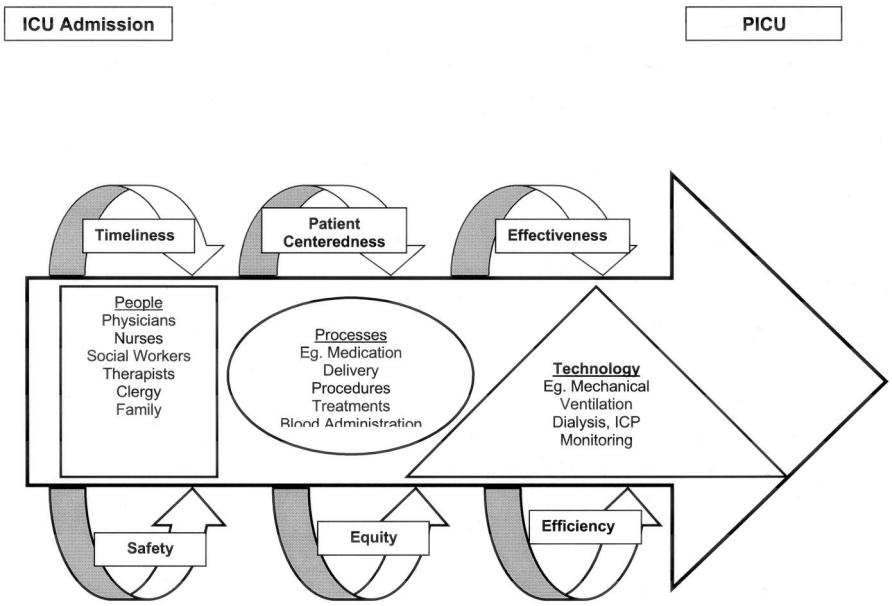

Figure 2. Patient care processes within the microsystem of the pediatric intensive care unit (*PICU*) must integrate the personnel of a multidisciplinary critical care team and the technology in a manner that achieves the best outcomes for the patient. *ICU,* intensive care unit; *ICP,* intracranial pressure.

proves outcome associated with the low cardiac output syndrome (27) and the "tunneling" of femoral central venous catheters (28).

Other. The PICU environment may be an independent contributor to patient safety. The IOM highlights communication errors, equipment failures, and system failures as components of an unsafe environment (5). Clinical microsystems are small, discrete, yet functional frontline units that provide health care to patients (4, 29) and function within larger clinical macrosystems (4, 29). For example, the microsystem that cares for a postoperative congenital heart disease patient includes the nurse, trainees, intensivist, cardiologist, cardiac surgeon, respiratory therapist, social worker, and parent. Two characteristics of microsystems contribute to the likelihood of errors (4, 29). Complexity is the degree to which system components are specialized and interdependent. Complex systems are more prone to errors. The second is coupling. Tightly coupled systems have little "room for error," whereas loosely coupled systems can tolerate delays or variations in sequencing (30). The expansion of PICUs beyond traditional academic medical centers into community hospitals tests the importance of the integration of micro- and macrosystems and potentially results, at least initially, in incompletely formed and integrated micro- and macrosystems (Fig. 1).

Effectiveness

Evidence-based practice incorporates the best research evidence, clinical expertise, and patient values to achieve the best outcomes for the patient (1). Critical care medicine is highly variable between practitioners and institutions (24). Practice guidelines are a way to reduce the variability in care (31–34). The American Academy of Pediatrics and the Society of Critical Care Medicine have developed guidelines and policy statements to help improve the care of critically ill children (31–34). The impact of guidelines has not been well studied (25–26). Even well-known and accepted guidelines such as brain death or the treatment of septic shock may be commonly violated (32–34). The pediatric traumatic brain injury guideline is an excellent guideline; a) it relies heavily on randomized controlled trials; b) when evidence did not exist, it used effective multidisciplinary groups for consensus-driven recommendations,; and c) the guidelines are clearly a "work in progress" recognizing that recommendations will change as new data become available (32–33).

