American Academy of Pediatrics
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FROM THE AMERICAN ACADEMY OF PEDIATRICS

Organizational Principles to Guide and Define the Child Health Care System and/or Improve the Health of all Children

Policy Statement—Principles of Pediatric Patient Safety: Reducing Harm Due to Medical Care

STEERING COMMITTEE ON QUALITY IMPROVEMENT AND MANAGEMENT AND COMMITTEE ON HOSPITAL CARE

KEY WORDS

patient safety, quality improvement, culture of safety, medication errors, medical errors, adverse events, avoidable harm

ABBREVIATIONS

IOM—Institute of Medicine
AAP—American Academy of Pediatrics
CPOE—computerized physician order entry

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abstract

FREE

Pediatricians are rendering care in an environment that is increasingly complex, which results in multiple opportunities to cause unintended harm. National awareness of patient safety risks has grown in the 10 years since the Institute of Medicine published its report *To Err Is Human*, and patients and society as a whole continue to challenge health care providers to examine their practices and implement safety solutions. The depth and breadth of harm incurred by the practice of medicine is still being defined as reports continue to uncover a variety of avoidable errors, from those that involve specific high-risk medications to those that are more generalizable, such as patient misidentification. Pediatricians in all venues must have a working knowledge of patient-safety language, advocate for best practices that attend to risks that are unique to children, identify and support a culture of safety, and lead efforts to eliminate avoidable harm in any setting in which medical care is rendered to children. *Pediatrics* 2011;127:1199–1210

Patient safety is defined as "freedom from accidental injury" caused by medical care, such as harm or death attributable to adverse drug events, patient misidentifications, and health care–associated or health care–acquired infections.[1] Although patient safety is but 1 of the 6 domains of quality of care defined by the Institute of Medicine (IOM), it is undoubtedly one of the most pressing domains, given the IOM estimate that 44 000 to 98 000 inpatient deaths attributable to medical errors occur each year in the United States. The phrase "patient safety" may be mistakenly interpreted as the focus on injury-prevention strategies such as the use of car seats and helmets.[2] However, pediatricians can help champion the concept that pediatric patient safety means preventing injury to children caused directly by the health care system itself.

Over the past 10 years, patient safety has become a key priority for health systems. Starting with the 1999 IOM report, *To Err Is Human*, there have been dramatic increases in research, standards, collaborative efforts, education, and measures focused on patient safety.[1,3–6] In 2001, after recognizing the necessity to coherently guide and understand pediatric patient-safety issues, the American Academy of Pediatrics (AAP) published the statement "Principles of Patient Safety in Pediatrics,"[7] and in 2003 it published "Prevention of Medication Errors in the Pediatric Inpatient Setting."[8] In 2007, the AAP released the statement "Patient Safety in the Pediatric Emergency Care Setting."[9] Since

the publication of these seminal policy statements, much has been learned about pediatric patient safety.

This statement, "Principles of Pediatric Patient Safety: Reducing Harm Due to Medical Care," elucidates the current understanding of issues and practices to minimize pediatric medical errors and improve the quality of care. Three key issues are the focus of this statement: (1) the significance of pediatric patient safety; (2) the science behind the culture of safety; and (3) patient-safety strategies. (Definitions of patient-safety tools and terms and other references are provided in Appendices 1–4.)

SPECIAL CONSIDERATIONS FOR CHILDREN

Medical errors and patient harm differ in several ways for children compared with adults. First, children are at greater risk of medication errors than are adults because of children's development, demographics, dependency on parents and other care providers, and different epidemiology of medical conditions.[10] Errors in prescribing, dispensing, and administering medications represent a substantial portion of the preventable medical errors in children.[11–14] Second, computerized physician order entry (CPOE) systems that are designed for adults have limited effectiveness in reducing pediatric medication errors.[14] Also, efforts that eliminate catheter-related bloodstream infections in adults do not have the same effect for children.[15,16] Pediatric patient-safety efforts need to be researched further to determine the best strategies for reducing these preventable harms in children.

Reasons for the unique attributes of patient-safety problems and solutions for children are multifactorial.[17] Woods et al[17] detailed these factors as involving 3 key overarching domains: (1) physical characteristics; (2) developmental issues; and (3) minor legal status issues. Layered onto these distinguishing characteristics is a general patient-safety approach that involves 3 main strategies: (1) understanding the epidemiology of errors and having sources of error identification; (2) understanding the science behind improvement, including the safety culture; and (3) having a source of core patient-safety solutions. Each of these overarching strategies should be incorporated into pediatric patient-safety risk assessment and solution development, and attention should be paid to each of the unique domains of pediatric patient-safety risks as defined by Woods et al.

