

Intramuscular Injection: An Integrative Research Review and Guideline for Evidence-Based Practice

Leslie H. Nicoll and Amy Hesby

Intramuscular injections (IM) are a common yet complex technique used to deliver medication deep into the large muscles of the body. More than 12 billion IM injections are administered annually throughout the world. However, it is not a benign procedure, and unsafe injection practices are estimated to have significant impacts on patient morbidity and mortality and result in millions of dollars in direct medical costs on an annual basis. Although there is significant research, spanning 8 decades, on the procedure and techniques of administering medications by the IM route, instruction materials and clinician practice do not always reflect research-based practice. An integrative review of the literature has resulted in the development of a guideline for evidence-based practice of IM injections. Use of this guideline can assist the clinician to maximize the therapeutic effects of administered medication while minimizing or eliminating patient injury and discomfort associated with IM injections.

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ADMINISTRATION OF medications is a responsibility of the professional nurse. Basic nursing courses spend a considerable amount of time and content dealing with the proper techniques for the administration of medications and medication side effects. Medications can be administered to patients by a variety of routes, including oral, topical, and parenteral (Kozier, Erb, Berman, & Burke, 2000). Within the category of parenteral medications are intramuscular (IM) injections in which the skin is punctured with a needle and syringe and the medication is administered deep into a large muscle of the body for prophylactic or curative purposes (WHO, 1999).

Although there are relatively few medications that must be administered by the IM route, there are a large number of medications that may be given this way, thus it is a function with which nurses must be familiar (Table 1). Injections are among the most frequently used medical procedures, with an estimated 12 billion administered throughout the world on an annual basis. Of these, 5% or less are for immunization and more than 95% of injections are given for curative purposes, many of which have been judged to be unnecessary (Simonsen, Kane, Lloyd, Zaffran, & Kane, 1999; Sohn, 1996).

Giving an IM injection is not a benign procedure; there are numerous reports in the literature of patient complications related to improperly administered IMs (Beecroft & Redick, 1989; Greenblatt

& Allen, 1978; Hanson, 1963). Common complications include skeletal muscle fibrosis and contracture (Drehobl, 1980; Haber, Kovan, Andary, & Honet, 2000; Talbert, Haslam, & Haller, 1967) abscesses at the injection site (Cockshott, Thompson, Howlett, & Seeley, 1982; Hanson, 1966; Michaels & Poole, 1970), gangrene (Ozel, Yavuz, & Erkul, 1995; Talbert, Haslam, & Haller, 1967; Weir, 1988) and nerve injury (Tong & Haig, 2000). Internationally, unsafe injection practices result in millions of infections that lead to serious morbidity and mortality, particularly blood-borne transmission of hepatitis B and C and human immunodeficiency virus. In the developing world, it is believed that more than 50% of injections given in health care settings are unsafe, and up to one third of immunization injections are unsafe in four out of six regions of the world. Unsafe injection practices are estimated

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doi:10.1053/apnr.2002.34142*

Table 1. Medications Routinely Administered by the IM Route With Site Recommendations

