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Patient Safety (Ma Coffey, Section Editor)

Aligning Patient Safety and Stewardship: A Harm Reduction Strategy for Children

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Abstract

Purpose of review Review important patient safety and stewardship concepts and use clinical examples to describe how they align to improve patient outcomes and reduce harm for children.
Recent findings Current evidence indicates that healthcare overuse is substantial. Unnecessary care leads to avoidable adverse events, anxiety and distress, and financial toxicity. Increases in antimicrobial resistance, venous thromboembolism, radiation exposure, and healthcare costs are examples of patient harm associated with a lack of stewardship. Studies indicate that many tools can increase standardization of care, improve resource utilization, and enhance safety culture to better align safety and stewardship.
Summary The principles of stewardship and parsimonious care can improve patient safety for children.

Introduction

Healthcare leaders and frontline staff understand and emphasize the importance of patient safety and stewardship, yet these topics are often relegated to separate silos. Patient safety efforts focus on reducing or preventing harm to patients. Harm can be defined broadly to include temporary or permanent physical harm, emotional harm, and/or financial harm. It is well known that patients experience harm in hospitals [1, 2] and clinics [3] every day. The goal of patient safety work is to reduce and eliminate these harms.

Stewardship is most often narrowly thought of from two lenses in healthcare: antibiotics and resources. Emergence of multidrug-resistant pathogens has placed a spotlight on the misuse and overuse of antibiotics leading to a global focus on appropriate use in order to promote their preservation. In addition, stewardship focuses on appropriate care and avoidance of waste to make care more affordable in the setting of rising healthcare costs and increased financial burdens on individuals, hospitals, and societies. The focus on cost-cutting can place stewardship at odds with safety efforts. Where safety and stewardship can powerfully align is through parsimonious care, which is defined as "delivering appropriate health care that fits the needs and circumstances of patients and that actively avoids wasteful care—care that does not benefit patients" [4]. Both healthcare leaders and frontline staff practicing and promoting parsimonious care will deliver care that meets the prescribed tenets of both safety and stewardship.

Why safety and stewardship can appear dissonant

At times, safety and stewardship can appear at odds. One example is the balance of antimicrobial stewardship and timely management of sepsis. While sepsis is rare in children particularly in those without chronic medical conditions, it accounts for roughly 20% of pediatric healthcare spending in the USA [5]. Clear evidence exists that antibiotic overprescribing contributes to the emergence of drug-resistant bacteria [6]. Concurrently, rapid recognition and treatment of sepsis with fluids and antibiotics in the first 1 to 3 h is recognized as standard of care [7]. Where the balance exists is in finding the right screening tool that targets patients at highest risk of sepsis and values both escalation and de-escalation of therapy in clinical practice [8].

Resource-constrained clinics, units, and/or hospitals often feel the dissonance between safety and stewardship. Resource stewardship can become a cost-cutting exercise and a threat when the impact on patient safety is not considered. In a well-known patient safety event, a laboring woman was inadvertently given a large dose of intravenous (IV) anesthesia that was intended for her epidural which subsequently led to her death. In the root-cause analysis, it was discovered that the pharmacy was combining small bags of bupivacaine so that fewer orders and requests were needed, particularly at night when hospital staff resources were limited. As a result, the small bags appeared similar to antibiotics commonly administered to laboring women [9]. Efforts to cut costs or reduce strain on hospital resources like tired doctors, nurses, and pharmacists are understandable. In these cases, there may be a genuine tension between resource control and patient safety. While the hospital would not have made this change if they knew a death would result, they also put a bright warning label on the bag recognizing that an error was possible. Safety and stewardship should be seen as critical partners to help make strategic decisions such as the

process for preparing medications with limited staff resources or whether to purchase the latest equipment or staff training module.

Where safety and stewardship align

Safety and stewardship are often well-aligned concepts as demonstrated in the example of preserving and optimizing PPE in the COVID-19 pandemic. Organizing stewardship into the following five categories: testing, treatment, procedures, monitoring, and screening, can help identify the many ways in which stewardship can improve and enhance patient safety in important ways (Table 1).

