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Techniques in
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The Practice of Pediatric Interventional Radiology

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There is a stark contrast between adult and pediatric interventional radiology practice. The essential elements of this all relate to working with children, including a need for greater procedural sedation and anesthesia; the psychology of working with children and their families; a skill set based around smaller bodies; and technology for smaller and growing humans. Interventional radiology departments that cater to children need to accommodate these factors so that sick children can access minimally invasive image-guided therapy in a safe and nonthreatening environment.
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This article discusses how to offer an interventional radiology (IR) service that can treat children. A doctor trained in pediatric IR is an essential element. There is debate about the best means of training a pediatric interventional radiologist. According to the membership records of the Society for Pediatric Interventional Radiology, currently there may be fewer than 100 people who would consider themselves full-time pediatric interventional radiologists in the English-speaking world. There are, however, many interventional radiologists who either occasionally or in a regular noncontinuous fashion perform image-guided therapy on children.

The current community consists of radiologists with fellowship training in pediatric IR as well as adult IR physicians and pediatric radiologists who perform procedures on children. There are also pediatricians and pediatric surgeons with training in pediatric IR and pediatric interventional cardiologists who perform vascular procedures. Ultrasound (US) guidance for needle placement into vessels, fluid collections, and joints is being used by increased numbers of pediatric craft groups, including anesthesia, emergency medicine, intensive care, rheumatology, and rehabilitation medicine.

Some argue that the best training for a pediatric interventional radiologist is a fellowship in pediatric IR. A list of North American pediatric IR fellowships can be viewed online on the Society for Pediatric Radiology's Web site.[1] It is preferable for fellowship candidates to have completed training in pediatric radiology, adult IR, or both. This latter aspect requires considerable personal investment, but perhaps creating dedicated radiology residencies in IR would be helpful.

Well-rounded training in pediatric IR would include training in enteric access, line placement, and pediatric vascular intervention, including vascular malformations, radiofrequency ablation, procedures for the chronically ill child, and pain and palliative care intervention. The place where a pediatric IR fellowship is performed may create considerable skill bias, perhaps greater than in adult IR. Whereas adult IR practices have a core set of procedures, such as line placement, angiography, angioplasty and stenting, and drain placement, the range of procedures practiced in the pediatric IR department may be strikingly different from one children's hospital to another. For example, one department may have concentrated knowledge in enteric access and minimally invasive venous access, whereas another department may perform almost none of those procedures but will instead focus on embolization of vascular malformations, or have a large practice in bone intervention. It is this author's belief that programs should create rotations for their fellows to offer well-rounded training and learn these other skills.

Pediatric IR cannot function without a team, with each member contributing essential skills to the care of children. Five staff types are critical. (Pediatric anesthesia will be discussed later.) In combined adult and pediatric centers, staff should be dedicated to these positions rather than rotating from a pool.

1. *Pediatric radiation technologists/radiographers.* Pediatric radiation technologists are familiar with children and families. They are aware of the need to use low-dose

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radiation techniques, such as removing the fluoroscopic grid in neonates.

2. *Pediatric nurses* are critically important. They are comfortable with sick children, and they understand pediatric hemodynamics, sedation, and analgesia. Nursing staff recruited from environments including pediatric emergency or neonatal intensive care are immensely competent in pediatric resuscitation.
3. *Nurse practitioners*. Although it is not appropriate for the IR department to assume a level of care that replaces the community pediatrician, it is important that the children we treat receive ongoing care to safely manage complications or other parental concerns related to their treatment. The person best able to perform this task is often a nurse practitioner, skilled in understanding both our specialty and the needs of sick children.
4. *Reception and front of house*. It has been reported that 27% of parents rate their child's micturating cystourethrogram, a routine pediatric radiologic examination, as extremely stressful.[2] What must be the effect of having a procedure like a biopsy of a primary abdominal mass and placement of tunneled line? Empathic front-of-house staff in the scheduling and patient waiting areas is critically important.
5. One way to improve the patient journey is by employing *child life or play therapists*. A child life specialist can remove fear and anxiety in a child and so remove fear, suspicion, and hostility in an accompanying parent. Child life specialists should work with all team members training them to provide constant and reassuring signals to the child throughout his/her time in the IR department.

In addition, sustainable pediatric IR departments require support from hospital and radiology administrators as well as pediatric imaging and clinical colleagues.

Creating an Environment in Which Children and Their Parents Feel Comfortable

Whenever possible, children referred for IR procedures should be met with their parents or caregivers in an environment that is comforting and friendly before the procedure (ie, not an anesthetic bay or special procedures suite). In a children's hospital, clinic rooms will often have a friendly ambience. Interventional radiologists who use shared adult and pediatric clinics should not be afraid to keep a supply of toys/stickers/children's books in the clinic. Toys are fomites and should be kept clean.[3] Fluffy toys are generally discouraged as these are thought to harbor more pathogens.

Much of what is described here is common sense. While these techniques are, naturally, used in care of both adults and children it is worth sharing those skills found useful in the care of sick children, particularly for fellows who may be starting a pediatric IR secondment.

When a child and her parents enter the clinic room, the staff should make an effort to greet each of them. Children will read cues from their parents, so this initial interaction is very important. Greeting a young child by squatting to her height will appear less threatening. Young children like compliments, such as about their dress or shoes. I take a moment to explain what a pediatric interventional radiologist is ("a doctor who does operations through tiny holes in the body, seeing inside the body with tools like x-ray and ultrasound") and then take a social history. Getting to know a family is important, particularly in vascular anomalies care because care may be ongoing.

When taking a medical history, it should be assumed that the child may be listening, even when it appears she is playing in another part of the room. This includes children who are developmentally delayed (unless preverbal/nonverbal) and children who appear to be asleep or even unconscious. It is worth gauging how a problem affects the parents as well as the child. Close attention should be paid to the parents' concerns, particularly the child's mother. Parental interactions sometimes do not go as well as planned. There is considerable literature about this, especially in stressful environments like pediatric intensive care and emergency medicine.[4] When parents seem overly demanding, it should be noted that their primary motivation is usually love for their child rather than being unreasonable.[5]

Hand washing before and after pediatric physical examination is proven to decrease a clinician's risk of contracting gastroenteritis or respiratory infections,[6] particularly when an alcohol rubbing gel is used. It is useful to engage with children in a playful manner before examining them. Before touching a lump or mass, ask for the parents' permission, rather than the child's. Although it seems polite to ask the patient for permission, consent will sometimes be refused, which then creates a difficult situation. Parental consent signals to the child that examination by the clinician is acceptable. Children who are nervous can be examined in a parent's arms. Good behavior should be acknowledged and rewarded, if possible. Even something as simple as drawing a face on a child's finger can elicit a smile.

Developmentally Delayed Children

Children with special needs create special circumstances. In a simplified sense, children with special needs can be divided into those with intellectual delay, autism, spasticity, and sensory (visual or hearing) impairment. The best people to ask about how to interact successfully with such children are their parents. Conversely, as such children are often most comfortable with their parents, it is very useful to have a parent present, who can talk quietly to the child during an anxiety-provoking procedure, such as exchange of a gastrojejunal catheter. A child life/play therapy specialist can also help in these circumstances.

When treating a person with intellectual disability, it is important to avoid complex language and be as specific as possible. Describe each part of the procedure simply and directly and, as with any child, warn them if something is expected to be uncomfortable, such as removal of a drain.

There is an erroneous belief that telling a child in detail