Pediatric Nuclear Medicine, Part I: Developmental Cues

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Objective: Children provide a continuous challenge for the nuclear medicine technologist. The task of successfully completing a nuclear medicine procedure varies little among a 20-y-old, a 40-y-old and a 60-y-old patient. Successful completion of a procedure varies much more among a 2-y-old, a 4-y-old and a 6-y-old. Successfully completing a pediatric nuclear medicine procedure includes quick acquisitions, technically acceptable images or calculations, and satisfied patients and parents. Understanding your patient is crucial, and it provides the parents with a greater sense of comfort and confidence about the nuclear medicine technologist and the procedure. After reading this article the nuclear medicine technologist should be able to: (a) discuss the developmental stages of children according to several major theories; (b) identify the physical and mental expectations for each age group; (c) explain applications for incorporating this information into common pediatric nuclear medicine practice; and (d) discuss the common realities surrounding the behavior of children and their parents. A second article will feature tips, indications and populations for common pediatric procedures.

Key Words: pediatric nuclear medicine; child development

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CHILD DEVELOPMENT THEORIES

As long as there have been children, there have been adults who seem to understand them better than others. These people studied children and developed theories as to how they grow physically, mentally and emotionally. Only a few of the countless theories are presented here and no single theory is all encompassing. The nuclear medicine technologist can favor one theory or any combination to help understand what children are learning or are expecting when they are in the nuclear medicine department. A good starting point is to know the capabilities for each age group (Tables 1 and 2).

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Psychosexual Development

Sigmund Freud based his theory (Table 3) on sexual or life energy, fixation and gratification (*1–3*). Infants focus their attention on the mouth, lips, gums and tongue, or the oral area. The sucking reflex and eating, therefore, give the greatest pleasure and comfort to infants. At this age, pacifiers and bottles are the best way to quiet and ease fear in an infant.

Toddlers reach the anal stage when they focus on controlling body functions and toilet training usually begins. This sense of control becomes important during procedures, such as voiding cystourethrograms (VCUs). Many children are taught not to use the diaper or to void only on the toilet. The contrary request to void on the imaging table easily confuses and upsets toddlers. The nuclear medicine technologist can help children during VCUs by reassuring them that not voiding on the toilet is appropriate for the test.

The next stage is the phallic stage, which occurs during the preschool years. Children begin to learn the difference between the sexes and they begin to develop separate, and sometimes preferential, relationships with the opposite-sex parent, called the Oedipus complex for boys and the Electra complex for girls. The nuclear medicine technologist can use this preference to advantage. When only one parent is available, the technologist may arrange the exam when the favored parent can be present. An alternative is to have a male nuclear medicine technologist work with a girl and a female nuclear medicine technologist work with a boy, providing measures against any perceived sexual misconduct.

The school-age years begin the latency period when the sexual energy seems to be in a state of dormancy, and the Oedipus and Electra complexes have resolved. Now girls should interact better with female nuclear medicine technologists and boys with male nuclear medicine technologists.

The last phase begins when the child approaches the teenage years. This stage is the genital stage when sexuality is fully realized. This stage brings with it a sense of privacy and shyness about the body. The nuclear medicine technologist can help patients of this age by providing a complete, detailed explanation of the procedure emphasizing what will be done to the body and by providing privacy for changing clothes or more intimate

TABLE 1
Routinely Accepted Age Groups

Actual age	Age group
0 to 12 mo	Infant
1 y to 3 y	Toddler
3 y to 6 y	Preschooler
6 y to 12 y	School age
12 y to 18 y	Adolescent

procedures, such as VCUs or testicular torsion studies. Be aware that some children would rather not have their parents with them during the exam.

Psychosocial Development

Erik Erikson bases his theory (Table 3) of childhood development on internal conflict (*1–3*). Infancy brings the conflict of trust versus mistrust. The child learns trust by having people provide care, especially the mother. The nuclear medicine technologist can create trust in a patient of this age by simple gestures of talking or of touching, and by having the primary caregiver close. Ensuring food and comfort are the best ways to work with children at this age.

The next few years bring the new conflict of autonomy versus shame and doubt. Again, the controlling of bodily functions figures prominently. The independence of saying ''no,'' of learning to crawl and to walk, and of learning to use the toilet are to be rewarded. Parents begin to teach social demands; if children have been excessively reprimanded during these acts, then they may feel a sense of shame about doing them. The nuclear medicine technologist can reward these acts by smiling, laughing or following the parents' lead. Overcriticism can put children in a highly sensitive mood and damage the working relationship.

