

PRN OPINION PAPER

Pediatric Pharmacotherapeutic Education: Current Status and Recommendations to Fill the Growing Need

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The Accreditation Council for Pharmacy Education and the Canadian Council for Accreditation of Pharmacy Programs state that their respective programs should provide a curriculum appropriate to produce general practitioners of pharmacy. Millions of prescriptions are written for infants and children each year, and relatively few pharmacists practice in environments devoid of pediatric patients. To fulfill the stated mandate, professional pharmacy curricula must include adequate content dedicated to pharmaceutical care of the pediatric patient. Current pediatric curricula are inadequate and must be improved. Pediatric topics should be introduced early in the curriculum to increase students' awareness of the special needs of this vulnerable population. Other recommendations include the provision at least 25 hours of didactic instruction in core pediatric areas and at least one pediatric clinical rotation to all students. Pharmaceutical care of pediatric patients can also be improved by offering pediatric rotations to all pharmacy practice residents and encouraging their participation. However, a change in attitude may be most important. The contention that pediatric pharmacy practice is an isolated subspecialty can no longer be supported.

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Children are an important segment of the population that pharmacists serve. In 2003, approximately 80.2 million children resided in the United States, representing 27.6% of the total

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population.¹ Canadian statistics are similar to these, with 7.8 million children making up 24.6% of the population.² In a study conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention, pediatricians prescribed drugs in approximately 65 million office visits in 1998.³ With the continued trend to outpatient therapy, no signs suggest that this level of prescribing will abate, and there are relatively few pharmacists who are not exposed to pediatric patients. Therefore, all pharmacists are expected to have baseline knowledge about the most common medically treated diseases and the drugs used in pediatric patients. This knowledge must be introduced at the earliest possible time in their education.

The Accreditation Council for Pharmacy Education⁴ and the Canadian Council for Accreditation of Pharmacy Programs⁵ state that Doctor of Pharmacy curricula and undergraduate

programs, respectively, should provide content to prepare graduates to become general practitioners. Keeping with these goals, we contend that professional pharmacy curricula should foster a core of knowledge, skills, abilities, attitudes, and values necessary for pharmacists to become well-rounded general practitioners who can provide care to a wide variety of patients, including infants and children. This contention is true regardless of the terminal degree—Doctor of Pharmacy in the United States or Bachelor of Science in Canada and in the United Kingdom.

The purpose of this opinion paper from the Pediatric Practice and Research Network (PRN) of the American College of Clinical Pharmacy is to assess the state of pediatric pharmacy education, to recommend standards for pediatric content in a Doctor of Pharmacy or Bachelor of Science program, and to discuss postgraduate training in pediatric pharmacotherapy. The current state of pharmacy education with regard to pediatric content is unacceptable. It is time to move the conversation from repetitive descriptions of the problem to the collaborative development of practical solutions. Individual institutions bear the responsibility to formulate the best plan to achieve the designated end point.

Unique Aspects of Pediatric Pharmacotherapy

The quintessential challenge of providing pharmaceutical care to children is selecting the appropriate drug, dosage, and route of administration. Because of their relative good health, children generally require fewer drugs than adults. As a result of the small pediatric market and the logistical and ethical difficulties of studying drugs in children, few drugs have a specific pediatric indication. In 2000, the U.S. Food and Drug Administration approved 27 new molecular entities, of which only five (19%) were approved for use in children.⁶ Since 1999, pediatric data have been evaluated for 101 drugs; 86 have been granted first-time exclusivity, and five have been granted a second period.⁷ These numbers correspond to estimates that as many as 70% of the drugs listed in the *Physician's Desk Reference* have a precaution or disclaimer regarding their use in children.

The Food and Drug Administration Modernization Act of 1997, the Children's Health Act of 2000, and the Best Pharmaceuticals for Children Act of 2002 should help increase the number of pediatric drug studies.⁸ In children,

many drugs are used for off-label indications without the rigorous research necessary to establish safety and efficacy in this population.⁹ This lack of information complicates selection of the most appropriate drug and dosage. A reference devoted to pediatric dosing should be consulted to determine if the dosage is appropriate. However, this information may not be available for new off-label indications.¹⁰⁻¹³ The pharmacist must be able to critically appraise the primary literature to verify the effectiveness and safety of a drug for the patient receiving it.