Testing

Appropriate testing improves and saves lives. For example, imaging and pathology studies are essential to diagnose a 4-year-old child with neuroblastoma. The

Table 1. Examples of parsimonious care that aligns safety and stewardship in pediatrics

	Why we use them	Why we overuse them	Examples of harm	How we can be safe stewards
Treatment: Antibiotics	Treat infection	"just in case" when there is diagnostic uncertainty	Antibiotic resistance, anaphylaxis, Steven's Johnson syndrome, DRESS syndrome, diarrhea	Antimicrobial stewardship teams, guidelines, prospective audit and feedback
Testing: Head CT for trauma	Identify brain trauma and hemorrhage	Clinician and parental concern, lack of guideline-driven care, habit	Cancer, cost, anxiety	Clinical practice guidelines, prospective audit and feedback
Procedures: Central venous catheter (CVL)	Ease of venous access, longer-term solution than IV, safe infusion of venous irritants	Ease of use, validate need for PICC team, delayed conversion to oral medicines, CVL not removed expeditiously	CVL-associated bloodstream infection, venous thromboembolism	Clear CVL insertion and removal criteria, insertion and maintenance bundles, guidelines for IV versus oral medicines
Screening: Electrocardiogram (ECG) during pre-participation examination (PPE)	Concern for sudden cardiac death during exercise	Belief that universal screening ECG during PPEs is safer than risk-based ECG strategy	ECG shows a spurious result that leads to additional testing, cost, and unnecessarily delay in participation	Apply a risk-based strategy, clinical practice guideline
Monitoring: Pulse oximetry for children not requiring oxygen	Concern for hypoxemia, ease of monitoring	It seems safer and easier to have continuous monitoring	Unnecessary admission or increased length of stay because of temporary physiological decrease in pulse oximetry reading	Hospital policy, clinical practice guidelines, EMR alert

benefits of advanced imaging and obtaining and processing a biopsy sample outweigh the risk of radiation, sedation, and the potential for misdiagnosis because disease-appropriate therapy will be essential to survival and recovery. The balance of risks and benefits associated with testing is not always this clear. If an otherwise well 4-year-old child fell down two stairs, immediately started crying without losing consciousness, and vomited once on the way to the emergency department (ED), the balance of benefits and risks of testing changes. Historically, many of these children underwent head imaging with a CT scan to ensure no evidence of hemorrhage or significant brain injury. The risk associated with radiation exposure from a single CT is low [10]. However, when many unnecessary CT scans are done, it results in excess cancer cases [11]. The evidence demonstrates that children with minor head trauma, like the child described above, do not benefit from head CTs because the results rarely impact care [12, 13]. Attempts to understand drivers of overuse of head CTs identified patient expectation that they will get a CT, both patient and provider anxiety about the diagnosis, and the ability to establish trust between the provider and patient as key themes [14]. Providers who can demonstrate their clinical confidence paired with good bedside manner can advocate for resource stewardship in these scenarios will prevent an unnecessary test with radiation exposure, avoid additional cost that contributes to financial toxicity, and avoid patient fear and anxiety from a potentially scary imaging study.

When imaging is needed, stewardship and safety should still align. Children with ventriculoperitoneal shunts often undergo extensive evaluations when they have fever, vomiting, or headache including head CT and radiographs of the shunt. Over time, radiologists have been able to reduce the dose of radiation for these CT scans without compromising diagnostic accuracy [15]. More recently, some centers have replaced CT scans with fast MRI, eliminating radiation for children who do not require sedation for the study [16]. These studies were small and require larger prospective studies powered to ensure that rare diagnoses are not missed more frequently; however, diagnostic sensitivity for the main diagnoses of interest is preserved.

