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Keeping up with the kids: Diffusion of Innovation in Pediatric Emergency Medicine Among Emergency Physicians

With 30,000,000 emergency department (ED) visits annually, children account for nearly one fourth of all ED visits in the United States. Despite these statistics, EDs across the country remain underprepared to care for pediatric patients [1, 2]. Based on published data, only 45% of EDs report having a pediatric quality improvement plan in place, one third of hospitals do not weigh children in kilograms, less than half have disaster plans in place for pediatric patients and more than 15% are missing critical pediatric emergency equipment [1]. These deficiencies may be due in part to the fact that 80% of children are cared for in non-children's hospital EDs of which 39% nationally see fewer than 5 children per day and 69% see fewer than 14 children per day [1]. Pediatric readiness has improved over the last ten years since the 2006 Institute of Medicine (IOM) call for improved pediatric emergency care, however, it is clear that there are still improvements to be made [3]. This paper will address current challenges, novel opportunities for educational innovations, and next steps in the maturity of emergency care for children in all practice settings.

Advancing pediatric emergency medicine (PEM) within emergency medicine (EM) is challenging at all levels, from undergraduate medical education into clinical practice. At the undergraduate level, medical students entering EM residencies often have only 8-10 weeks of total pediatric exposure. The mechanism for this training is also varied with "all-comers" emergency departments, stand alone pediatric emergency departments and pediatric emergency departments embedded within the general emergency department, all serving as settings to deliver educational and practice content. This is further exacerbated into residency where only 16% of EM training time is devoted to pediatrics [4]. The limited residency time that is devoted to PEM can lead to a superficial understanding of pediatrics, and may preclude trainees from experiencing the seasonal variability of pediatric illnesses.

Most EM residents in the US train in one of nearly 200 tertiary pediatric centers where the fraction of critically ill patients is low, even in high volume centers; ultimately only 1% to 5% of pediatric visits require resuscitation [5]. The limited number of learning opportunities with critically ill pediatric patients leaves learners vying for hands on experience [6]. Cloutier et al. in 2010 presented a set of "Best Practices for Pediatric Emergency Medicine Training in EM Residency," outlining educational challenges facing modern EM programs and proposed methods to maximize limited resources in both time and patient exposure [4]. While some of the information cited was based on survey data collected in the mid- to late-90s, many of the challenges still persist today.

At the attending level there are several barriers to dissemination and adoption of information. Emergency physicians (EPs) often mistakenly assume there are gaps in their skills to manage the critically ill child when, in fact, they possess a high level of critical care resuscitation competency. The greatest area of need is, paradoxically, how to risk stratify the relatively well appearing ambulatory pediatric patient. EPs in general are capable of resuscitating the "crashing" pediatric patient yet may fail to

recognize the compensated ill child, and specifically infants who account for a larger proportion of children requiring resuscitation, and thereby miss the opportunity to divert that child from a potentially fatal outcome. Numerous studies have compared the behaviors of PEM trained to EM trained (non-PEM) practitioners, and have noted significantly higher diagnostic testing rates among non-PEM trained physicians [7]. While such testing may assuage the clinical uncertainty derived from inexperience, it does little to refine medical decision-making or optimize patient care and resource utilization. Viewed broadly, the best use of educational time for EPs would focus on high-frequency, high-impact events: evidence-based guidelines for antibiotic stewardship, the appropriate use of diagnostic imaging, pediatric pain management/procedural sedation, and clinical pathways for common pediatric visits such as bronchiolitis or appendicitis. These are skill sets EPs would be likely to use in a wide variety of clinical environments. Attention to the critical child remains a priority - however it is no longer a sufficient core for EPs. Additionally, retaining core pediatric emergency care skills allows for greater practice flexibility over a full career time frame.

