

# Clinical pharmacists in pediatric units

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Clinical pharmacists give valuable administrations to grown-up patients, however their advantages for pediatric and neonatal emergency clinic patients are less characterized [1]. The 2016 National Survey of Children's Health estimates that 37.5% of children in the United States have at least 1 chronic health condition, and 14.2% have required at least 1 prescription medication for 12 months or longer [2]. An estimate is that children in ancient Egypt had a 30% chance of dying before puberty, while a similar estimate in the United States in the 19th century was 25% [3]. Child and young person mortality have fallen in Europe, but child death rates from treatable causes including asthma, pneumonia and meningitis are higher in the UK than elsewhere in Europe, highlighting a need to better manage acutely sick children [4]. The preventable infectious disease spectrum are the major cause of death and disability in South Asia, contributing to 3.7 million deaths in children, over 60% of whom are under 5 years old. Studies on the pediatric ED disease spectrum in developing countries show that majority of chief complaints and final diagnoses are infection-related (up to 64%) [5]. Even though Global under-five mortality rate dropped 53% since 1990, the WHO estimates that approximately 5.9 million children under age five died in 2015, 16 000 every day, and respiratory infections especially pneumonia contributes about 13% [6]. Younger children under the age of 2 in the developing world, account for nearly 80% of pediatric deaths secondary to pneumonia. Approximately a third to half of these cases lead to hospitalizations [7]. Currently there are more than 3600 therapeutic products available for the treatment of children in the United States and Canada, with approximately 20 to 30 new drugs entering the market every year [8]. According to most studies, medication errors in children are more common than in adults with a greater risk of death [9]. Medication administration error was found 2.6% in hospitalized children of UK, 8.4% in Argentina, 21% in USA, 68% in India, 75% in Nigeria and around 90% in Ethiopia at different point of time [10]. Medication mistakes caught by pharmacists included over-and under-dosing, missed portions, medication history holes, sensitivities, and close misses. Interventions to address these blunders were emphatically gotten, and actualized by doctors, with a normal acknowledgment rate of over 95% [1]. Developmental, psychosocial, and chronic disease issues for children and adolescents may require frequent counseling and treatment visits separate from preventive care visits. Additional visits also may become necessary if circumstances suggest variations from the normal [11]. Over the last 25 years, the pharmacy profession has been engaged in organized efforts both to elevate practice and educational standards for pediatric pharmacy practice and to design medication management systems that benefit children and their families and caregivers. Moreover, alignment with pediatric clinical pharmacologists will aid in the development of new practice-based research paradigms that can be applied in the clinical setting [12]. Pediatric practice differs in many ways including, but not limited to, patient and family education efforts; pediatric dosage forms and devices; intravenous medication and enteral feeding

tube compatibility consultations; fluid, electrolyte, and parenteral nutrition consults; the necessity to individualize doses (e.g., weight based); common off-label use of medications; lack of robust data informing prescribing practices; and complex age-specific pharmacokinetic and pharmacodynamic differences [13]. The special issue will expand on the needs of further advancing the care of pediatric patients, including the following: (a) addressing the need for a multi-disciplinary national pediatric pharmacotherapy collaborative practice network; (b) exploring sub-specialty needs, processes, and models of care; and (c) describing examples of collaborative practice agreements (CPAs) between clinical pharmacists, clinical pharmacologists, and pediatricians for providing comprehensive medication management (CMM) for children with special health care needs and medical complexity (CSHCN-CMC) [14]. Reviews for formulary additions should include a thorough evaluation of the available literature, focusing on efficacy, safety, cost, and comparison to other agents. This is especially important in pediatrics, as many medications are not adequately studied in children and must often be prescribed "off-label" [15]. Pediatric pharmacotherapy poses numerous challenges that are best suited for pharmacists with specialized training. Some of these challenges include limited data on the efficacy and safety of drug therapy in children; changes in pharmacokinetic and pharmacodynamic parameters with growth and development; dose calculations based on body weight or body surface area; manipulation of commercially available dosage forms for administration to young patients; age and developmentally appropriate medication counseling for patients as well as their caregivers; and an increased risk of adverse drug events [16]. Pediatric Pharmacy Advocacy Group (PPAG) underwrites and advocates for the contribution of pediatric pharmacists in pharmacogenomic testing and in utilizing those outcomes to give protected and compelling medication use in pediatric patients all things considered [17]. Pediatric clinical pharmacists also routinely serve on pharmacy and therapeutics committees and work closely with pharmacy information technology support. In these roles they are well positioned to recommend gene/drug pairs for implementation within an institution as well as to create clinical decision support tools that are tailor-made for prescribing physicians, physician assistants, and nurse practitioners [18]. In a 2014 survey of children's hospitals, one-third of the 88 hospitals that completed the survey had some level of pharmacist-physician collaborative drug therapy management (CDTM) in place that allowed pharmacists to modify doses and monitor therapy, with almost 75% of hospitals allowing pharmacists to initiate the first dose [2]. A pharmacist with pediatric training should provide the pharmacy