TABLE 2
Several Age Groups and Their Capabilities (*1*)

Age	Capabilities
Birth to 1 mo	Eats every 2–3 h
2 mo to 4 mo	Brings objects from hand to mouth; eats every 3–4 h; turns from side to back
4 mo to 6 mo	Teeth begin breaking through gums; turns from back to abdomen; begins eating baby food; eats 4+ times a day
6 mo to 8 mo	Sits without help; eats 4+ times a day
8 mo to 10 mo	Crawls; pulls self from sitting to standing position; eats 4+ times a day
10 mo to 12 mo	Stands without help, begins walking; drinks with cup; eats 4+ times a day
1 y to 2 y	Runs; undresses self; eats 3 times a day, begins regular milk
2 y to 3 y	Draws
3 y to 6 y	Learns letters and numbers
6 y to 12 y	Begins sports and musical instruments; self-esteem developing; cooperative play
12 y to 18 y	Puberty, privacy and embarrassment; pregnancy considerations; peer groups and use of slang; independence developing; emotional relationships developing

TABLE 3
Freud's and Erikson's Theories of Development

Age group	Freud	Erikson
Infancy	Oral (sucking reflex, eating)	trust versus mistrust (primary care)
Toddler	Anal (toilet training)	autonomy versus shame (social demands begin)
Preschool	Phallic (Oedipus/Electra complexes)	initiative versus guilt (exploration)
School age	Latency	industry versus inferiority (outside activities, peers)
Adolescence	Genital (sexuality, privacy)	identity versus confusion (sense of self, goals)

The preschool years give rise to the conflict of initiative versus guilt. These are the years when children learn to explore and consider new concepts. Erikson acknowledged Freud's theory of Oedipus and Electra complexes and believed that some children may feel powerless over them. Any questions or apprehensions that the child may have should be addressed honestly and completely. Erikson speculates that unreasonable negative reactions or criticism could lead the child to question their initiative or could even lead to guilt.

School-age children must learn industry versus inferiority. Children of this age begin participating in outside-the-home activities, such as sports. They begin to take pride in themselves and compare themselves to others. If this making-of-self is not acknowledged, then feelings of inferiority can occur. Once again, any question the child may ask the technologist should be explained thoroughly, even if the question pertains to the camera, the pictures on the wall or even about you. This age group will talk casually if there is a sense of safety, such as parents nearby. The nuclear medicine technologist can talk with children during the exam, such as to suggest a video or TV, ask if they are cold, tell them what is next during the exam, ask their age. Verbal rewards are effective for this age group, as well as for the preschool group. Praising the child for a good job or saying ''good boy'' or ''good girl'' serves to give the child a chance to feel pride in the exam and to leave with a positive attitude. Tangible rewards such as stickers or coloring books are an excellent choice as well. This helps the nuclear medicine technologist with future exams with the same patient.

The last of Erikson's stages concerns identity versus role confusion. During the teenage years, children learn to place themselves in the society around them. They closely examine their role and the roles of the people in their lives. It is a time of searching for an identity or a goal in life. If medical personnel perform exams as though working on an assembly line of patients, it can belittle or damage a fragile sense of self in the patient. You can help to ease their fears by taking time to talk to them, answering their questions, and reassuring them that the

test is well established and that they will be able to resume normal activities soon.

Often teens ask if the procedure will change the way they feel, how they look or how they act. What they are asking is if they will lose control. Answer all questions honestly and try to give the teen some sense of control over the procedure, such as letting them decide the return time for a delayed procedure. Some bone and renal delayed images can be acquired 2 hr to 4 hr postinjection. If your schedule allows, let the teen select when to return. The nuclear medicine technologist also can let the teen choose the site for an injection or intravenous line. Spot images can be acquired in any order, so give the patient the opportunity to choose which image is done first, second and so on.

