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### Abstract

The administration of injections is a fundamental nursing skill; however, it is not without risk. Children receive numerous vaccines, and pediatric nurses administer the majority of these vaccines via the intramuscular route, and thus must be knowledgeable about safe and evidence-based immunization programs. Nurses may not be aware of the potential consequences associated with poor injection practices, and historically have relied on their basic nursing training or the advice of colleagues as a substitute for newer evidence about how to administer injections today. Evidence-based nursing practice requires pediatric nurses to review current literature to establish best practices and thus improved patient outcomes.

**Key words:** Child; Evidence-based nursing; Injection intramuscular; Vaccination.

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# Pediatric Intramuscular Injections:

## GUIDELINES FOR BEST PRACTICE

Over the past decade, the childhood vaccine schedule has increased in complexity. Depending upon the combinations administered, children now may receive as many as 24 immunizations via intramuscular (IM) injection by 2 years of age (Centers for Disease Control and Prevention [CDC], 2011). Pediatric nurses administer the majority of injections and thus have an essential role in maintaining safe and successful immunization programs. The administration of injections is a fundamental nursing skill, yet it is not without risk. Complications from poorly administered IM injections include sciatic nerve damage (Mishra & Stringer, 2010), unnecessary pain (Celebioglu, Akpınar, & Tezel, 2010), muscle contracture, bacterial abscesses, cellulitis, tissue necrosis, gangrene, local atrophy, and accidental injection into a joint space (American Academy of Pediatrics [AAP], 2012).

Successful injection practice stems from nursing knowledge of pharmacology, microbiology, anatomy, and physiology (Nicoll & Hesby, 2002). Comfort techniques, positioning, vaccine preparation, and site selection should be assessed prior to each vaccination and determined by the child's age and development (CDC, 2012; Hensel, Morson, & Preuss, 2013). It is essential for pediatric nurses to apply evidence-based practices to their daily routines in order to improve the quality of care for children and their families (Christian, 2012). The purpose of this article, therefore, is to provide evidence-based guidelines for the administration of IM vaccines in the pediatric population.

## Aspirating for Blood: Should it be Done?

Aspirating for blood prior to injection of vaccine or medication is an established nursing practice that has been taught in nursing schools at least for the past 40 years (Crawford & Johnson, 2012). This procedure, originally identified as a safety measure, was meant to prevent accidental injection into intraarterial or intravenous spaces (Nicoll & Hesby, 2002). Historically, nurses were taught to pull back on the syringe plunger and then to look for blood return within the syringe. If blood was found, they were to remove the syringe, change needles, and insert the needle into a new site (Wong, Hockenberry, Wilson, Perry, & Lowdermilk, 2006). According to a study by Ipp, Sam, and Parkin (2006), however, nurses who reported aspirating did so too quickly (less than 5–10 seconds) and paradoxically were unlikely to visualize blood in the syringe. Leading authorities including the AAP (2012), the Advisory Committee on Immunization Practices

(2011), and the World Health Organization (2004) have now all strongly discouraged the practice of aspirating for blood when administering an IM injection. A randomized control trial found that the standard injection technique consisting of slow aspiration and injection followed by withdrawal of the needle was more painful and took longer than rapid injection without aspiration (Ipp, Taddio, Sam, Gladbach, & Parkin, 2007). Additionally, aspiration is not necessary because large blood vessels are not present at the recommended injection sites (CDC, 2011). Despite the evidence and recommendations from professional organizations, Hensel and Springmyer (2011) have shown that nurses are not aware of these new recommendations and continue to hold strongly to practices taught in fundamental nursing courses.

## Site Selection, Needle Length, Age

Recommendations for the route and site for pediatric immunizations are established from clinical trials, experience, and theoretical considerations (CDC, 2012). Most vaccines are administered via the IM route. In

order to prevent complications, nurses should be familiar with the anatomy of each IM site and know how to correctly identify each site by the presence of bony landmarks (Nicoll & Hesby, 2002). This might be an obstacle for nurses who may not have received any formal education or training on site selection after completion of nursing school. Variation from the recommended route may diminish vaccine efficacy or increase the possibility of local adverse reactions (CDC, 2011).

### Newborn to 2 Years of Age

The IM site for injection is selected after considering the child's age, the volume of drug to be administered, and the level of muscle development present (Figure 1) (CDC, 2012). The anterolateral aspect of the thigh, or the vastus lateralis, is the preferred site for infants and toddlers (birth to 2 years) due to the large muscle mass (CDC, 2012; Jackson et al., 2013). The vastus lateralis is part of the quadriceps muscle and is easily accessible (Figure 2). When identifying the site, nurses should look for the portion of the muscle below the greater trochanter of the femur and above the knee joint. Injections should be administered into the middle third of the muscle (CDC, 2012).