EPIDEMIOLOGY OF PEDIATRIC PATIENT HARM

Pediatric errors in the inpatient setting have been reviewed by several investigators.[18–20] The authors of 1 study reported 12.91 adverse events per 1000 hospital discharges among patients from birth through 15 years of age.[21] Negligence was determined in 27.6% of the events. Among 10 778 orders reviewed by Kaushal et al[13] in 2 academic pediatric hospitals, 616 medication errors (5.7% of all orders) were identified. One-fifth of these errors were near misses, and 1% caused patient harm. Adverse drug events were identified in 2.3% of hospitalizations, and 19% were deemed preventable. Serious errors occurred more often in critical care settings, and adverse drug events occurred 3 times more frequently among pediatric patients than among adults. In the Vermont Oxford Network, an analysis of medical errors in NICUs revealed that 47% of the errors involved medications, 11% involved patient misidentification, 7% involved delays or errors in diagnosis, and 14% involved errors in the administration or method of using a treatment.[22] In addition, a review of charts among 15 NICUs revealed that adverse event rates are more common than previously described.[23] Analysis of the Agency for Healthcare Research and Quality patient-safety indicators further revealed the breadth and variability of patient-safety events, revealing rates per 10 000 pediatric discharges of less than 1 (in-hospital postoperative hip fractures, transfusion reactions) to 68 (birth trauma), 103 (postoperative sepsis), and 703 (failure to rescue, failure to prevent a clinically important deterioration).[24]

Errors in pediatric emergency department (ED) settings may be attributable to improper patient identification, lack of experience of adult emergency staff with pediatrics, and challenges with performing technical procedures on and calculating medication doses for children.[25,26] Other sources of error include communication between prehospital and ED staff; among ED staff, particularly during change-of-shift sign-off; between ED and inpatient staff; and between ED staff and family members. Other important sources of error in the ED include diagnostic mistakes, medication errors, and environmental deficits such as equipment malfunction. In a Canadian pediatric ED, 100 prescribing errors and 39 medication-administration errors occurred per 1000 patients.[27]

Studies on errors in pediatric ambulatory care have been limited.[28] The Learning From Errors in Ambulatory Pediatrics study[29] found 147 medical errors reported from 14 practices. The largest group of errors was attributed to medical treatment (37%). Other errors included patient identification (22%); preventive care, including immunizations (15%); diagnostic testing (13%); patient communication (8%); and less frequent causes. Among medical treatment errors, 85% were medication errors. Of these errors, 55% were related to ordering, 30% were related to failure to order, 11% were re-

lated to administration, 2% were related to transcribing, and 2% were dispensing errors. In a prospective cohort study at 6 Boston, Massachusetts, area pediatric practices over a 2-month period, 3% of 1788 patients ($n = 57$) had preventable adverse drug events.[30] Although none of these events were found to be life-threatening, 8 (14%) were serious. The preventive strategies with the most preventive potential were improved communication between providers and parents and between pharmacists and parents. Among new prescriptions for 22 common medications in outpatient pediatric clinics, 15% were issued with potential dosing errors.[14] In addition, medication samples are often dispensed with inadequate documentation.[31]

THE SCIENCE OF PATIENT SAFETY

The Safety Culture

In addition to understanding the epidemiology of medical harm to children, the awareness and attitude of health care providers regarding patient safety is important. Specifically, a "culture of safety" is fundamental for avoiding patient harm and emphasizes improving systems rather than blaming individual people.

Society is demanding a safer health care system. State and federal agencies (eg, Centers for Medicare and Medicaid Services), certifying organizations (eg, the Joint Commission), and professional societies (eg, AAP, American Board of Pediatrics) also have patient-safety expectations. These combined forces are placing greater pressure on the health care community to develop a culture of safety in which leaders and members understand and act on the basis of a systems approach.