Equity

The goal of equity is to provide impartial care for populations and to individuals that is free from bias related to race, ethnicity, insurance status, income, or gender (1). This bias may be manifested at two independent levels. First, discrimination may be targeted at a population by restricting access to health care. Second, and most overt, patients may receive differential treatment based on personal characteristics. Inequities in ICU resources due to race or insurance status have been found in adult ICUs (35). For example, critically ill adults with *Pneumocystis carinii* pneumonia had diagnostic tests performed at rates that were correlated with insurance status (36). ICU patients with private insurance received pulmonary artery catheters in greater proportions than other patients (37). Medicaid and Medicare patients undergoing liver transplantation experienced higher costs and longer lengths of stay (LOS) than did patients with commercial insurance (38). Operative procedures in Medicaid patients in a trauma ICU were less likely to be provided compared with commercially insured patients (39).

There are pediatric and neonatal ICU inequities associated with access to care, insurance status, and race. A recent regional study found that emergency PICU admissions from lower socioeconomic strata had higher severity of illness and are consistent with a lack of prehospital care (40). Additionally, children with Medicaid hospitalized with diabetic ketoacidosis experienced coma more often and had longer LOS than their commercially insured counterparts (41). Inequities in care related to insurance status continue to be documented even among the sickest children requiring PICU admission (41–45). Medicaid status is associated with more maternal transfers, increased medical errors, higher mortality rates from congenital heart disease, more complications from appendicitis, and worse outcomes from head trauma (41–45). Although studies have addressed racial disparities in the adult ICU, little has been established in PICUs. A 25-yr study of mortality associated with congenital heart disease found that black patients had a nearly 20% higher mortality rate than white patients (46). For patients requiring single ventricle palliation, there was much more variation in the age of palliation in black children compared with white children, and black children with renal failure were less likely to be listed for kidney transplantation (47).

Table 1. Pediatric benchmarking opportunities

Organization	Web Site	Program Description
Pediatric Intensive Care Unit Evaluations	www.picues.org	Provides comparative, severity adjusted, multiple-institution PICU outcome reports for quality and efficiency
National Nosocomial Infections Surveillance System	http://www.cdc.gov/ncidod/hip/nnis/nnis	A multiple-institution infectious disease collaborative operated by the Centers for Disease Control that tracks and benchmarks nosocomial infections in pediatric and adult institutions
Virtual PICU	www.picu.net	Real-time, online, automated data gathering with analysis of outcomes, severity of illness analysis, and defined therapeutic protocols
Child Health Corporation of America: PHIS Project	http://www.chca.com/servpediat.html	Online clinical and financial comparative data that helps guide owner hospitals in improving both business and clinical practices
Vermont Oxford Network	http://www.vtoxford.org/	Collaboration of healthcare professionals dedicated to improving the quality and safety of medical care for newborn infants and their families

PICU, pediatric intensive care unit.

Timeliness

Timeliness is a marker of the adequacy of processes to achieve acceptable outcomes (1). The IOM report characterizes timeliness in two ways (1). A "customer service" focus addresses issues such as timely and effective communication and wait times. Second, and more important to ICU patients, lack of resource availability can risk adverse outcomes. Children treated at pediatric trauma centers have a lower proportion of missed injuries compared with children treated at adult trauma centers (48, 49), and children treated in PICUs compared with adult ICUs have a significantly lower mortality rate, especially for the most seriously ill children (48, 49). PICU outcomes have been associated with specific care factors and may be related to the experience and competency of the physician, nursing, and technical staff (50). The presence of pediatric intensivists and pediatric critical care fellows has a positive impact on outcome (50). Unfortunately, many critically ill children with fatal outcomes may never have received the highest level of care at these centers.

Timeliness in information transfer is probably related to improved PICU outcomes. The ICU is a complex and dynamic, tightly coupled system. Multiple processes and personnel must interact to provide high-quality, error-free care. Multidisciplinary critical care teams are required. A central component that affects the functioning of the team is the communication, especially nurse-physician communication (51, 52). When the practitioners are able to participate in an open dialogue and exchange opinions concerning a patient's condition, timely interventions can be made that improve patient outcomes. These issues are probably related to the recent observation that better management of neonatal ICUs is associated with improved outcomes (53).