To date there are over 2000 PEM certified physicians in the US. Only 294 of these providers are certified through the American Board of Emergency Medicine. The results of this imbalance are clear in two key ways. First, PEM clinical progress has grown rapidly over the last 20 years, and nearly all of it emanates from pediatrics rather than EM. Second, the PEM research consortia, such as Pediatric Emergency Medicine Collaborative Research Committee (PEM-CRC) and Pediatric Emergency Care Applied Research Network (PECARN) are overwhelmingly administered and run through pediatrics with the vast majority of meaningful findings presented at meetings that are not typically attended by EM-trained providers. The quality and quantity of research, especially by larger research collaborations such as the PEM-CRC and PECARN, have contributed to PEM's development of a unique identity that seems a world apart from general EM. What remains is an insufficient interface between Pediatrics and EM that limits the proper diffusion of PEM knowledge across the broadest possible scope of clinical environments. Indeed, the vehicles

such as social media Free Open Access Medical Education (i.e.; #FOAMed and #FOAMped) may serve to assist in bridging the knowledge gap between pediatrics and EM and offer improved yield for the dissemination of critical PEM information [8]. Nonetheless, greater engagement with EM to incorporate advances in PEM is a vital step to help bridge key gaps between these two intertwined specialties.

Increased use of technology to diffuse innovation such as FOAMed or simulation curricula for EM physicians is an effective instructional methodology that can provide prescribed exposure to pediatrics for students, residents, and attendings in pediatrics. Rapid integration of simulation into PEM fellowships and EM residency programs may provide powerful opportunities for diffusion of the new workforce with subsequent expansion to established providers in novel venues.

There exists an increasing gap between what we *know* (the creation of knowledge through basic and clinical research) and what we *do* (the application of systems and structures of knowledge systems to the care of individual patients and at the level of population health). The process of knowledge translation is meant to span that gap, identifying clinical problems, informing basic science and clinical research, implementing the findings of scientific inquiry at the bedside, and evaluating clinical outcomes.

Various terms have been coined to describe the process by which problems stimulate innovations and inform practice: knowledge transfer, knowledge exchange, implementation, dissemination, diffusion, and knowledge translation. This latter term has gained favor in recent years, and has been adopted by international research and clinical bodies. The Canadian Institutes of Healthcare Research (CIHR) defines knowledge translation as "a dynamic and iterative process that includes the synthesis, dissemination, exchange and ethically sound application of knowledge to improve health, provide more effective health services and products, and strengthen the health care system. [9]"

There is not a fully validated theoretical framework on which best practices in knowledge translation can be based [10]. To address this gap in understanding, CIHR has funded a multidisciplinary Team in Pediatric Emergency Medicine and Knowledge Translation (TREKK http:trekl.ca) whose goal is to improve health outcomes for children in both pediatric and general hospital emergency departments [11]. Their work is based on an "Iterative Figure of Eight" conceptual framework (Figure 1), which includes a clinical research component and a knowledge translation component, but which runs the gamut from epidemiology to basic clinical knowledge to dissemination and diffusion to real-world evaluation of clinical and public health outcomes [12].

Another conceptual framework for knowledge translation, the "Knowledge-to-Action" (KTA) cycle, emphasized the importance of the broad range of stakeholder involved in knowledge translation – including, but not limited to, researchers, policymakers [13].

Each conceptual framework emphasizes that the process is *not* unidirectional. Information and innovation cannot be "pushed" into practice if their application is not relevant and useful. Likewise, clinicians cannot simply "pull" ready-made solutions from basic researchers. The process of knowledge translation must be multidirectional or cyclical, involving development, uptake and dissemination. Innovators must make their work available for dissemination, while clinicians and policy-makers must recognize opportunities to evaluate current practices in light of new information, incorporating innovation into practice [14]. The cyclical nature of this process is meant to ensure that knowledge generated is relevant, useful and applicable, and that its implementation into practice leads to improved health outcomes, is intuitive to the practitioner with direct application to the front-line clinician [15, 16].