Human Factors Perspective

A culture of safety approaches human fallibility by concentrating on the conditions under which people work and building defenses to avert errors or mitigate their effects.[32] The culture of safety does not focus on errors of individual people, because errors within organizations that deal with high-hazard processes rarely have their ultimate cause rooted in individual behavior. High-reliability organizations recognize variability as a constant and are focused on minimizing that variability and its effects.[32] The basis for this framework in health care rests on research in high-hazard industries (eg, aviation, nuclear power, and petrochemical industries) that have significantly decreased the incidence of catastrophic events.[33–35] Although the complexity of medical care may present difficulties in creating a culture of safety, the science of human factors provides common principles that can endow all facets of our medical system with the resilience to avoid errors and adverse events.

The optimal culture of safety requires an organizational culture that supports 4 key elements: reporting, being just, being flexible, and learning. The goal of a culture of safety is to be an informed culture with constant attentiveness and commitment to avoiding failures such as giving a wrong dose of medicine or failing to wash hands before seeing patients; reluctance to simplify interpretation; commitment to resilience; deference to expertise; and sensitivity to systems-based practices.[36]

For an organization to be informed, it must be a "reporting culture." A reporting culture collects, analyzes, and disseminates data about medical errors and adverse events. Front-line staff must be willing and able to report errors and adverse events without fear of retribution. Crucial to this culture are the abilities to communicate easily, confidentially, or anonymously[37] to separate entities responsible for data analysis from those with disciplinary functions and to provide rapid and useful feedback.

Organizations with a "just culture" encourage and reward error-reporting by maintaining a nonpunitive environment. A just culture focuses on a systems approach to human fallibility while holding accountable those who intend to harm or intentionally fail to adhere to policies and procedures designed to keep patients safe.

An optimal culture of safety has a "flexible culture" that is capable of adapting effectively to changing demands. Although a flexible culture depends on a disciplined staff, it ignores rank to defer to technical expertise. For children, defining this expertise should include assessment of specific training and skills necessary to safely render care while attending to factors such as varied ages, disease states, and developmental needs. This culture depends on teamwork; shared values; use of well-tested standardized operating procedures and prospective risk assessment, such as failure modes and effects analysis; and investment in staff training.

Finally, a "learning culture" has the competence and will to make the right conclusions on the basis of safety information and to implement changes when needed. This culture learns from its mistakes through system-oriented assessments such as root-cause analysis; shares that learning throughout the whole organization; and does not hide its mistakes. A culture of safety promotes compassionate disclosure of its mistakes to those who have suffered harm from those mistakes.

These optimal human factors interact to create an informed system that perpetuates safety independent from individual personalities or external forces and provide a set of principles that promote a common culture of safety across our complex medical system.

PATIENT-SAFETY STRATEGIES

Despite best efforts, active error detection, and ideal safety culture, errors will inevitably occur in systems as complex as health care.[32,38] The 1999 IOM report identified key safety-design concepts to consider when striving to reduce medical errors. Additional guidance on creating systems can be found in the IOM principles for the design of safety systems in health care organizations[1] (Appendix 1).

Methods used to assess and resolve patient-safety issues incorporate the IOM's broad key safety-design concepts to improve reliability through redundancy, simplification, and standardization.[1] Specific goals, such as accurate patient identification and prevention of indwelling catheter infections, are amenable to the introduction of checklists, double-checks at the bedside, or forcing functions such as mandated bar-code scanning before a drug can be administered to a given patient.

Other safety goals, such as recognition of a change in a patient's status or encouraging patient and family involvement in the patient's care, require a composite of changes to health care systems and expectations of both providers and the consumer. Many institutions involve patients and families in critical care unit rounds, which is felt to enhance the prevention and identification of problems.[39] Patient- and family-centeredness play important roles in the culture of safety, including consideration of ethnic culture and language.[40]

Leadership

In *To Err Is Human*, the IOM addressed the need for national leaders to set goals for patient safety but also charged that "Chief Executive Officers and Boards of Trustees should be held accountable for making a serious, visible and ongoing commitment to creating safe systems of care."[1] This charge applies to leaders in all settings including solo practices. Leaders and clinicians who strive to improve patient safety need to appraise their organization's safety culture to determine the best means for implementing safety strategies.