Similarly, electrolyte testing is often considered part of a baseline assessment in the ED and part of daily monitoring and management of children in the hospital. The American Academy of Pediatrics (AAP) published recommendations for fluid management, but do not recommend a specific frequency to check electrolytes for children on IV fluids [17]. For diagnoses like severe dehydration, diabetes insipidus, acute kidney injury, or diabetic ketoacidosis, electrolyte testing is warranted. Yet, electrolyte testing is frequently done for children with other diagnoses to ensure lab values are normal, to monitor the correction of minor abnormalities, or as part of what is believed to be standard of care management. Several studies have shown that electrolyte testing can be safely reduced by 20% or more without adverse effect [18, 19].

Reducing electrolyte testing improves patient safety in a number of ways. For patients without a central venous catheter (CVC), it reduces pain from phlebotomy or the risk of IV infiltration if lab work is drawn from a peripheral IV. Peripheral IV infiltration is a leading cause of harm to children in hospitals [20]. For children with CVCs, reducing electrolyte testing reduces the number of times the catheter is accessed thus reducing the risk of central line associated bloodstream infection (CLABSI). Harm can also occur downstream when spurious lab results have to be repeated or additional testing is ordered. For

example, when a potassium level is elevated due to hemolysis, it may be repeated, an EKG may be ordered, and additional medications may be administered while awaiting repeat testing. While an individual basic metabolic panel is not costly by hospital standards, the aggregate impact of choosing not to test over time is significant [18, 21].

Treatment

To minimize patient harm and maximize patient safety, the first step of stewardship is identifying whether a patient truly needs a specific test or treatment. Antibiotic use provides the best example of both individual and societal consequences of overuse and the need for stewardship efforts to drive safety. Using antibiotics both appropriately and inappropriately drives natural selection for resistant populations of bacteria [22]. In the USA each year, antibiotic-resistant organisms infect at least 2 million people, cause 23,000 deaths, and result in $20 billion dollars in excess direct healthcare costs [23]. Furthermore, antibiotic-associated adverse drug events (ADEs) are a constant threat to patient safety. Antibiotic-associated ADEs include rashes, gastrointestinal disturbances, nephrotoxicity, secondary infections with yeast, neurological or psychiatric disturbances, and allergic reactions. Their use is the leading cause of ED visits for ADEs in children [24], and their use promotes the development of *Clostridioides difficile* infection [25]. Emerging studies even link antibiotic use in childhood to increased risks of autoimmune diseases and obesity [26].

A cross-sectional analysis of antibiotic prescribing across 32 children's hospitals found that 35% of children received one or more antibiotics and 21% of antibiotics were suboptimal [27]. In the ambulatory setting, antibiotics are the most commonly prescribed medication in children [28]. One study found that at least 30% of antibiotics prescribed in physician's offices and EDs were unnecessary [29]. These studies highlight the need and opportunity for each provider to re-evaluate their own prescribing patterns and become antibiotic stewards. The sustainability of antibiotics is threatened simply by their use. Even when appropriately prescribed, antibiotic resistance can emerge over time. Prescribing antibiotics only when necessary will promote their preservation and ultimately improve patient safety by avoiding antibiotic-associated ADEs including the development of *C. difficile* infections.

The standard antibiotic duration for a majority of acute bacterial infections is 7 to 14 days, based on the fact that the week has 7 days in it [30]. Emerging literature on shortened antibiotic courses challenges the traditional length of antibiotic therapy. Some experts feel that it is time to adopt a new antibiotic mantra, "shorter is better" [30]. A recent meta-analysis including adolescent (>12 years of age) and adult patients found no difference in efficacy for short versus longer antibiotic courses for hospitalized patients with pneumonia, complicated urinary tract infections (UTIs), intra-abdominal infections, or nosocomial infections of unknown origin [31].