The traditional process of dissemination and diffusion of novel or innovative understanding or practices via publication in peer-reviewed journals and spread

through slowly evolving practice patterns is both ponderous and unpredictable. Recent advancements have streamlined this process, harnessing the power of social and other networks to speed the dissemination of knowledge and practice. Social media as a paradigm for rapid dissemination of innovation has been proposed as one solution to the knowledge-practice gap [17]. Though risks of rapid dissemination prior to rigorous peer review are real, the use of free, open-access distribution may still offer a critical route by which innovative findings can be made widely available. Several traditional print journals have partnered in this process, though outcomes in terms of uptake into practice and clinical outcomes are largely unknown at this point [18-21]. As noted above, national meeting attendance as a vehicle for best practice dissemination is challenging for PEM. The temporal proximity of the Pediatric Academic Societies and Society of Academic Emergency Medicine annual scientific assemblies in the spring and the American Academy of Pediatrics and American College of Emergency Physicians meetings in the fall illustrates this barrier. Pragmatic relationship building between shielded communities of practitioners and innovators, even in the advent of technology, must remain as part of the solution.

In the United States, state and local government regulations may exist to mandate emergency department pediatric standards. For example, in the state of New Jersey, all emergency departments (EDs) are required to have a designated pediatric liaison physician and a designated pediatric liaison nurse, in addition to meeting other pediatric readiness standards. This is supplemented by federally funded initiatives such as the Emergency Medical Services for Children (EMSC), which has various emergency department pediatric readiness resources on its website and maintain the Emergency Department Approved for Pediatrics (EDAP) certification program in some states. The pediatrics readiness score, a multi-organizational collaborative with AAP, ENA, and ACEP, is an example of a leadership collaborative that allows for accessible pediatric emergency care practice in any setting.

In certain countries, government bodies may take the lead in setting the standard for care. An example is the National Institute for Health and Care Excellence (NICE) in the United Kingdom, which examines the prevailing literature to determine the best practice in various settings including pediatric patients treated in EDs. In the United States, clinical practice guidelines are generally produced by specialty organizations such as the American Academy of Pediatrics (AAP) and the American College of Emergency Physicians (ACEP). Examples of CPGs relevant to pediatric emergency care include bronchiolitis guidelines, febrile seizure guidelines, and otitis media guidelines [22-24]. ACEP has also partnered with the American Board of Internal Medicine Foundation in developing Choosing Wisely® items, aimed to minimize unnecessary testing in the ED. The AAP/ACEP Advanced Pediatric Life Support (APLS) course was created to enhance pediatric skills in emergency care providers, and has been a popular offering since its inception. Finally, broad publication of pediatric hospital clinical pathways and guidelines and standardized order sets, and utilization of the electronic medical record to streamline care is an ongoing movement with the goal of decreasing practice variation and increasing provider access to evidence-based standards of care.

Recommendations from landmark clinical trials have at times been widely adopted at the national level. A great example is the Pediatric Emergency Care Applied Research Network (PECARN) head injury imaging recommendations, which resulted from a multi-institutional, rigorously conducted, large sample size study [25]. In addition to sound, easy to remember criteria, coordinated dissemination of the study findings also likely contributed to its widespread acceptance. Regrettably, this is more the exception than the rule for dissemination of PEM innovations.

Best practice consistent with current scientific knowledge can also be implemented at the local ED level. Often a well-planned, multi-prong, multi-disciplinary approach with a dedicated task force made up of various stakeholders is necessary for its success. Examples of ED process change leading to improved pediatric outcomes include those dealing with sepsis, appendicitis, sickle cell disease, asthma and

bronchiolitis [26-31]. Although most of the published literature on best practice examples took place in pediatric emergency departments, effective integration of best practice in general EDs have also been reported [32, 33]. Furthermore, meaningful practice change in community EDs is likely underreported because of the non-academic nature of many of their staff. Suggested best practice to address these issues is supporting a physician and nursing coordinator as pediatric champion for every emergency department.

Another underreported means of diffusion of innovation is community provider outreach education efforts by those familiar with latest development in the field e.g. pediatric emergency medicine specialists. This can take the form of lecture, interactive workshop, webinars, online discussion groups or even department-wide global educational efforts. The obvious shortfall of this method is that it can only reached a limited number of audiences at a time.