Patient Centeredness

Patients and families are demanding active participation in health care decision making. Patient centeredness as an IOM aim helps to characterize the interactions between practitioners and their patients. Personnel traits comprising service quality include empathy, compassion, and respect. Actions that demonstrate appropriate service quality include the provision of information, communication, education, attention to physical comfort, emotional support, and the involvement of family and friends in care (1). When the family's perceptions of emotional support are inadequate, their satisfaction with their experience and, more important, their long-term viability and cohesion as a family unit are at risk (54). PICU microsystems also operate within this aim (4). In a multiple-institution study in pediatric hospitals, parents reported problems with >25% of the health care processes (55). The two most common processes were inadequate information and lack of coordination of care; both were exaggerated in academic health centers.

There are many opportunities to improve patient-centered care in the PICU. Frontline staff may be able to quickly and easily elicit process deficiencies from parents. Validated and reliable surveys investigating satisfaction with the ICU care are available to assist providers (56). The adequacy of information provided by staff helped to predict the intensity of long-term grief. Communication, especially explaining tubes, catheters, and physical appearances, is important. A partnership between members of the PICU team and the parents of critically ill children can minimize the pressures of the situation and allow the family to cope more effectively. Increasing family involvement with open visitation and presence during procedures and during particularly stressful times many be beneficial and is becoming more common. Creating an environment that includes family photographs, the child's special toy, and familiar voices on a tape recorder assists in alleviating the seclusion that families often perceive and open avenues of communication (57).

Efficiency

Current health economics "encourages" that health care resources are delivered in a cost-effective and efficient manner while not jeopardizing quality (58). Quality at a given level of cost determines the value of a commodity such as ICU care (59). The value of an individual ICU will be increased by its ability to achieve appropriate outcomes while keeping costs to a minimum. The increase in the number of ICU beds increases fixed infrastructure costs and reduces operating margins if they are appropriately used (59).

Patients who are sicker require more services in the ICU, stay longer, die more often, and have increased costs (59–61). "Targeted benchmarking" refers to the effort to achieve comparability up to a specified level and requires appropriate case-mix controls to enable PICUs to be compared. There are a number of opportunities available for benchmarking clinical services (Table 1). Clinical scoring systems are the most common way to provide controls for case-mix variables (physiology, diagnoses, etc) and thus allow for standardized comparisons (51). For example, LOS is a common measure of resource use in the ICU, and reducing it is one important method of reducing cost. The standardized LOS ratio is the ratio of observed to predicted LOS where predicted LOS is derived from a process to control case mix that is dependent on diagnosis and physiologic status (62). The standardized LOS ratio can be used to compare a particular unit over time on this element of resource use, but it can also be used to determine whether a particular ICU's resource use is above or below that of similar ICU (62–65). The standardized LOS ratio has become standard in benchmarking ICU performance and quality.

An established method of assessing the efficiency of ICU resource use is based on unique ICU therapies, those best delivered in the ICU such as mechanical ventilation and vasoactive infusions (62–65). This approach enables benchmarking of PICUs for their proportions of "low-risk," monitor-only patients (62–65) and "high-risk," critical care patients. Excess bed capacity leads to a higher ratio of monitored-only to high-risk patients and reduces ICU efficiency (62–65).

A variety of factors have been identified that influence ICU efficiency. Admission and discharge criteria, transfer policies, 24-hr intensivist coverage, ICU design and staffing patterns, physician and nurse work patterns, and organizational characteristics including the concept of a critical care team and the presence of medical directors have been identified as important associated factors (62–65).

A Practical Guide to Improving Care in the PICU

Matching the growing enthusiasm for interventions to improve quality for patients is an awareness of the need for further understanding a systems approach in analyzing the innumerable patient care processes that contribute to bad outcomes in the PICU. This starts with a blame-free environment, but one that holds providers accountable for the care they deliver. Furthermore, if success in the improvement of quality for patients is to be achieved, opportunities to capitalize on the knowledge and tools provided by other industries should be considered and studied. Risk assessment techniques can be coupled with process analysis strategies to prioritize initiatives, formulate a plan, and redesign clinical practices, based on the evidence-based literature, to affect the best outcomes. In addition, specific documentation of performance indicators across each of the IOM's aims needs to be incorporated into the daily work of the clinical team so that they can monitor their progress and become engaged in the process.

CONCLUSION

If the care for PICU patients is to be fundamentally improved, an understanding of the current care environment, the existing evidence base, the opportunities for improvement, and the documentation of the improvements needs to be realized. The IOM's six aims provide a useful framework to advance the quality of care in this pediatric subspecialty and perhaps others.

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