Multiple studies have evaluated shorter versus longer antibiotic courses in pediatric patients. The risk of relapse in children with uncomplicated gram-negative bacteremia was unchanged in patients who received a 7–10-day course of antibiotic therapy versus a longer course of 10 days or more of therapy [32]. Short-course parenteral therapy with early transition to oral antibiotics in young infants (<60 days) with bacteremic UTIs did not result in more frequent

recurrent UTI or hospital utilization compared with infants who received longer antibiotic therapy [33]. A randomized, open-label, non-inferiority trial in adult patients found that an antibiotic course of 7 days versus 14 days for uncomplicated gram-negative bacteremia was non-inferior [34]. There is significant variation across children's hospitals in appropriate prescribing of surgical antibiotic prophylaxis (SAP) and multiple adverse events are attributable to SAP including increased risk of *C. difficile* [35]. Tribble et al. found that SAP accounts for a large portion of suboptimal prescribing and duration is commonly prolonged across children's hospitals [36].

From a patient safety perspective, shorter courses make more sense as they are more likely to be completed, have fewer side effects, and are less expensive. Christensen et al. found an association between shorter intravenous courses for community-acquired pneumonia (CAP) and reductions in cost and hospital length of stay (LOS) without affecting 30-day hospital readmission rates [37].

A quicker transition to oral antibiotics decreases the need for IV access and may lead to a reduction in hospital LOS. Shorter durations of antibiotic therapy, especially in those without severe disease, may lead to fewer adverse events, better patient compliance, and reduced cost. In the context of antibiotic resistance, shorter durations are necessary to reduce selective pressure on a patients' endogenous flora. Some clinicians remain concerned that short-course antibiotics could lead to an increase in partially treated bacterial disease with resultant relapse. While some pediatric studies are not powered for such rare outcomes [33], recent studies including large randomized controlled trials [34] and meta-analyses [31] add credence to the argument that shorter courses are safe.

Procedures

Central venous line (CVL) access is increasingly common in children for treatment of chronic diseases and to maintain venous access for fluid and medication administration [38]. CLABSIs and venous thromboembolism (VTE) are two sources of hospital-acquired harm that have received considerable attention over the past decade. CLABSI is a common and preventable cause of morbidity and mortality in children. Both single-center studies [39] and large collaborative efforts [40] have shown notable reductions in CLABSI with consistent use of insertion and maintenance line care bundles. VTE is increasingly common in children and CVL placement is the leading cause of pediatric VTE [41–43]. Studies of pediatric VTE have demonstrated process improvements in screening and prophylaxis, but reductions in VTE have not been demonstrated [44]. While the role for VTE risk screening and CVL line care audits are both clear, the most certain way to prevent these hospital-acquired harms is to insert fewer CVLs. Opting to convert a child with osteomyelitis, for example, from a short course of intravenous to oral therapy is safe and will spare the child from these potential harms that carry significant morbidity, mortality, and cost associated with CVLs [45].

Tonsillectomies are a common procedure done to otherwise healthy children with obstructive sleep apnea or frequent throat infections to relieve those symptoms. Decades of high rates of tonsillectomy in children have decreased by half in recent years [46]. Research has shown that tonsillectomies are only clinically beneficial for children with the most severe sleep disturbance and most frequent throat infections [47]. In addition, the recognition in these

studies that adverse events do occur after tonsillectomy, including bleeding and dehydration, contributes to a 9.5% revisit rate at US children's hospitals [48]. Recognizing the need for tonsillectomy stewardship to enhance patient safety and prevent surgeries unlikely to be beneficial, the American Association of Otolaryngology publish clinical practice guidelines recommending tonsillectomy for fewer children [47]. Through a better understanding of longer term outcomes and adverse events, the principles of parsimonious surgical care have led to safer, more judicious use of tonsillectomy for children.