Mechanisms for knowledge translation, communication of standards, and new developments in PEM are currently haphazard. These loosely converge through the myriad of professional societies and health care organizations that oversee the emergency care of children. In an era of rapid information delivery, cost imperatives, and consumer advocacy, the more static model for diffusion of innovation is ripe to transform into a dynamic one. Moreover, each innovation must offer a clear advantage over existing practices or technology: “Innovation means change, whether it is incremental or on the ‘big bang’ level. Regardless of the scope of the innovation, it must be real in the sense that it results in a true improvement in quality. A true quality improvement follows the discovery of a market need for something that fits with the organization's purpose [34].” True innovation ultimately facilitates the engagement of stakeholders, and propels the knowledge-to-action cycle forward [35]. Each viable innovation must have at its core a simplicity that disrupts other practices or technology, and a value that cannot be ignored [36]. Viewed broadly, the next steps for consistently translating innovations in PEM into action entail both reliable sources to identify true

innovation, and a network that sustains a dynamic diffusion of that innovation to all of the providers who care for children.

Novel research developments and evidence-based practices continue to emerge in PEM. Much of this progress can be readily adopted at pediatric tertiary care centers, with a relatively slower integration through the many other centers and providers that care for pediatric patients. The reasons for this differential pace are clearly multifactorial. A key issue is cost and feasibility for the end-user. What is novel and interesting may not be innovative enough to justify cost and thereby transform care on a broad scale. National networks are vital to the dissemination of information that can close "knowledge gaps and share evidence and best practices [37]." The next step is to reliably identify each innovation – sift it out from other developments - and provide a consistent and clear message on its value to end-users. Pediatric tertiary care centers, professional societies, and other agencies that focus on PEM share the task to bring innovation to the fore and promote its dissemination through local, national, and global networks.

Rogers's diffusion of innovation theory posited a normal distribution of adoption over time. The "innovators" and "early adopters" embrace the change of an innovation, while those in the "early majority" and "late majority" weigh in on feasibility issues and local obstacles, which ultimately delays their process of change. Finally, the "traditionalists" or "laggers" refrain from change on the assumption that it represents a loss until eventually proven otherwise [38]. Indeed the spectrum of innovation diffusion is as diverse as Rogers described, yet the process of change is now far more dynamic. In a dynamic diffusion of innovation process, "ideas are evolving during the course of adoption, and innovation researchers are already well aware that people actively modify an adopted idea whenever it is possible and necessary … it is the rule rather than the exception that every modified innovation may well compete with all its predecessors, so the picture becomes more colorful than the dichotomy of a new idea versus an old one [37]." Coordinated initiatives and networks that are possible in our modern world

277 are key to promoting and sustaining widespread practice change [34]. Broader
278 channels for communication and coordination between professional societies,
279 healthcare organizations, and government entities are key to a robust and dynamic
280 diffusion of innovative ideas, practices, and technologies to benefit children
281 nationally and worldwide. In a new era where diffusion of innovation evolves as a
282 dynamic process, "knowledge-to-practice gaps" can be closed or even eliminated to
283 sustainably improve healthcare outcomes for children. "Carrot vs. stick" mentality
284 must be carefully balanced to ensure broad adoption and implementation. The
285 marching orders are clear for emergency physicians in all practice settings:
286 collaboration among providers from all training pathways must be solidified in
287 educational forums, practice guidelines, FOAMed forums, and leadership
288 development.
289
290 The practice of pediatric emergency medicine is a true team sport across the
291 country and worldwide, with providers of all backgrounds required to provide
292 appropriate and excellent care for 30,000,000 children annually. Emergency
293 medicine providers shoulder the largest share of initial diagnosis and management
294 of children, making the diffusion process imperative for our specialty. Best practice
295 models for this exist and coordination among lifelong learning entities must focus
296 on this specialty content knowledge moving forward.
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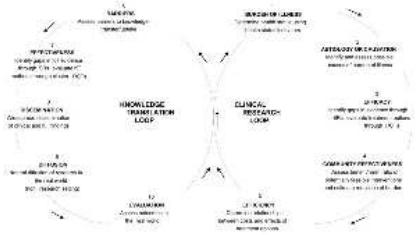

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