The positive contributions of pharmacists to the health of children have been reported since the early 1980s.^{14, 15} A survey of community pharmacies showed that approximately 30% of all prescriptions were filled for children and that 30% of pharmacies provided clinical services to children.¹⁶ Pharmacists also provide services to hospitalized children by selecting drugs, monitoring their clinical effects, participating on resuscitation teams, and preventing medication errors.¹⁷⁻¹⁹ Many activities in clinical pharmacy (e.g., identification and prevention of drug-related problems, monitoring of drug effects, provision of drug information, and drug therapy education) are common to adult and pediatric practices.

The American Academy of Pediatrics has acknowledged the value of pharmacists in the prevention of medication errors affecting children. Recommendations to decrease the rate of medication errors in hospitalized pediatric patients are that hospitals should provide an adequate number of pharmacists who are trained to prepare and dispense drugs to children and that pharmacists should participate in development and monitoring of drug therapy.²⁰ The academy acknowledges the importance of specialty training and of the pharmacist's place as a member of the pediatric health care team. To optimize the care of children, pharmacy students must have a core of knowledge, and they must develop the skills, attitudes, abilities, and values necessary to provide care for this population. Students must be informed of what is expected of them in this regard, and they must accept the responsibility of providing this standard of care. Then, they must be afforded opportunities to apply these standards in practice.

Pediatric Content of Current Undergraduate Pharmacy Curricula

Pediatrics-related curricula of the colleges of

pharmacy in the United States and in Canada have been assessed.^{21, 22} In the most recent survey, investigators characterized the pediatric didactic and experiential content of Doctor of Pharmacy programs.²¹ A mean \pm SD of 16.7 \pm 11.6 hours (range 2.8–52.8 hrs) were dedicated to pediatric topics in required didactic courses. The five pediatric topics most frequently covered were otitis media, meningitis, immunizations, pharmacokinetics in children, and cystic fibrosis. Only 18% of programs offered an elective course in pediatrics. Each year, a mean of only 25 students (range 11–50) attend these offered elective courses in pediatrics. About 36% of the programs offered elective courses that included but that were not dedicated to pediatric topics. Of the 93% of programs that offered a pediatric clerkship, only 20% required it. Most sites for pediatric clerkships were general pediatric wards, pediatric intensive care units, or neonatal intensive care units.

Although the extent of pediatric education in current Doctor of Pharmacy programs may not be ideal, it seems to be better than that provided in early U.S. baccalaureate programs. Early programs dedicated only 5 hours (range 1–15 hrs) to pediatric topics in didactic courses, and only 9% of programs offered an elective course in pediatrics.²² Pediatric clerkships were available in 70% of the programs.

Revisions in pharmacy curricula necessitated by their transition to entry-level Doctor of Pharmacy programs increased instruction in the provision of care to pediatric patients. Although the time dedicated to this subject varies considerably, the hours devoted to pediatrics during required courses (2.8–52.8 hrs) was inadequate in most schools.²¹

Recommended Pediatric Content of Professional Pharmacy Curricula

The Future of Pediatric Education II Task Force, under the guidance of the American Academy of Pediatrics, outlined some of the basic principles for pediatric education in medical schools.²³ The task force recommended that medical students be instructed in history taking and physical examination of pediatric patients, in the normal growth and development of pediatric patients, in pediatric health maintenance issues, and in environmental influences on pediatric health care. Like medical students, pharmacy students are expected to have a broad but basic knowledge base; therefore, topics similar to those

of the medical curriculum should be included in the pharmacy curriculum. Standard 11 of the Accreditation Council for Pharmacy Education, which addresses curricular areas and content, includes pharmacy practice in pediatrics as part of the core curriculum.⁴ With regard to clinical experience, the education task force of the American Academy of Pediatrics recommends that medical students gain equal experiential training in internal medicine and in pediatrics.²³ No less should be expected of pharmacists, as they strive to be recognized as primary providers of health care.