Clinicians must be involved to ensure the success of patient safety as part of larger quality-improvement efforts. Roles vary and depend on the type of clinician, practice setting, and system. In all settings, individual physician participation includes taking responsibility for maintaining knowledge of patient-safety principles, providing patient and parent education, positively engaging safety efforts, and working effectively within a multidisciplinary structure. Although financial incentives may be used to facilitate involvement, providing physicians with data and reminders and ensuring their involvement in designing processes of care is most compelling.[41,42] Group leaders can perform a physician/practice patient-safety assessment on topics such as medication management or clinical (eg, laceration repair) or administrative (eg, acknowledgment of laboratory results) procedures.[43] Leaders also can initiate patient-safety projects such as creating a tracking system for high-risk pregnant teenagers or a tool for parents of children with special needs that clearly defines what changes in clinical status should prompt a call to which specific clinician[44,45] (see Appendix 3). System leaders also can use knowledge of organizational goals and external agency mandates to target changes with wider impact, such as a multidisciplinary approach toward medication reconciliation.[5]

In community and adult settings, there is an added need to advocate for pediatric-specific issues. Physician participation on key hospital committees, such as pharmacy and therapeutics, information technology, sedation, rapid-response team, and ambulatory clinical practice, is invaluable. Creation of a pediatric multidisciplinary safety committee that reports to the hospital or larger medical group board can be a productive way to link specialists and ancillary providers to ensure cross-communication on safety issues for children.

Role of Information Technology

Pediatric-specific technological support of safety endeavors is improving, yet most interventions are still in the development phase. Although information technology cannot solve all ails of patient safety, some safety issues are particularly amenable to information technology. Since publication of the AAP statement "Prevention of Medication Errors in the Pediatric Inpatient Setting," it has become more apparent that CPOE systems require robust decision support to be safe and effective.[7,46–48] Some decision-support rules for drug and dosing schedules and CPOE systems are commercially available for children; however, most of them are created locally.[11,49–51] Order sets, reminders, and clinical practice guidelines embedded within information systems increase adherence to best practice.[52,53] Use of electronic equipment—specifically, programmable "smart" infusion pumps—has resulted in improved documentation of medication errors and decreases in calculation and administration errors.[54–56]

Technological solutions to more generalized medical safety concerns have been applied to pediatric settings. Barcoding has been used to compare identification bands with medications and blood products before administration.[57] Computers can generate code sheets for bedside posting and link to a patient's most recently updated visit

list for patients within an enclosed system. Electronic patient-tracking systems assist with patient flow and notification of abnormal study results.[58] Although electronic health records have been reported to yield an overall economic benefit to ambulatory practice, only a small percentage of this financial gain is associated with proven improvements in patient safety, such as avoidance of adverse drug events.[59,60]

Despite noted advantages, some limitations to technological support still exist, such as variable ease of use, physician acceptance, cost, software integration into existing facility systems, standardization across systems, the increase in errors after implementation, and ability to address only a subset of potential medical errors.[60,61] Other examples of medical errors that currently elude decision-support programs include inappropriate selection of medication for the condition being treated and failure to recognize a change in patient status.

Patient-Safety Goals and Efforts

Current national patient-safety efforts are best described by the Joint Commission's national patient safety goals[6] and campaign initiatives by the Institute for Healthcare Improvement. The Joint Commission requires for all venues of patient care: verbal, written, and electronic communication of test results; information transfer at transitions of care (hand-offs); medication reconciliation; and ensurance of patient/family understanding of care plans.[5] The Joint Commission requires hospitals to reduce the risk of health care–associated infections such as multidrug-resistant organism infections, central line-associated bloodstream infections, and surgical-site infections and to improve recognition and response to changes in a patient's condition, for which many pediatric hospital rapid-response teams are using the Pediatric Early Warning System.[62] Family-centered care is of particular importance and value for children in high-risk settings such as the emergency department and for children with special needs.[63,64] Patients and families should be able to articulate care plans and demonstrate understanding of the anticipated treatment outcome. Stress and fatigue also have been associated with errors, and national efforts focused on reducing workplace stress for physician trainees and other staff are being promoted.[65–69] Diagnostic errors have been recognized as an important issue as well.[70] Medication management continues to be a specific focus for children because of variations in body weight, body surface area, organ system maturity, developmental stage of absorption and excretion ability, dependence on others for medication administration, and need for specially compounded formulations.[7] Accurate weight scales, standardized equipment throughout a system, drug dose-range limits, programmable "smart" infusion pumps for hospitals, and standardized order sets should be used.[52–56,71–73] Clinical pharmacists trained in pediatrics should be integrated into inpatient rounds and used for education of staff and families in all settings as often as possible.[42,73–75]

The AAP has launched webinars and Web sites and has partnered with other national leaders to offer specific tools, resources, and links to best health care safety practices for children[44,45,76–78] (Appendix 4). Collaborative implementation and measurement of both the process (adherence to practice) and clinical outcomes of shared strategies are necessary to track and refine care practices for all children.