Cognitive Development

Jean Piaget devised a theory of childhood development (Table 4) that revolves around the child's ability to learn and reason (*1,4*). He believed that the child is a ''philosopher who perceives the world only as he experiences it.'' Children in their first 2 years learn primarily by sensory input and their own motor activity. Piaget broke this stage into 6 categories. The first substage is the first month when the reflexes, such as sucking, grasping and random movements, are primary and provide stimulation. The first 4 mo incorporate primary circular reactions when the child learns to repeat an action that gives pleasure. These infants will forget about an object if it is out of sight. Secondary circular reactions are seen in 4-mo to 8-mo infants. Children begin to associate certain actions with pleasure, such as the sound of the nursery door opening signaling that someone has come for them. Secondary schemes are for children commonly 8 mo to 12 mo old. Children have learned which sounds and gestures create a favorable response. They deliberately use these for their own pleasure. Tertiary circular reactions, typically from 12 mo to 18 mo of age, go beyond repeating an action and eliciting a response. Children tend to explore their environment, repeating actions if necessary and observing others' responses to their play. Lastly, mental combinations occur when language is associated with all the child has already learned. Around 18 mo to 24 mo, children begin to put words in place of actions or gestures. They begin to think before acting, and they can begin to think in terms of past, present and future. The nuclear medicine technologist can use this to distract an infant with a toy or trick. For a short procedure, a favorite toy can be comforting. Longer procedures may need different stimulations such as new toys or pictures that are in the department. Certain songs or videos also can be helpful.

TABLE 4
Piaget's Theory of Cognitive Development

Age	Cognitive Development
Birth to 2 y	Sensorimotor
	Reflexes: primary stimulation
	Primary circular: repeats pleasurable actions
	Secondary circular: associate other's responses with pleasure
	Secondary schemes: elicits response for pleasure
	Tertiary circular: elicits response for observation
	Mental combinations: thinks before acting
2 y to 7 y	Preoperational: language, no logical reasoning
	Preconceptual (2 y to 4 y)
	Intuitive (4 y to 7 y)
7 y to 11 y	Concrete operational: can reason with objects not ideas
11 y+	Formal operational: abstract ideas, deductive reasoning

From 2 y to 7 y, language continues to develop, but logical reasoning does not. A common action is animism or giving animate behaviors to inanimate objects. Blankets and stuffed animals are great comfort, and the nuclear medicine technologist can create a puppet if necessary or show how the teddy bear lies down for a bone scan. This preoperational stage is generally seen as the most impressionable. The nuclear medicine technologist must try to create a nonthreatening environment and minimize fear and apprehension. The child is completely egocentric and can believe that any negative reaction, whether by the child or parent or nuclear medicine technologist, is the fault of the child or even a punishment.

Ages 7 y to 11 y fall within the concrete operational stage. Children can reason well if real objects (as opposed to abstract ideas) are used to illustrate concepts and they begin some mental operations. Now the nuclear medicine technologist can begin to explain the procedure in better detail and perhaps gain better cooperation from the child. Instead of explaining a bone scan as ''pictures of your bones to see why you are having trouble walking,'' it can be explained as ''special pictures of your feet and your legs to see if there might be a tiny break.'' This age group is curious and will ask many questions.

The last stage begins when children can use abstract concepts and are capable of deductive reasoning. It is called the formal operational stage and generally begins at 11 y (*5*). The nuclear medicine technologist generally can expect a child of about 11 y to understand the procedure and the instructions for successful completion. An 11-y-old has little knowledge of biology or anatomy, so there will be some ideas that the nuclear medicine technologist will need to explain more thoroughly. For the most part, however, this child can be considered an adult in that she does not need toys or overly simplistic explanations.

TABLE 5
Kohlberg's Theory of Moral Development

Age	Moral Development
4 y to 7 y	Preconventional (avoid punishment, please others)
7 y to 11 y	Conventional (conscience develops)
12 y+	Postconventional (personal ethics, universal truths)

Moral Development

Lawrence Kohlberg developed a theory (Table 5) about how children make moral decisions (*1,4,5*). The preconventional

stage is usually at 4 y to 7 y of age and decisions are made primarily to avoid punishment and to please others. Ages 7 y to 11 y usually find children in the conventional stage. Children have a conscience and a set of standards, but pleasing others is still quite important. They keep order in their world. Kohlberg believes that the highest measure, the postconventional stage, is rarely achieved but still possible. The children have their own ethical standards and an understanding of social responsibility. They can debate both sides and arrive at a decision. They have a sense of conscience, of duty and of law.

The nuclear medicine technologist can use the first 2 stages to advantage if not used with a heavy hand. Children are eager to please others so it is tempting to tell the child ''this will make Mommy happy'' or ''the doctor will be happy if you do this.'' If the child is simply unable (as opposed to unwilling) to do as you ask, however, then that child could be incorrectly blaming himself for not making Mommy or the doctor happy.

The third stage can create a minor dilemma for the nuclear medicine technologist. A 14-y-old can refuse a study on his own principles. The child is a minor and the parent has legal power of consent. Yet this child could be morally developed enough to choose treatment. Cases like this will be resolved by institutional policy and by state or federal law. The nuclear medicine technologist must be aware that competency and consent do not always reside with the parents.