A study by Groswasser et al. (1997) used ultrasound to evaluate subcutaneous and muscle layer thickness to determine appropriate needle length based on either the United States technique of bunching the muscle at the injection site, or the WHO technique of stretching the skin flat between the thumb and the forefinger. The results from this study are reflected in the recommendations



by the Advisory Committee of Immunization Practices today. If the muscle and subcutaneous tissue is bunched, a 1-in., 22 to 25 gauge needle is necessary to successfully penetrate the vastus lateralis. In neonates, defined as the first 28 days of life and preterm infants, a 5/8-in. gauge needle may be used if the skin is stretched flat and the needle is inserted at a 90-degree angle (CDC, 2011). A randomized study including 59 macrosomic neonates (birthweight over 4,000 g) found that infants who were immunized with a 1-in. needle achieved significantly higher antibody titers after the hepatitis B vaccine than those immunized with a 5/8-in. needle (Ozdemir et al., 2012), thereby confirming the importance of adequate muscle penetration during vaccination.

### Ages 3 to 18

The deltoid is the preferred site for IM injections in children ages 3 to 18, once adequate muscle mass has developed there, usually around the age of 3 years (CDC, 2011; Nicoll & Hesby 2002). To identify this site properly, nurses should expose the entire arm from the shoulder to the elbow and palpate the acromion process (Figure 3). Injections should be given 3 to 5 cm below this landmark (Nicoll & Hesby, 2002). The deltoid is best for low-volume medications and IM injections not exceeding a maximum volume of 1 ml (Barron & Cocoman, 2008). If the deltoid cannot be used, the vastus lateralis may be utilized in this age group (CDC, 2012). For toddlers, a 5/8-in. 22-25 gauge needle may be used only if the skin is stretched flat and the needle is inserted at a 90 degree angle into the deltoid. The needle length for

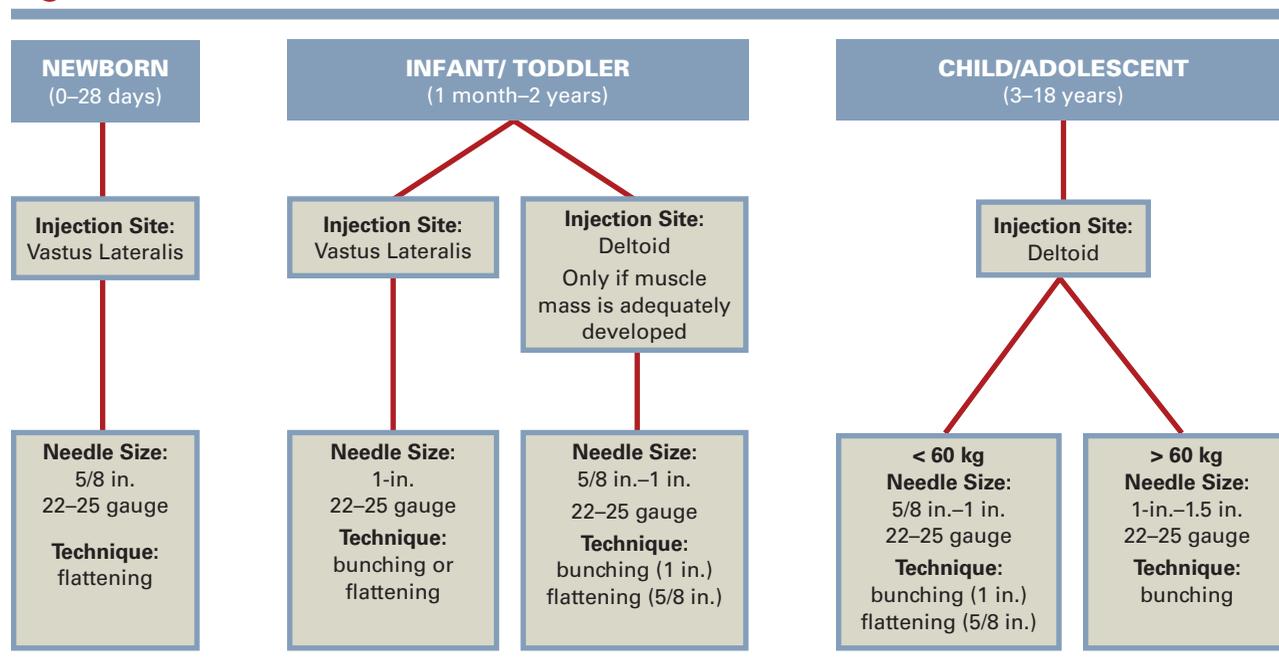
children and adolescents will vary from 5/8 to a 1-in. needle and from 22 to 25 gauge, depending on technique and body mass (CDC, 2012). Childhood obesity is a growing problem in the United States; however, currently no data are available that address needle length requirement for younger children who are overweight.