Medication Class	Generic Name	Brand Names (Selected) ^a	Recommend Sites and Needle Size ^b
Antibiotics	Streptomycin sulfate	Streptomycin sulfate injection	Adults: ventrogluteal with 38 mm, 18 to 25-g needle
	Pencillin G benzathine Pencillin G procaine	Bicillin, Wyclin, Pfizerpen	Infants and young children: vastus lateralis with 16 to 25 mm, 22 to 25-g needle
Biologicals, including immune globulins, vaccines, and toxoids	Diphtheria and tetanus toxoids adsorbed	DT (pediatric), Td (adult)	Adults: Deltoid with 25 to 38 mm, 22 to 25-g needle. Hepatitis B and rabies must be given in the deltoid site. Immune globulin may be given in the deltoid (volumes of 2 mL or less) or VG site (volumes of more than 2 mL). Toddlers and older children: deltoid, if the muscle mass is adequate, with 16 to 32 mm, 22- to 25-g needle Infants, young children and those with inadequate muscle mass at the deltoid site: vastus lateralis with 22 to 25 mm, 22- to 27-g needle
	Diphtheria, tetanus, and acellular pertussis	Acel-Immune, Infanrix, Tripedia, Certiva	
	Haemophilus influenzae type b conjugate	ActHIB	
	Haemophilus influenzae type b conjugate and hepatitis B (recombinant)	Comvax	
	Hepatitis A vaccine, inactivated	Havrix, Vaqta	
	Hepatitis B vaccine (recombinant)	Engerix-B, Recombivax HB	
	Heptatitis B Immune Globulin (human)	BayHepB, Nabi-HB	
	Hepatitis A inactivated and hepatitis B (recombinant)	Twinrix	
	Immune globulin for pre- and post-exposure prophylaxis for Hepatitis A infection		
	Influenza Virus Vaccine	Fluogen, FluShield, Fluvirin, Fluzone	
	Lyme disease vaccine	LYMERix	
	Pneumococcal vaccine, polyvalent	Prevnar	
	Rabies vaccine adsorbed	RabAvert	
	Rabies immune globulin (Human)		
Rh ^(D) immune globulin (human)	BayRhoD, MICRhoGAM, RhoGAM, WinRho SDF		
Tetanus immune globulin (human)	BayTet		
Tetanus toxoid adsorbed	Tetanus toxoid adsorbed purogenated		
Hormonal Agents	Medroxyprogesterone acetate	Depo-Provera	Adults: ventrogluteal with 38 mm, 18- to 25-g needle (these medications are typically not indicated for infants and young children)
	Chorionic gonadotropin Menotropin	Novarel, Pregnyl Humegon, Repronex	
	Testosterone enathanate	Delatestry	

^aSelected brand names are included to be illustrative of products widely used in the US; in other countries in which the generic products are available (this is particularly true in the case of vaccines) they may go by different names. All brand names are copyrighted trademarks of their respective companies.

^bNeedle sizes are provided in metric lengths to conform to the international standard; for US readers, corresponding needle sizes in inches are as follows: 16 mm = 5/8"; 22 mm = 7/8"; 25 mm = 1"; 32 mm = 1 1/4"; 38 mm = 1 1/2"

to cause more than 1.3 million deaths and cost more than \$535 million in direct medical costs on an annual basis (Miller & Pisani, 1999). The World Health Organization (WHO) has joined

with several international partners to create the Safe Injection Global Network, with a common goal of safe and appropriate injections worldwide (WHO, 2000).

In the United States, there is an increasing emphasis nationwide to recognize and reduce medication errors. The National Coordinating Council for Medical Error Reporting and Prevention (2001) defines a medication error as, "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer." It is estimated that 150 deaths per day and 1.3 million injuries per year occur because of medication errors (Phillips, Pierce, & Cohen, 2000). Numerous factors can lead to such errors, including improper administration of the medication (*About medication errors*, 2001). Clearly, complications from IM injections, such as those just described, fall into the realm of medication errors. Thus, it becomes the responsibility of the professional administering the IM injection to prevent such complications.

Ironically, even though IM injections are known to have iatrogenic complications, nurses have reported not receiving any education beyond their basic preparation on how to administer injections by the IM route (Chiodini, 2000). In a survey of infertility nurses, the investigators concluded that there was wide variation in the procedures used by the nurses to prepare and administer medications, and many nurses did not use procedures known to reduce pain and tissue trauma (Engstrom, Giglio, Takacs, Ellis, & Cherwenka, 2000). Lee, Lee, and Eldridge (1995) reported that techniques used by nurses in giving IM injections were "little more than a ritualistic practice, one based on tradition, which passes from one nurse to another and from one generation of nurses to the next" (p. 32). They concluded that rationales provided by nurses regarding their technique were contradictory and had no sound or scientific base, despite the fact that there is a vast body of research extending back to the 1920s conducted by investigators in a variety of disciplines including nursing, medicine, anatomy, physiology, pharmacy, and physical therapy (Beyea & Nicoll, 1995). Topics researched have included injection sites, blood flow, and absorption in various muscle groups; discomfort; positioning; and complications (Cockshott, Thompson, Howlett, & Seeley, 1982; Evans, Proctor, Fratkin, Velandia, & Wasserman, 1975; Hochstetter, 1954, 1955, 1956; Johnson & Raptou, 1965; Lachman, 1963; Shaffer, 1929). The purpose of this integra-