CHILD REALITY

Some children are mature beyond their years while others may be immature for their age. A 6-y-old came to the nuclear medicine department, and she understood the procedure and was confident to undergo the procedure alone. She asked her parents to leave during the scan. Another patient, a 19-y-old woman, became so physically and emotionally distraught by an injection for a bone scan that the study almost was rescheduled. She asked the same question multiple times and spent several minutes lying down to recover from the injection.

Younger children (usually from birth to 3 y) who may not comprehend anything explained about the exam will realize that they are in a different situation. They immediately recognize that they are in a different place; they see people they do not know; they may have missed their scheduled bottles, meals or naps; and they are being taken from the people who they do know. Try to keep this separation anxiety to a minimum by allowing the parent to hold the child as much as possible and by keeping the parents nearby. Take care, however, that the child is cooperating. Some children use this opportunity to seek attention from the parents and will become more cooperative if the parents leave the room. Distractions like videos, songs, books or toys are helpful. While a short attention span can work in the nuclear medicine technologist's favor, it can be a burden because children can become bored easily.

Another anxiety concerns needles. Children associate doctors and hospitals with ''shots,'' and they quickly learn that a tourniquet means the same thing. Practically nothing the nuclear medicine technologist can say will calm children if they know a ''shot'' is coming. Simply do it as quickly and smoothly as possible. Pediatric venipuncture is an art learned over many years. If you are not confident, find a more experienced person. The child will become increasingly upset, the parents will become increasingly upset and the working atmosphere is compromised if you continue unsuccessfully.

The best guide is to: (a) know what to expect for your patients' age group, then quickly adapt to the patients after talking with them and their parents; and (b) treat your patients as if they were your own children. The latter can be called a cliché, but it can make the difference between your patient leaving the department angry and hating doctors and nurses and your patient leaving the department waving good-bye and smiling while holding a handful of stickers.

PARENT THEORY

Ideally, parents of a child having a medical procedure should understand the reason for the procedure, the necessity of it and what the nuclear medicine technologist will need to do to acquire a good study the first time. It is hoped that the parents will explain the same to the child. Children who have been told by their parents about the procedure and what to expect are more cooperative, more understanding, and the exam proceeds quickly. Knowing what will happen and having the parents there are calming and provide security factors for the child. Parents should understand the need for immobilization or sedation, intravenous placement, catheterization, or nothing-by-mouth instructions. Parents know their children best and can offer useful information, such as previous difficulties with intravenous injections or if the child needs sedation. Parents also may offer tips to calm the child and assistance, such as holding arms for injections.

PARENT REALITY

More often than not, no information or the wrong information about the test is given to the parents before the procedure. This is somewhat understandable in that the doctors or nurses do not perform the nuclear medicine exam so they cannot explain it thoroughly. The nuclear medicine department can work with the referring physicians' offices to disseminate the correct information.

Often parents arrive with the child and know nothing about the exam. It is no surprise that these parents are apprehensive and question everything. These parents often seem overprotective. It is important to answer the parents' questions and explain the reasons for each step of the procedure. Some parents assume the child will be sedated. If the department uses immobilization instead of sedation, the nuclear medicine technologist must tell the parents this before the procedure. Some parents will consent to an intravenous injection or a catheter for their child, but will not allow any type of immobilization or vice versa.

The nuclear medicine technologist also must realize that the parents may be under a great deal of outside stress. Many parents must take time off from work, organize care for other children, and arrange transportation (sometimes by carpools or commercial bus lines).

Another reality revolves around today's family structure. The adults with the child might be divorced parents, a biological

parent and a stepparent, grandparents, adoptive parents, foster parents, other legal guardians, or any combination thereof. While the nuclear medicine technologist should focus on the child, attention to who accompanies the child can help to fine tune the working relationships among everyone. Although the parents should be encouraged to stay, the nuclear medicine technologist should not hesitate to ask the parents to leave if their behavior interferes with acquiring an acceptable study or if their behavior upsets the child.

SUMMARY

Children are constantly learning. With so many unknowns, they can have much to fear. The nuclear medicine technologist must ease children's fears and those of their parents. Working with pediatric patients requires constant attention, an active imagination, honesty and quick adaptation to both the patients and their parents. Combining the theoretical framework with realistic expectations will serve the nuclear medicine technologist well when working with pediatric patients and their parents. Balancing the professionalism and objectivity of a nuclear medicine technologist with the congeniality and caring of a family friend will create excellent working relationships among everyone in the department.

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