### Adolescents

In adolescents, body weight and mass contribute to the needle length requirement and must be considered prior to any injections (Koster, Stellato, Kohn, & Rubin, 2009). A study of obese adolescents and young adults found that higher antibody titer levels to the hepatitis B surface antigen were obtained when patients were immunized with a longer 1.5-in. needle compared to a shorter 1-in. needle. These findings reinforce the need to identify adequate muscle penetration and correct needle length; both can affect vaccine reactogenicity (Middleman, Anding, & Tung, 2010). The CDC (2012) has recognized the role of body mass and indicates that some obese adolescents may require a 1.5-in. needle to reach muscle tissue. Additional guidelines founded on research utilizing ultrasonography and BMI percentiles continue to be published. One study on immunization of adolescents at the deltoid site recommended a 5/8-in. needle for those weighing <60 kg, and a 1-in. needle for those weighing 60 to 70 kg (Koster et al., 2009).

The dorsogluteal site is not recommended for use in children due to the potential for injury to the sciatic nerve (CDC, 2011; Nicoll & Hesby, 2002; Rodger & King, 2000; Smalls, 2004). Additionally, the rectus femoris is not

**Figure 1. Pediatric Vaccine IM Administration.**



Insert needle at 90° angle to skin for all IM vaccine injections.

The flattening technique refers to stretching the skin out over the muscle before the IM injection.

The bunching technique refers to squeezing the muscle between the thumb and fingers before the IM injection.

advocated for use in children by most authorities (CDC, 2011; Nicoll & Hesby, 2002), yet some nursing textbooks continue to identify it as well as the dorsogluteal muscle as possible sites for injections (Carter-Templeton & McCoy, 2008).

Last, the “Rights of Medication Administration” should apply to each child with every medication administered. These rights include the following: the right patient; with the right vaccine or diluents; at the right age and interval; with the right dosage; utilizing the right route, needle length, and technique; at the right site; and with the right documentation (CDC, 2012).

## Comfort Measures When IM Injections are Administered to Children

Numerous evidence-based reports in the literature have detailed effective comfort measures for reducing discomfort association with IM injections including vaccination. Those measures can be divided into three categories, depending on the type of intervention: nonpharmacologic interventions, pharmacologic treatments, and injection procedure.

### Nonpharmaceutical Interventions

#### Infants

Nonpharmacologic comfort measures such as positioning, breastfeeding, and distraction are ideal due to the ease of implementation, multiple modalities, and effectiveness. In their study involving 230 infants, Harrington et al. (2012) found that the physical intervention of the 5 S’s:

- swaddling,
- side/stomach position,
- shushing,
- swinging, and
- sucking

**Figure2.** Photograph That Illustrates Proper Anatomical Location for IM Vastus Lateralis Injection.



led to decreased pain scores and crying time among 2- and 4-month-old infants after vaccination. After injection, the infants were quickly swaddled and positioned onto their side/stomach while the provider comforted them with “shushing” followed by the use of a pacifier (Harrington et al., 2012). Two other nonpharmacological methods, ingestion of sweet-tasting liquids and breastfeeding, have also shown effectiveness as calming measures for young children who received IM injections. Moreover, a Cochrane review concluded that breastfeeding provides pain relief as evidenced by reducing crying time and pain scores of infants (Shah, Herbozo, Aliwaia, & Shah, 2012). Thus, nurses should encourage breastfeeding mothers to begin breastfeeding before administration of the injection, and to continue for several minutes afterwards. There are no reports of adverse events associated with breastfeeding during immunization, and infants are not likely to correlate breastfeeding with the injection process (Taddio et al., 2010). Sucrose also can provide safe pain relief to infants; and it has been found to decrease both crying time and behaviors such as grimacing. An optimal dose of sucrose has not been identified in the literature, and additional research is needed to determine the minimally effective dose (Stevens, Yamada, Lee, & Ohlsson, 2013). Taddio et al. (2010) suggested that sucrose should only be recommended for infants who are not breastfed during vaccination.