tive review is to critically review research related to medication administration by the IM route to establish a clinical guideline that can be used by clinicians giving IM injections. The goal of this research based practice tool is to improve patient outcomes by minimizing and ultimately eliminating medication errors and negative sequelae that can result from improperly administered IM injections.

BRIEF HISTORY OF MEDICATION ADMINISTRATION BY THE IM ROUTE

Medical historians speculate that the first use of IM injections probably occurred as early as 500 AD (Hanson, 1966). However, it was not until the late 1880s that the procedure and equipment were refined and the skill more frequently practiced (Howard-Jones, 1971). Until the introduction of antibiotics in the late 1940s, the administration of medications by the IM route was a skill that was almost exclusively practiced by physicians (Stokes, Beerman, & Ingraham, 1944). Before 1957, there were fewer than 10 articles published in the nursing literature related to IM injections, and most were related to equipment and medication preparation (Henderson, 1963, 1966, 1970, 1972). Harmer and Henderson (1939) were among the first authors to delineate the role of the nurse during the administration of an IM injection: "The nurse in attendance is always responsible for the preparation and care of equipment, for preparing the patient and assisting the physician. . ." (p. 569).

In 1961, Zelman noted that nurses had essentially taken over the procedure of IM injection. Based on results of a survey conducted with nurses at his institution, he reported that the nurses had received little or no formal instruction pertaining to the techniques to IM administration of medications and reported observing problems with their technique. By the late 1960s, IM injections were routinely given by nurses and the nursing literature reflected this change in practice (Dison, 1967; Pitel & Wemett, 1964; Wempe, 1961).

Nurse researchers focused attention on IM injections, beginning in the 1970s, reporting studies that investigated complications (Beecroft & Redick, 1989; Chezem, 1973; Roberts, 1975), site selection (Beecroft & Redick, 1990; Daly, Johnston, & Chung, 1992), administration techniques (Katsma & Smith, 1997; Katsma & Katsma, 2000; Keen, 1986; Lee, Lee, & Eldridge, 1995;

MacGabhann, 1998; Quartermaine & Taylor, 1995), and procedures to minimize pain (Barnhill, Holbert, Jackson, & Erickson, 1996; Itty, Kurian, & Cherian, 1977; Kruszewski, Lang, & Johnson, 1979; Lang, Zawacki, & Johnson, 1976). This is an area of study that continues to be of interest to nurse researchers.

THE GOAL: ELIMINATION OF COMPLICATIONS FROM IM INJECTIONS

Administering an IM injection is a complex psychomotor task that requires skill and knowledge on the part of the clinician who is performing the procedure. The procedure requires manual dexterity to manipulate the equipment while preparing the medication and performing the injection. An IM injection is a two-handed procedure: one hand stabilizes the injection site while the other hand completes the injection. In addition to being able to physically perform the skill, the clinician needs knowledge of pharmacology, anatomy, physiology, physics, and microbiology. Legal and ethical issues, particularly relating to informed consent for the procedure, must also be considered.

The First Decision: Is An IM Injection Justified?

Whenever a clinician is faced with administering a medication by the IM route, the first decision that must be made is whether the IM injection is justified. The WHO-recommended policy states, "An injection should only be given if it is necessary—and each injection that is given must be safe" (WHO, 1998). When faced with the potential for administering an IM injection, the clinician must consider patient characteristics as well as the specific medication and the larger class to which the medication belongs to determine if an IM injection is warranted and justified. There are several scientific reasons why a medication may best be given intramuscularly.