Monitoring

Harm that leads to a serious safety event keeps HCWs up at night, but patient harm extends beyond serious safety events. Bronchiolitis is the most common reason for hospitalization in young children each winter. On occasion, children may require supportive care to manage dehydration and hypoxemia, but it is typically a self-limited disease with low mortality [49]. Yet, during the 1980s, admissions for bronchiolitis tripled in the USA as the pulse oximeter became widely available despite lack of clear evidence of concomitant benefit [50]. Children with bronchiolitis received more interventions such as hospitalization, insertion of IV lines, and medications. Each intervention carries a level of risk including increased cost to parents and healthcare systems, harm of IV insertion, adverse risks associated with medications, and potential for development of nosocomial infections. Recent de-implementation efforts focus on reduced reliance on pulse oximetry both in the ED and inpatient settings. These studies have demonstrated that reduced reliance on continuous pulse oximetry achieve the goal of reducing some of these downstream consequences of overmonitoring [51].

Screening

Returning to the example of neuroblastoma, we can see when screening causes harm. Children with neuroblastoma under 1 year of age often fully recover while older children with disseminated disease have poorer prognosis. The theory emerged that a universal screening program could identify neuroblastoma earlier and potentially save lives. Two large screening programs to test urine samples for neuroblastoma tumor byproducts began in the USA and Japan [52, 53]. Providers discovered and treated more cases of neuroblastoma and their efforts appeared to be a public health victory. However, upon review of the data, there was no impact on the rate of disseminated disease or mortality. Screening in younger children identified benign tumors, many of which did not need treatment but led to additional imaging, surgeries, and even full courses of chemotherapy. These screening efforts ultimately led to increased patient harm.

A more contemporary example is the use of electrocardiograms (ECGs) as a component of the pre-participation sports physical examination. In some countries and states, ECGs are a standard part of the evaluation due to their ability to identify arrhythmias or evidence of hypertrophy [54]. Professional organizations, including the AAP section of Cardiology Choosing Wisely recommendations, do not recognize ECGs as a beneficial broad screening tool [55]. Children who do not have a family history of associated cardiac disease are more likely to have a false positive on their ECG than a true abnormality. Broad screening may result in additional work-up, patient and family concern and

cost, and avoidance of sports until the work-up is complete without identifying additional cases of cardiac disease identified by more focused screening methods [55].

Tools

A number of tools and tactics exist to help align stewardship and safety. Change management strategies suggest these tools and tactics should be multimodal [56]. Efforts should impact hospital culture, institutional priorities, manager priorities, and frontline staff education and awareness. Strategies that make it easy to do the right thing are often the most successful [57].

Prospective audit and feedback

Most clinicians want to provide safe and effective care; however, without information on or oversight of their testing and prescribing patterns, they may not be aware of their role in inappropriate testing or prescribing. To address this, a growing number of medical centers have increasingly complex prospective audit and feedback (PAF) efforts [6]. Antimicrobial stewardship programs (ASPs) have extensive experience with PAF to aid frontline providers, nurses, and pharmacists in appropriate diagnosis, drug selection, and administration. ASPs measure compliance with clinical practice guidelines (CPGs) and report individual data with local and/or national benchmarking. ASPs can monitor antibiotic testing and prescribing for common pediatric conditions and present these data with education to providers on appropriateness of prescribing. A collaborative relationship with effective communication between the ASP and providers is essential to promote culture change around antibiotic prescribing. A "handshake stewardship" program is one way to promote a collaborative relationship between ASP leaders and frontline staff. Stewards review ordering practices and provide in-person feedback. Hurst et al. used this approach to reduce hospital-wide antimicrobial consumption of meropenem-days by 22% and total antimicrobial-days by 10.9% [58]. A cluster randomized study utilized PAF in pediatric primary care clinics leading to a 50% relative reduction in prescribing rates for broad-spectrum antibiotics [59]. Unfortunately, after the PAF intervention ended, the prescribing rates for broad-spectrum antibiotics reverted to above baseline levels highlighting the need for sustainability among AS interventions [60].

Electronic PAF through email or a dashboard are successful strategies to align safety and stewardship. Providers use electronic feedback in diverse projects to reduce testing and treatment for children with bronchiolitis [61], asthma [62, 63], and pneumonia [64] among others. In most cases, providing regular reports over time and provide near-real time data help sustain practice change [61, 63, 64].