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department and other healthcare professionals with information on new and investigational drugs, adverse effects of and contraindications to drug therapy, compatibility and stability information, drug shortages and alternatives, dosage computations, pharmacokinetics, pharmacogenomics, and drug interactions related to the pediatric population. Pharmacists shall keep the hospital's staff and healthcare providers informed about the use of medications in the pediatric population on an ongoing basis through appropriate publications, presentations, and programs [19]. Worldwide, there is growing recognition that pharmacy education needs to be developed and improved so as to better prepare graduates to provide pediatric pharmaceutical care [20]. The 2019 Recommendations for Preventive Pediatric Health Care (Periodicity Schedule) have been approved by the American Academy of Pediatrics (AAP) and represent a consensus of AAP and the Bright Futures Periodicity Schedule Workgroup. The AAP continues to emphasize the great importance of continuity of care in comprehensive health supervision and the need to avoid fragmentation of care [11]. WHO has developed the present evidence-informed recommendations with a view to promoting the best possible clinical practices that consider the risks and benefits, acceptability, feasibility, cost and other resource implications [21]. The implementation of a unit dose dispensing model based on a dose standardization program in pediatric patients improved pharmacy workflow by decreasing drug waste, missing medication request and preparation time [22]. Nearly 20% (or 17 million) of children under the age of 18 have at least one special need [23,24]. The Post-Acute Acuity Rating for Children, intended to reflect medical severity based on age, reason for admission, diagnoses, dependence in activities of daily living, and technology reliance for children admitted to post-acute care rehabilitation hospitals, has been found to be a comparable measurement of medical complexity for pediatric outpatient care [25]. Potential network infrastructures for collaborative practice focused on CSHCN populations, common language and terminology for CMM, and clinical pharmacist workforce estimates are provided. Embedding clinical pharmacists into the Patient-Centered Medical Home (PCMH) to provide comprehensive medication management (CMM) through collaborative practice agreements (CPAs) for children, especially for CSHCN, can improve outcomes, enhance the experience of care for families, and reduce the cost of care [26]. Literature suggests that up to 60% of all medication errors occur during transitions of care and nearly 1 in every 5 hospital discharges may result in readmission. A prospective study to investigate medication discrepancies for the discharge of pediatric patients reported that 8% of medications contained discrepancies between documentation sources [27]. Top opportunities identified to improve medication safety include using kilogram-only weight-based dosing, optimizing computerized physician order entry by using clinical decision support, developing a standard formulary for pediatric patients while limiting variability of medication concentrations, using pharmacist support within EDs, enhancing training of medical professionals, systematizing the dispensing and administration of medications within the ED, and addressing challenges for home medication administration before discharge [28]. Antibiotics are the class of medications with the most frequent interventions (34%). About half of the interventions in this class are pharmacokinetic evaluations to optimize drug levels and minimize toxicities. Agent recommendations accounted for 15% of antibiotic interventions, which included de-escalation of therapy as part of antimicrobial stewardship in PICU [29]. Dose optimization and IV to PO conversion play a large role in stewardship efforts. To ensure that patients are on the proper dose to optimally treat an infection, the

dosage of some antibiotics may need to be increased. The renal dosing protocol allows pharmacists to automatically adjust medications, including certain antibiotics, to avoid adverse effects in patients with fluctuations in renal function. The clinical decision support system can enable pharmacists to compare and leverage patient data in near real-time from the different systems within the hospital, for example, pharmacy and microbiology [30]. A unique partnership between nurses and pharmacists facilitated the discharge process for clinically complex children [31]. There is a need to expand clinical pharmacy services to cover the ambulatory pediatric cancer patients. Developing pediatric hematology-oncology clinical pharmacy services to cover the outpatient setting is essential to ensure continuity of care and to optimize therapeutics [32]. A pharmacist-led, educational program significantly improves knowledge of chemotherapy administration and monitoring in pediatric oncology nurses and was well received by participants as an additional training opportunity [33].

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