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Physiochemical and Pharmacokinetic Properties of the Medication. These properties of a drug restrict its use to IM injection. Certain biologicals, including vaccines, toxoids, and immune globulins, are in this category. Vaccines containing adjuvants should be injected into a muscle mass; aluminum adjuvants increase the immune response of the vaccine, but when they are administered subcutaneously (SC) or intradermally they can cause local irritation, induration, skin discoloration, inflammation, and granuloma formation (CDC, 1994; Mark, Carlsson, & Granstrom, 1999). The polypeptide nature of gonadotropins, including menotropins, causes them to be quickly destroyed in the gastrointestinal tract so they must also be given either by IM or SC injection (Gold Standard Multimedia, 2001).

Onset and Intensity of Effect. An intravenous bolus provides the most rapid onset of a pharmacologic effect; intramuscular injections usually produce a more rapid onset of effect than SC injections. Consideration of the onset and intensity of effect can help to determine the necessity of an IM injection (DiPiro et al., 1999).

Duration of Effect. An IM injection generally has a longer duration of effect compared with an intravenous injection. In particular, depot formulations are designed to provide slow, sustained release over an extended period of time. The injection creates a tissue depot at the site of injection, and the medication is slowly released into the systemic circulation over hours, days, or weeks. Medications of this type include depot neuroleptics, typically used in the treatment of schizophrenia, and antibiotics, specifically benzathine and procaine penicillin, which are used to treat *Streptococcus pyogenes*, *S. pneumoniae*, and treponemal and enterococcal infections. A number of hormonal agents are also available in depot formulations, including medroxyprogesterone acetate for contraception and the treatment of certain carcinomas and depot leuprolide, which is used in the treatment of endometriosis and advanced prostate cancer (Gold Standard Multimedia, 2001)

Patient Characteristics. In addition to medication effects, patient characteristics must also be considered when determining if an IM injection is justified. Patient compliance is frequently given as a rationale, although preliminary studies suggest that compliance is variable in different patient

groups. For example, compliance is higher in patients receiving depot neuroleptics rather than medroxyprogesterone acetate (Bunn, O'Connor, Tansey, Jones, & Stinson, 1997; Heyscue, Levin, & Merrick, 1998; Potter, Dalberth, Canamar, & Betz, 1997; Weiden et al., 1995). Patients who are uncooperative or reluctant may also be appropriate candidates for IM injection, although the clinician should balance issues of patient rights against the need for the medication. Many injections are non-useful or unjustified. Injections are given for the wrong reasons, such as acute respiratory infections, diarrhea, fever, skin infections, and urinary tract infections. Patients may also request injections, believing them to be more powerful or technologically advanced. Certain providers may earn income or status by giving injections (Reeler, 2000). Although these latter problems are more prevalent in developing countries, Flaskerud and Nyamathi (1996) found that Latina women in Los Angeles were self-prescribing and administering injections for birth control, anesthesia, and relaxation.

The Second Decision: Site for Injection. Once the decision has been made that based on medication and patient characteristics an IM injection is justified, the second decision is to determine the site for injection. Injection site is critically important because the medication effect can be enhanced or diminished depending on the site of injection.

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For example, administration of human diploid-cell rabies vaccine in the gluteal area has been associated with lower neutralizing antibody titers than vaccination in the deltoid area (CDC, 1985; Fishbein, Sawyer, Reid-Sanden, & Weir, 1988). Complications are also associated with site of injection; the most common include muscle contracture and nerve injury (Beecroft & Redick, 1989; Bergeson, Singer, & Kaplan, 1982). For each site for IM injection, the clinician should know how to properly identify the site by using bony landmarks and

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Biologicals. The Advisory Committee on Immunization Practices (ACIP) of the Centers for Disease Control and WHO provide guidance on site selection for administration of biologicals. Site selection varies depending on the age of the patient (CDC, 1994; WHO, 1998).