To facilitate the development of curricula in pediatric pharmacy, the Pediatric PRN has provided recommendations for pediatrics-related topics, for didactic hours in these topics, for requirements in pediatric clerkships, and for the qualifications of didactic and experiential instructors. These pediatric topics should be introduced in the first year of pharmacy education or in the first professional year of pharmacy school.

Table 1 lists topics that are recommended for the curriculum of all pharmacy programs, as well as topics that are strongly encouraged but that could, at a minimum, be covered in elective courses. The time allotted to each topic should be sufficient for the student to gain a thorough understanding of it and the ability to apply its principles in pharmaceutical care. Based on the recommended list, the goal curriculum includes a minimum of 25–30 hours of didactic education specific to pediatrics. These hours might be achieved in a single course, or they might be spread throughout corresponding courses about adult patients. In addition, elective courses in pediatrics (16–32 hrs) should be made available.

Pharmacy students would ideally receive their education from experts in the content area. Therefore, those involved in the health care of children should teach pediatric topics. When this approach is not feasible, lectures designed to address the topic in adults should include a section about children. Although sites may be limited, all students should have access to at least one experiential rotation that includes the pharmaceutical care of children. Access may be achieved by using a variety of institutional, hospital, and ambulatory care settings in pediatric and family medicine. In the ideal case, programs would offer at least one experiential rotation in pediatrics facilitated by a trained pediatric specialist.

Table 1. Recommended and Strongly Encouraged Pediatric Subject Areas

Recommended Courses for Undergraduate Core Curricula	Strongly Encouraged Electives
Pediatric physical assessment	Pediatric cardiology (e.g., structural heart defects, cardiomyopathy, cardiac arrhythmias)
Effects of renal and hepatic maturation on drug metabolism and elimination	Neonatology (e.g., apnea of prematurity, chronic lung disease, sepsis, respiratory distress syndrome, nutrition, enteral drug absorption)
Assessment of renal function in pediatric patients	Hematology (e.g., thalassemia, sickle cell disease)
Growth and development (e.g., embryonic and fetal development, failure to thrive, growth charts, obesity)	Oncology
Therapeutic drug monitoring (e.g., of aminoglycosides, vancomycin, antiepileptics)	Cystic fibrosis
Nutrition (e.g., with infant formulas, vitamins, supplements)	Psychiatry
Fluid and electrolyte therapy (e.g., for dehydration)	Nephrology (e.g., hypertension, nephrotic syndrome, vesicoureteral reflux)
Safety issues about neonatal exposure to excipients in pharmaceutical products	Immunology (e.g., juvenile rheumatoid arthritis, lupus, food allergies, anaphylaxis)
Strategies to reduce medication errors in pediatric patients	Gastroenterology (e.g., gastroesophageal reflux, short-gut syndrome)
Selection of drug doses and dosing forms for pediatric patients	Neurology (e.g., epilepsy, migraine, cerebral palsy)
Appropriate sources of drug information for pediatric patients and policies for off-label drug use	Drugs commonly used in pregnancy and lactation
Pediatric infectious diseases	Substance abuse in adolescence
Immunizations	Human immunodeficiency virus and acquired immunodeficiency syndrome
Clinical toxicology	
Effective communication techniques for parents and children	

Postgraduate Training: Status and Recommendations

Although most pharmacists provide care to children, few specialize in pediatric pharmacotherapy. The availability of pediatric residency sites limits their opportunity to specialize in pediatrics. The American College of Clinical Pharmacy (ACCP) observed a shortage of advanced-training opportunities in its 2000 white paper on the future roles of pharmacy.²⁴ This shortage will not soon be remedied.

To identify and prepare the next generation of pediatric practitioners, academicians, and researchers, students in professional programs must have access to information about pediatric pharmacy as a career. For those who choose this specialty, recognition of their interest early in their education is highly desirable. In addition, they should have opportunities to gain experience in pediatric clinical rotations and to interact with successful pediatric practitioners, who can serve as role models.