#### Older Children

Implementing distraction techniques as a means to reduce the pain of injections has been widely researched in

**Figure3.** Photograph That Illustrates Proper Location for IM Deltoid Injection.



the pediatric population. The gate-control theory proposes that cognitive attention may affect the processing and awareness of pain (McCaffrey, Frock, & Garguilo, 2003). Nurses should consider the cognitive development of the child and select age-appropriate techniques and stimuli for distraction (Schechter et al., 2007). Techniques may be parent-led, child-led, or initiated by the provider, with the latter two identified as being more effective (Taddio et al., 2010). Deep breathing or the use of bubble blowing and pinwheels in younger children is another inexpensive option (Taddio et al., 2010). Very few studies have sought to determine which stimuli may be most effective; however, research suggests that the level of engagement of the child is more important than the stimuli itself (Schechter et al., 2007).

### Pharmaceutical Interventions

Pharmacologic interventions involve the administration of pain relievers and the use of topical anesthetics. Routine administration of Tylenol, before or at the time of IM vaccine administration, is not recommended due to the possibility of reduced antibody response (Prymula et al., 2009); alternatively, an age-appropriate dose may be given for treatment of discomfort or fever if it occurs after vaccination (CDC, 2012). Eutectic mixture of local anesthetic (EMLA) cream is a topical anesthetic that may be effective in reducing pain associated with IM immunizations. EMLA decreases pain as the needle enters the skin and may reduce muscle spasms associated with pain (Schechter et al., 2007). Research indicates that EMLA does not interfere with antibody response of diphtheria–tetanus–poliovirus–acellular pertussis, *Haemophilus influenzae* type b, and hepatitis B vaccination in the newborn, or cause any unexpected adverse reactions (Halperin, Halperin, Mcgrath, Smith, & Houston, 2002). The relatively long onset of action, about 1 hour, precludes its use in most offices (Schechter et al., 2007). To combat this, some providers may order topical anesthetics prior to the visit so that parents are able to apply them at home.

Skin cooling sprays, or vapocoolants, are inexpensive and they contain chemicals that produce a cooling effect when applied to the skin. This is thought to reduce the sensation of pain at the time of injection. Some children may identify the cold sensation as painful, or the sensation may actually increase their focus on the injection procedure (Taddio et al., 2010). Research on the effectiveness of vapocoolants has been inconclusive, and additional research is needed (Schechter et al., 2007; Taddio et al., 2010).

### Injection Technique

The injection technique of the nurse is another important variable to be considered, especially since we now know that aspirating before administering an IM injection may in fact add to the pain of injections (Taddio et al., 2010). Some parents, children, and adolescents may prefer to have two individuals simultaneously administer vaccines at different sites when multiple vaccines are required; it is thought that this method may reduce anxiety associated with the anticipation of the subsequent injections. According to the CDC (2012), however, there is not enough

## Suggested Clinical Implications

- The IM site for injection is selected after considering the child's age, the volume of drug to be administered, and the level of muscle development present.
- Needle length recommendations vary depending upon the child's age, weight, and technique of the nurse.
- The technique of aspirating prior to injection is no longer indicated.
- Numerous evidence-based strategies are available to promote comfort and minimize pain during childhood vaccine administration.

evidence to make a recommendation for or against this technique. Furthermore, some experts in pain management believe that this method may actually increase pain, as the child may feel vulnerable and overwhelmed with little control over the procedure (CDC, 2012). If possible, allowing older children to choose their preferred method of administration may decrease anxiety and enhance their feeling of self-control.

If the IM injection is a vaccine, research has also shown that nurses should consider the order of vaccine administration, for some vaccines are known to cause more pain than others. In a randomized control trial conducted on infants receiving two immunizations (Pentacel and Prevnar), pain was lessened when the most painful injection, Prevnar, was administered last (Ipp, Parkin, Lear, Goldbach, & Taddio, 2009). This simple adjustment by nurses could be an effective modality that can easily be implemented in clinical practice.

Last, the position of the child during vaccine administration may also affect pain. Lacey, Finkelstein, and Thygeson (2008) randomly assigned children ages 4 to 6 into two groups. One group was placed in the supine position and the other in the sitting position prior to vaccination. They found that the children placed in the sitting position were less fearful about the injection than the children who were supine. Other studies suggest that when infants or children lie supine, they experience more pain than when sitting upright or being held by a parent; therefore, nurses should not place children in the supine position when administering injections (Taddio et al., 2010).

## Conclusions

The administration of IM injections of vaccines may be the single most important health promotion intervention that pediatric nurses provide for their patients. Immunizations are a routine part of well-child visits, and nurses are charged with ensuring that the “Rights of Medication Administration” are applied to every child. Nurses must be diligent in reviewing best practices for IM vaccine administration. Use of the most current evidence-based guidelines for IM vaccine administration allows nurses to practice safely, thus increasing the likelihood of improved outcomes for pediatric patients and their families. ❖

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