For infants (<12 months), the anterior aspect of the thigh is the preferred site for injection. The target muscle of the anterior thigh is the vastus lateralis (VL), which is part of the quadriceps femoris, one of the largest muscle groups in the body that is well developed at birth (Bergeson et al., 1982; CDC, 1994). To locate the site, first determine the position of the muscle along the thigh. The portion of the muscle below the greater trochanter of the femur and within the upper lateral quadrant of the thigh is the target site for injection. The rectus femoris, which is anterior on the thigh, should not be used for injection.

Two techniques are described in the literature for giving an injection into the VL. In the first, promulgated by ACIP and described as "the United States method," the clinician uses the nondominant hand to bunch the muscle and direct the needle inferiorly along the long axis of the leg at an angle appropriate to reach the muscle while avoiding nearby neurovascular structures (CDC, 1994). Other authors suggest that bunching the muscle is only necessary if needed to increase the penetrable area and stabilize the muscle (Bergeson et al., 1982). The second technique, described by WHO, uses the same bony landmarks to identify the muscle. Once the site is identified, the skin is stretched flat between the index finger and thumb and the needle is pushed down and inserted at a 90° angle through the skin (WHO, 1998).

Three needle lengths are recommended: 16 mm, 22 mm, or 25 mm. Final selection should be based on the age of the child and the size of the muscle. If the "US bunching" technique is used, the longer needles (22 and 25 mm) are recommended. A 16-mm needle with this technique would risk SC not IM injection. However, if the WHO procedure of stretching the skin and injecting at a 90° angle is used, a 16-mm needle allows perfect intramuscular delivery of the medication (Groswasser et al., 1997).

The VL is associated with injury (Haber et al., 2000; Ozel et al., 1995; Talbert et al., 1967), either through damage to the femoral nerve or the femoral artery. The clinician can minimize the potential for injury by assiduously identifying the location for injection and using the proper length needle.

For toddlers and older children, according to the ACIP, the deltoid may be used if the muscle mass is adequate, otherwise the VL is preferred (CDC, 1994). The deltoid muscle is small but adequate for low-volume injections, such as those found in immunizations (Ipp et al., 1989). The deltoid is a triangular-shaped muscle that originates from the lateral one third of the clavicle, the acromion, and the spine of the scapula. It converges downward into the deltoid tuberosity near the middle of the humerus (Bergeson et al., 1982). To identify the site, expose the entire shoulder and arm area. Palpate the acromion process and choose a site for injection 3 to 5 cm below the bony landmark (Beyea & Nicoll, 1995). Needle lengths for the deltoid site range from 16 mm to 32 mm; again, the clinician should select the needle length based on the age of the child. Obesity begins to be a factor in older children; in younger children the layer of SC tissue over the muscle is fairly consistent (approximately 4.9 mm), regardless of weight (Groswasser et al., 1997).

There is potential for injury in the deltoid area. The axillary nerve lies beneath the deltoid at the surgical head of the humerus and provides motor innervation to the deltoid (Bergeson et al., 1982). The radial nerve lies under the scapular portion of the deltoid muscle and an injection placed posteriorly and inferiorly has the potential for injury. The radial, brachial, and ulnar nerves and the profunda brachii artery are under the triceps muscle so

this muscle should not be used for injection (Bergeson et al., 1982).

The ACIP recommends the deltoid site for routine IM vaccination in adults, particularly for hepatitis B vaccine. The suggested needle length is 25 mm to 38 mm. Site selection is as described previously. Immune globulin, administered for pre- and postexposure prophylaxis against hepatitis A infection, may be administered in either the deltoid or ventrogluteal (VG) site. The volume of medication is the critical factor in determining which site to use; volumes of 2 mL or greater should be administered in the VG site (CDC, 1999).

Other Medications. Nonbiologicals, such as antibiotics and depot medications, are typically larger in volume, more viscous, often oily solutions, and potentially more irritating; thus, the preferred site in older children and adults are the large muscles of the gluteal area, specifically the VG site. Injections in the VG site should be performed with a 38-mm needle, which will reach the muscle in the vast majority of adults because as the subcutaneous layer is uniform in thickness, irrespective of patient weight (Cockshott et al., 1982). In infants and younger children (≤ 2 years), the VL remains the preferred site (Bergeson et al., 1982) with a needle of 16 to 25 mm.