RECOMMENDATIONS

Reducing pediatric patient harm attributable to medical care requires not only preventing errors but also identifying and reporting errors and adverse events, disseminating best practices, and cultivating a culture of safety. Many interventions to improve the culture of safety are available and are based on principles derived from the experience of other high-risk industries. These processes have been successful in reducing the incidence of catastrophic events, and their implementation in health care should be encouraged. The outcomes of these interventions should be rigorously measured with valid and reliable tools and monitored for their effectiveness in health care. Leadership is needed to continue to make and accelerate a transformation that acknowledges that providers (1) work in high-risk, complex environments, (2) are fallible, and therefore, medical errors do happen to children, (3) are independently and collectively accountable for patient safety, and (4) are integral to the success of systems change. Continuous system improvements are central to creating a culture of safety through reporting of errors and adverse events, being just and flexible, and learning and implementing change on the basis of experience and rigorous science.

The following are recommendations to ensure a comprehensive, accelerated approach toward pediatric patient safety:

1. Raise awareness and improve working knowledge of pediatric patient-safety issues and best practices throughout the pediatric community.
   a. Educate: Expand educational efforts to reach a broad scope of clinicians. Ensure that all clinicians can identify pediatric patient-safety issues in the med-

ical setting and describe what they can do to improve them both individually and within systems. Include patient-safety curricula for all child health trainees.

b. Network: Create standing patient-safety programming at national and regional meetings to encourage sharing of patient-safety issues and best practices among pediatric clinicians.

c. Create a safety culture: Challenge all organizations, including small practices, to adopt a plan that informs, supports, and educates on pediatric patient safety by using appropriate local examples. Strive to develop programs that support members to improve their safety culture in their clinical care settings.

d. Expand focus: Direct attention to ambulatory settings. The majority of work in patient safety to date has been in hospitals, yet the majority of children in this country interact primarily with the health care system in ambulatory settings. Develop patient-safety metrics for the ambulatory pediatric setting.

2. Act and advocate to minimize preventable pediatric medical harm by using information on pediatric-specific patient-safety risk.

   a. Develop pediatric-specific error-reporting: Develop and support broad-scale pediatric error-reporting systems and analysis of submitted events. Identify trends and areas in need of action by using these data to guide action on pediatric patient-safety risks.

   b. Foster leadership: Take individual responsibility for maintaining awareness of pediatric patient-safety issues. When possible, lead or participate in practice-based safety initiatives and quality or patient-safety committees in any setting, including ambulatory, hospital-based, community, or tertiary care centers. Spread the current hospital-based focus on patient safety to the ambulatory setting through designation of patient-safety officers for practices.

   c. Enhance family-centered care: Actively engage patients and families in safety at all points of care and address issues of ethnic culture, language, and literacy. Direct families to appropriate resources, and review patients' rights and responsibilities from the perspective of safety.

3. Improve health care outcomes for children by adhering to proven best practices for improving pediatric patient safety.

   a. Adhere to best practices: Disseminate and exercise proven patient-safety interventions such as vigilant hand-washing, time outs before procedures, and medication reconciliation, particularly in ambulatory settings and for children with special health care needs. Embed safety strategies, such as redundancy, forcing functions, bar-coding, standardized order sets, and office protocols (Appendix 2), whenever possible.

   b. Target drug safety: Focus efforts on medication safety by advocating for the development of effective and safe pediatric medications and formulations and for the withdrawal of medications with unfavorable risk/benefit ratios; developing, spreading, and advocating for pediatric-specific health care information technology for drug delivery; educating providers on methods to reduce medication errors; ensuring that providers maintain access to and proficiency in the use of a comprehensive and current pharmaceutical knowledge base; and creating policies that advocate for safe medication delivery to children in all health care settings.

   c. Redesign clinical systems: Instill safety-design concepts when renovating or creating medical care systems and processes. Focus on human-factor issues in patient safety and include pediatric-specific information technological advancements whenever possible (eg, when implementing bar-coding and CPOE systems).

   d. Support research: Expand research to identify and refine effective pediatric patient-safety interventions. Motivate national health care research-funding systems to include a mandatory pediatric patient-safety component.