Pharmacy practice residencies provide excellent opportunities for increasing pharmacists' exposure to pediatric practice. All such residencies should offer at least one rotation site in pediatric practice. In the ideal situation, both an acute or ambulatory care rotation and an intensive care (neonatal or pediatric) rotation would be available. Rotation preceptors should have an active pediatrics practice and extensive clinical experience or advanced training from a

pediatrics residency and/or fellowship. Institutions that offer a pharmacy practice residency without pediatric patients should consider collaborative agreements with other sites that do serve this population. Residents in pharmacy practice who have not identified a specialty interest or who plan to maintain a general practice should be encouraged to complete a rotation in pediatrics. Residents who choose a career in pediatrics should have the option of completing more than one pediatrics rotation during their general training, as long as they can meet overall experiential requirements of their residency program.

All mid-size-to-large children's hospitals should consider developing and supporting residency and fellowship programs in pediatric pharmacy as part of their teaching mission. A number of such programs already exist. For the 2003–2004 academic years, the ACCP Directory of Residencies and Fellowships listed 22 pediatric pharmacy training programs in the United States and Canada.²⁵ These programs are well established, with a proven track record of producing qualified clinicians, teachers, and researchers. For institutions considering a program, the standards for residencies in pediatric pharmacy practice from the American Society of Health-System Pharmacists is a useful guide.²⁶ These standards include objectives for practice development, direct patient care, drug information, and drug policy development.

Colleges of pharmacy and institutions have traditionally provided monetary support for these residency and fellowship programs as part of their commitment to education. In recent years, the emphasis on clinical research of new drugs in children has created an additional source of funding. The Best Pharmaceuticals for Children Act of 2002 added federal funding to previous incentives for the pharmaceutical industry to increase research in children.²⁷ In early 2003, the Department of Health and Human Services announced the provision of \$93 million budgeted over 2 years as grants to fund this research. Training programs in pediatric pharmacy that can provide the study sites and personnel needed to conduct these studies may considerably benefit from the government's current interest in pediatric drug research. Other funding opportunities also exist. For example, although the ACCP does not offer a specific fellowship or research award for pediatrics, several investigators have obtained ACCP grants for research in pediatric aspects of infectious disease, oncology, and neurology.

Conclusions

The contention that pediatric practice is an isolated subspecialty cannot be supported. To fulfill the mandate to produce general practitioners, curricula in professional pharmacy must include an adequate number of hours dedicated to the needs of pediatric patients. In addition, the continued development of postgraduate training programs in pediatric pharmacy is essential to maintaining an adequate supply of practitioners and educators. Collaborative arrangements among institutions and the maintenance or expansion of residencies and fellowships are necessary to support the educational needs of pharmacists and the health care needs of children.

Although the Pediatric PRN has strong feelings about the aforementioned recommendations, we present this document with the realization that dwindling financial resources, increasing demand, and a changing medical landscape all serve to tax even the most fiscally sound academic institutions. The challenges we face in pharmacy education, and in all medical education, argue against placing additional requirements on an already-stressed structure. However, with a deep appreciation of the struggles in education, the committee continues to believe that a national discussion of how to best train the pharmacists of

the future must be started. We believe that this training should include the care of the smallest and most vulnerable segment of our population—the children. Mindful of all these conditions and facts, we put forth the following recommendations:

- All professional pharmacy programs in the United States and Canada should include a minimum of 25 hours of didactic instruction in pediatrics.
- Pediatric instruction should begin in the first year of pharmacy school or in the first professional year of pharmacy education.
- Content experts in pediatrics should teach specific pediatric topics (Table 1), when possible.
- All Doctor of Pharmacy programs should offer students at least one experiential rotation that includes the care to children in an institutional, hospital, or ambulatory care setting.
- Pharmacy practice residencies should offer at least one rotation in pediatric practice.
- Every pediatric hospital should consider developing a residency and/or fellowship program in pediatric pharmacy if they have not done so.

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