There is tremendous confusion in the literature and among practicing clinicians regarding the sites of the gluteal area and the procedures used to identify those sites (Engstrom et al., 2000). Early texts referred to injection in the gluteus maximus, which is the target muscle of what is commonly referred to as the dorsogluteal site (DG) (Shaffer, 1929; Stokes et al., 1944). Originally Shaffer identified this site by instructing the clinician to draw an imaginary cross across the left or right buttock and then selecting the injection site in the upper outer quadrant of the cross. If the clinician went too high, there was the potential to hit bone; too close to the central point of the cross and the clinician might involve the lesser and greater sciatic nerves. Later references (Fuerst & Wolff, 1956; Harmer & Henderson, 1957) modified the instructions and instructed the clinician to draw an imaginary line between the posterior iliac spine and the greater trochanter of the femur. Injections are given to an area lateral and superior to this imaginary line. By using this technique, the clinician would be injecting into either the upper outer

mass of the gluteus maximus or directly into the gluteus medius.

Interestingly, the gluteus medius is the target muscle of the VG site, first described by Hochstetter (1954, 1955, 1956). It is a large muscle that is well developed in young children and adults, contrary to the gluteus maximus, which does not develop in size until a child has been walking for a period of time (Bergeson et al., 1982; Hanson, 1963). The VG site offers a large muscle mass that is relatively free from major nerves and vessels. Only one case study of a complication at the VG site could be found in the literature (Kunzi, Ramstein, & Pirovino, 1995) and that was a local reaction to the medication (phenylbutazon in combination with other medications) rather than a complication related to poor technique.

Paradoxically, many clinicians who give injections into what they describe as the DG site may in fact be injecting into the gluteus medius muscle of the VG site. The problem seems to arise from the methods used to properly identify the site. For the DG site, patients are instructed to lie in a fully prone position with the toes pointed inward to relax the gluteal musculature. The imaginary line is drawn, and the clinician moves up and out to find the site of the injection. However, in practice, many patients are not able to lie in a fully prone position but rather are semilateral so the perspective of visualization of the site shifts according to the patient's position. In other words, the imaginary line moves up higher on the patient's body. As the clinician identifies a site lateral to this line, the site of injection may shift from the gluteus maximus to the gluteus medius muscle, which is the target muscle of the VG site.

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To locate the VG site, the patient lies in either a supine or lateral position; accurate visualization of the site is difficult with a patient in the prone

position. The site is identified by placing the palm of the opposite hand (i.e., right hand to left hip) against the greater trochanter. The index finger is placed on the anterior superior iliac spine, and the middle finger is extended along the iliac crest toward the iliac tubercle. When properly located, the gluteus medius muscle “pops” up between the fingers, affording an accurate visualization of the muscle for injection.

To identify the DG site, descriptions in the literature emphasize the drawing of imaginary lines or crosses and de-emphasize identifying bony landmarks. From the complications reported with the use of the DG site, it appears that this technique of drawing imaginary lines leaves too much margin for error in the actual placement of the injection. On the other hand, the literature describing the VG site is uniform in that the first step is always to palpate the greater trochanter and anterior superior iliac spine; once that is performed, the muscle and site for injection are then identified.

Preparation of Injection

Once the site has been selected, the clinician can prepare the medication for injection. Many medications come in prefilled syringe units, such as Tubex® or Carpuject®. These are convenient and sterile and dosing is accurate. With such a unit, the sizes of the syringe, needle length, and gauge have been predetermined by the manufacturer. Still, the clinician should ensure that the needle on the unit is the appropriate length for the site selected.

If a prefilled unit is not available, the clinician must select an appropriate size syringe and needle for the injection. Needle length should be determined based on site for injection and patient age, as discussed previously. Needle gauge is often dependent on needle length. In general, biologicals and medications in aqueous solutions can be given with a 22- to 27-g needle; medications that are more viscous or in an oil-based solution require a needle of 18 to 25 g. The size of the syringe is determined by the volume of medication and should correspond as closely as possible to the amount to be administered. Volumes of less than 0.5 mL should be given with a low-dose syringe to ensure accuracy of the dose (Zenk, 1982, 1993).