CONCLUSIONS

The field of pediatric patient safety has matured much in recent years; there are now more robust epidemiology of errors for children, a deep understanding of the concept and measurement of a culture of safety, clear guidance on key elements of patient-safety solutions, and introduction of successful pediatric patient-safety solutions. Nonetheless, continued work is needed to infuse these data and concepts into everyday pediatric practice for all clinicians, and special attention should be paid to the training of new clinicians to ensure that the future workforce can exercise all the tenets of pediatric patient safety as part of their everyday work life. It is only through complete incorporation of the culture of safety, assumption of personal responsibility for patient care

outcomes, increasing examination of the risk areas for pediatric patient safety, and deployment and rigorous evaluation of systems enhancements that the risks of medical errors to children can be reduced further.

APPENDIX 2: GLOSSARY OF TERMINOLOGY

Adverse event: An injury that results from a medical intervention[1] or an event that results in unintended harm to the patient because of an act of commission or omission rather than the underlying disease or condition of the patient.[79]

Cause-and-effect diagram: A diagram that organizes potential causes into general categories, such as methods, materials, machines, and people, and illustrates the common relationships with quality characteristics.[80]

Checklist: "Algorithmic listing of actions to be performed in a given clinical setting . . . to ensure that, no matter how often performed by a given practitioner, no step will be forgotten."[81]

Clinical decision support: "Any system designed to improve clinical decision-making related to diagnostic or therapeutic processes of care. [Clinical decision-support systems] thus address activities ranging from the selection of drugs (eg, the optimal antibiotic choice given specific microbiologic data) or diagnostic tests to detailed support for optimal drug dosing and support for resolving diagnostic dilemmas."[81]

Control chart: A statistical tool used to distinguish variation in a process attributable to common causes and variation attributable to special causes.[80]

Error: Failure of a planned action to be completed as intended or use of a wrong plan to achieve an aim (the accumulation of errors results in accidents)[1] or the failure of a planned action to be completed as intended (ie, error of execution) and the use of a wrong plan to achieve an aim (ie, error of planning). Error also includes failure of an unplanned action that should have been completed (omission).[79]

Failure mode and effect analysis: "[A] methodological approach to analyzing potential problems, errors, and failures and evaluating the robustness of a product design" that "can be used to evaluate systems, product designs, processes, and services" and to identify "how a part, subsystem, or system might fail, as well as the impact of failure on safety and effectiveness. Thus, [failure mode and effect analysis] provides an opportunity to design a potential failure mode out of a product or process."[83]

Flowchart: A display of the various stages in a process in which different types of symbols are used to demonstrate the flow of product or service over time.[80]

Forcing function: "Constraints" designed into processes "that guide the user to the next appropriate action or decision."[1]

High-reliability organizations: Organizations such as "power grid dispatching centers, air traffic control systems, nuclear aircraft carriers, nuclear power generating plants, hospital emergency departments, wildland firefighting crews, aircraft operations, and accident investigation teams" that "operate under very trying conditions all the time and yet manage to have fewer than their fair share of accidents" have "a mindful infrastructure that continually does all of the following: tracks small failures; resists oversimplification; remains sensitive to operations; maintains capabilities for resilience; [and] takes advantage of shifting locations of expertise."[33]

Mistakes/slips: Mistakes are failures of planning, whereas slips are failures of execution.[1]

Pareto chart: A bar graph in which the "lengths of the bars represent frequency . . . and are arranged with longest bars on the left and the shortest to the right. In this way the chart visually depicts which situations are more significant."[84] Pareto charts are used to focus quality-improvement efforts on the basis of the "80/20" rule, which postulates that 80% of problems come from 20% of causes.

Process map: Same as a flowchart.

Root-cause analysis: A process for identifying the basic or causal factors that underlie variation in performance, including the occurrence or possible occurrence of a sentinel event. Typically, the analysis focuses primarily on systems and processes, not individual performance.[79]

Redundancy: Duplication of critical components of a system with the intention of increasing reliability of the system, usually in the case of a backup or fail-safe.