Risk stratification

Development of risk stratification tools or clinical management algorithms can help providers determine when testing and treatment are necessary. In neonates, it is notoriously difficult to identify signs of infection as they may be subtle, non-specific, or similar to other pathologic processes. Development of a neonatal early-onset sepsis (EOS) calculator revolutionized the landscape of

EOS work-ups in infants 0–3 days of life born greater than 34 weeks' gestation. This clinical management algorithm is associated with a significant reduction in the use of empiric antibiotics for suspected EOS without missing clinically significant infections [65].

Similarly, providers created several risk stratification tools to reduce the need for head CTs in children with minor head trauma [66]. Application of these risk stratification tools led to a reduction in head CTs in both children's hospitals and community hospitals [67, 68]. The impact of risk stratification for minor head trauma on safety includes fewer radiation-induced cancers, lower cost of care, and lower net quality-adjusted life-year loss [69].

Clinical practice guidelines

CPGs are "systematically developed statements to assist practitioners and patient decisions about appropriate health care for specific clinical circumstances" [70]. CPGs encourage practices with proven benefit, discourage ineffective care, and standardize care both within and between hospitals and clinics [71]. Rutman et al. described the impact of a CAP CPG for hospitalized children and found an increase in ampicillin use from 8% pre-CPG to 63% post-CPG [72]. Beyond CAP, there are encouraging examples of institution-wide development of multiple CPGs across pediatric, neonatal, and cardiac intensive care units (ICUs) [73]. Post-guideline implementation targeted broad-spectrum antibiotic days per 1000 patient days (PD) decreased by 99%, 75%, and 61% in the cardiac, pediatric, and neonatal ICUs, respectively [73]. CPGs have improved care across diverse pediatric diagnoses including eating disorders, sepsis, and enhanced recovery after surgery [74–76].

Electronic medical record integrations

The electronic medical record (EMR) provides opportunities to encourage alignment of safety and stewardship. EMR offers links to CPGs, alerts and reminders of best practice, and "hard stops" limit access to high risk or overprescribed medications [77]. Passive alerts remind clinicians of common errors or harms when ordering tests or treatments. More active alerts can force clinicians to review appropriateness criteria and selecting why the ordered test or treatment is clinically indicated. Hard stops can require approval or subspecialty consultation to order a test or treatment or completely remove a test or drug from the EMR or formulary. Some ASPs require infectious disease consults or ASP approval before ordering certain broad-spectrum antibiotics. These tactics have been shown to achieve the desired process change and, in many cases, improve patient outcomes [78]. Pediatric ED providers have shown a willingness to conform to CPGs. In a cross-sectional survey of children's hospitals, ED providers preferred a clinical decision support tool integrated into the EMR for implementation of stewardship activities [79]. Integrating institutional CPGs into the EMR may promote optimal antibiotic prescribing from the start of a patient encounter. Yet the impact of computerized decision support tools appears to be modest though the evidence in the pediatric setting appears more impactful than adult settings [80]. EMR changes should be monitored closely for unintended consequences like alert fatigue, workarounds, and delays in care [78].

Culture work

Pediatric hospital safety culture varies greatly between institutions and perceptions of safety culture differs by health profession [81]. Aligning leaders and staff to make patient safety the number one priority is difficult. Health care systems are complex. Layering interventions like safety event reporting systems, early warning scores, safety huddles, staff training, and other interventions that enhance visibility and transparency of safety work and potential threats are recognized as important steps toward a strong safety culture [82, 83].

Conclusion

Recent work in the areas of safety and stewardship demonstrates the power of aligning these principles to help clinicians and health care entities deliver parsimonious care that improve outcomes and patient safety.

Author contribution

M.S., A.N., and E.G. each conceptualized, researched, contributed to writing, and editing the manuscript.

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Conflict of Interest
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