Run chart: Plot of data in time order.[80]

Smart infusion pumps: Intravenous pumps that contain a "brain" consisting of customized software that contains a drug library. This software transforms a conventional intravenous pump into a computer that alerts staff if an infusion is programmed outside of a particular medication's recommended parameters such as dose, dosing unit (eg, mg/kg per minute), rate, or concentration. Smart pumps log data about all such alerts, including the time, date, drug, concentration, programmed rate, and volume infused. In addition, smart pumps have free-flow protection, which includes safety features that are designed to prevent unintentional overdoses of medication or fluid.

Standardized order sets: Algorithmic listing of orders to be performed in a given clinical setting to ensure that, no

matter how often performed by a given practitioner, no step will be forgotten.

Trigger tool: Clinical data related to patient care indicating a reasonable probability that an adverse event has occurred or is occurring. An example of a trigger tool for an adverse drug event is a physician order for an antidote, a medication stop, or a dose decrease.[79,82]

APPENDIX 3: TOOLS, PROJECT GUIDES, AND CULTURE-OF-SAFETY INTERVENTIONS

AAP Tools and Project Guides

Chapter Quality-Improvement Resources

Many chapters, or leaders with quality-improvement knowledge, may not have the infrastructure or resources to implement quality-improvement activities. The following resources will help chapters and their partners move toward quality-improvement work and build chapter capacity to better support pediatric practices.

"A Resource Guide for Chapters, Building Local Capacity for Improvement" (based on the 4 principles of raising awareness, building knowledge, building infrastructure, and implementing improvements to improve the quality of care provided to children).

Measuring for quality improvement: the AAP policy statement "Principles for the Development and Use of Quality Measures" (AAP Steering Committee on Quality Improvement and Management and AAP Committee on Practice and Ambulatory Medicine).

Quality-improvement literature (evidence-based literature, reports, and other publications about the implementation science of quality improvement).

2007 chapter quality-improvement needs assessment (summary of needs-assessment findings and full report of needs-assessment findings).

"Who's Doing What?" A list of chapters involved in quality improvement (a list of quality-improvement activities in which chapters are involved).

Chapter quality-improvement champions and committee chairs (log in using AAP member ID and password to access a list of chapter quality-improvement champions and or quality-improvement committee chairs).

Chapter spotlight (the Chapter Quality Improvement Spotlight recognizes chapters that are making great strides in supporting their members in quality improvement and building infrastructure for quality-improvement work).

To access these resources, visit www.aap.org/member/chapters/caqi/index.html.

AAP Quality-Improvement Programs and Resources

Education in Quality Improvement in Pediatric Practice (EQIPP): EQIPP allows one to evaluate his or her practice online using tools that can be easily implemented to enhance patient care. The goal of eQIPP is to help physicians collect and analyze practice data over time to document improved quality of care. For more information, visit www.eqipp.org.

Quality Improvement Innovation Network (QuIIN): The QuIIN is a network of practicing pediatricians and their staff teams who use quality-improvement methods to test tools, interventions, and strategies to improve health care and outcomes for children and their families. The QuIIN serves as a practical working laboratory for pediatricians to test how improvements can be implemented in practice while sharing strategies and learning from colleagues who are members of the QuIIN. For more information, visit www.aap.org/qualityimprovement/quiin.

Medical home initiatives: The AAP's medical home Web site is the premier resource for improving the lives of children and youth with special health care needs and their families through a medical home. For more information, visit www.medicalhomeinfo.org.

Partnership for Policy Implementation (PPI): In June 2005, the AAP, with funding support from the federal Maternal and Child Health Bureau, launched the PPI, a pilot program to integrate health information technology functionalities into AAP policy. The goal of the PPI is to create fundamental paradigm shifts in the development of policy statements, clinical reports, technical reports, and clinical practice guidelines—specifically, how they are written. For more information, visit http://practice.aap.org/content.aspx?aid=2712 (log-in required).

Practice Management Online (PMO): The quality-improvement section of PMO provides pediatricians with theoretical and practical content as well as applicable tools that can be incorporated into the practice. Examples of topics included are quality-improvement basics, evidence-based medicine, improving and measuring quality in the pediatric practice, patient safety, and maintenance of certification for pediatricians. For more information, visit http://practice.aap.org.

Safer Health Care for Kids: This comprehensive Web-based resource center for pediatric safety information and strategies is designed for physicians, allied health professionals, administrators, parents, and caregivers who share a commitment to ensuring a safe health care environment for infants, children, adolescents, and young adults. For more information, visit www.aap.org/saferhealthcare.

AAP Steering Committee on Quality Improvement and Management (SCOQIM): The SCOQIM was established in 2001 in response to the increasing national emphasis on quality in health care and serves as the academy's integrated

voice for quality. The committee comprises pediatricians with expertise in quality improvement, health information technology, and evidence-based medicine. Committee priority areas include quality measurement, patient safety, evidence-based guideline development and implementation, open-access scheduling, and other innovative practice models. For more information, visit www.aap.org/visit/scoqim.htm.

APPENDIX 4: WEB LINKS TO OTHER ORGANIZATIONS WORKING ON PATIENT SAFETY TOOLS AND EDUCATION

1. Agency for Healthcare Research and Quality patient safety tools: www.ahrq.gov/qual/pips.
2. Alliance for Pediatric Quality: www.kidsquality.org.
3. Child Health Corporation of America: www.chca.com/index_flash.html.
4. Institute for Healthcare Improvement (IHI): www.ihi.org/ihi.
5. Institute for Healthcare Improvement Safety Webinars: www.ihi.org/IHI/Programs/AudioAndWebPrograms/WebandACTIONUsingtheIHIGlobalTriggerToolApril2009.htm.
6. Institute of Medicine: www.iom.edu/Global/Topics/Quality_Patient_Safety.aspx.
7. Institute for Safe Medication Practices: www.ismp.org/tools/abbreviations.
8. The Joint Commission: www.jointcommission.org/topics.patient_safety.aspx and www.jcrinc.com/jcr-quick-finder/.
9. National Association of Children's Hospitals and Related Institutions: www.childrenshospitals.net/AM/Template.cfm?Section=Homepage&Template=/customSource/homepage/homepage.cfm.
10. National Initiative for Child Health Quality: www.nichq.org.

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APPENDIX 1 IOM Key Safety-Design Concepts and Principles for the Design of Safety Systems in Health Care Organizations

	Examples/Components
Key safety-design concepts	
Make things visible so that the user can determine what actions are possible at any moment	Defibrillator dials should be clearly visible to the user on the front display
Simplify the structure of tasks to minimize the load on working memory, planning, or problem-solving	Concentrations for continuous-drip medications should be limited and standardized on the hospital formulary
Use affordances—characteristics of equipment or workspace that communicate how it is to be used	Oral syringes are designed to administer oral medications and cannot be connected to an intravenous line because of the bulbous tip, except with exceptional force
Use natural mappings—relationships between a control and its movement	Turning a medical instrument knob to the right should make the related dial needle point further to the right
Use constraints or "forcing functions" that guide the user to the next appropriate action or decision	CPOE systems can be programmed so that they do not allow the prescriber to proceed without the patient's weight and allergy history
Assume that errors will occur and design and plan for recovery by making it easy to reverse operations and hard to perform nonreversible ones	Machine-readable patient-identification systems, such as bar-coding, act as a final check to prevent harm in situations in which another patient's medication has been mistakenly retrieved to administer to the wrong patient
If applying the earlier strategies does not achieve the desired results, standardize actions, outcomes, layouts, and displays	Chemotherapy protocols and order sets should be standardized and preprinted or programmed into CPOE systems
Principles for the design of safety systems in health care organizations	
Provide leadership	Make patient safety a priority corporate objective
	Make patient safety everyone's responsibility
	Make clear assignments for and expectation of safety oversight
	Provide human and financial resources for error analysis and systems redesign
	Develop effective mechanisms for identifying and dealing with unsafe practitioners
Respect human limits in process design	Design jobs for safety
	Avoid reliance on memory
	Use constraints and forcing functions
	Avoid reliance on vigilance
	Simplify key processes
	Standardize work processes
Promote effective team functioning	Train in teams those who are expected to work in teams
	Include the patient (and/or family) in safety design and the process of care
Anticipate the unexpected	Adopt a proactive approach: examine processes of care for threats to safety and redesign them before accidents occur
	Design for recovery
	Improve access to accurate, timely information
Create a learning environment	Use simulations whenever possible
	Encourage reporting of errors and hazardous conditions
	Ensure no reprisals for reporting of errors
	Develop a working culture in which communication flows freely regardless of authority gradient
	Implement mechanisms of feedback and learning from error

Data source: Institute of Medicine. *To Err Is Human: Building a Safer Health System.* Washington, DC: National Academies Press; 2000.

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