Medications are packaged in glass ampules and rubber-topped, single- and multiple-dose vials. When withdrawing a medication from one of these containers, the safest practice is to withdraw the

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medication by using a filter needle and change the needle before injection (Hahn, 1990; McConnell, 1982). This technique prevents many real and potential complications. The use of a filter needle prevents particulate matter, such as bits of glass or rubber, from being drawn into the syringe. In addition, a needle may be bent or dulled in the act of pushing it through a rubber stopper.

Although this is the safest and most conservative practice, using a filter needle does add an extra step for the clinician and the additional expense of an extra needle. Some clinicians argue that particulate matter cannot fit through a small gauge needle (23 g or higher) (Rodger & King, 2000). This may be true, but there is no research evidence to support the claim. Likewise, there are no case studies that document rubber bits in syringes, although glass particles have been found in ampules after they have been opened (Meister, 1998). Firm research evidence is not currently available to definitively state that a filter needle must be used routinely to withdraw medications from rubber-topped vials, although the evidence does exist that a filter needle should be used with a glass ampule (Falchuk, Peterson, & McNeil, 1985; Sabon, Cheng, Stommel, & Hennen, 1989). With a goal to eliminate medication errors and patient complications, using a filter needle represents the best practice for the drawing up of all medications. However, many biologicals are packaged in multiple-dose, rubber-topped vials and given that these are often administered to children, the injection will be given with a higher gauge needle. Clinicians who work in settings such as immunization clinics for children may argue that the cost and use of filter needles are unwarranted in their practice. Given this circumstance, the decision may be justifiable. If the clinician works in a setting in which a filter needle is not routinely used per institution policy, the following points can help to minimize potential complications:

- When inserting a needle in a rubber-topped vial, insert the needle bevel up. This will prevent the needle from coring the rubber (McConnell, 1982).
- When withdrawing medication from the vial, hold the container down. Do not withdraw the last drops in the container. This allows any particulate matter that may be present to precipitate out of the solution; leaving the last drops reduces the chances of withdrawing foreign particles (McConnell, 1982).
- After the medication is withdrawn into the syringe, any excess medication should be expelled through the needle. If medication drips on the needle, it should be wiped off with a sterile gauze pad. Medication remaining on a needle could be tracked through the subcutaneous tissue, which causes pain at the injection site. Likewise, wiping the needle with an alcohol wipe would leave alcohol on the needle, which is also painful if tracked through the subcutaneous layer, thus the recommendation to use a gauze pad (Hanson, 1963; Keen, 1983; Newton, Newton, & Fudin, 1992).

Finally, the clinician should be alert to any problems with the needle (i.e., bent or damaged) and change it if necessary.

Air Bubble. As noted by Beyea and Nicoll (1995), the use of an air bubble in the syringe is a topic that engenders heated debate among clinicians, especially nurses. Despite their conclusion that “drawing up an air bubble is an outdated recommendation and should be eliminated from the IM injection procedure” (Beyea & Nicoll, 1995), it still appears to be a prevalent practice (Engstrom et al., 2000). However, the scientific basis for this technique is weak to nonexistent.

Two views among clinicians surrounding the need for an air bubble in the syringe are prevalent. View one suggests that an air bubble is necessary to ensure that a correct dose of medication is in the syringe; view two suggests that the air bubble seals the medication in the muscle after injection. Although view one does have a basis in historical fact, neither view is scientifically supported or appropriate for the procedure in current practice.

View one is based on the fact that in the days of glass syringes, a small air bubble (approximately 0.2 mL) was necessary to account for dead space in the needle hub and ensure that an accurate dose of

medication was withdrawn into the syringe. In the United States, disposable plastic syringes came into wide use in the 1960s. These devices are calibrated to deliver an accurate dose of medication, taking into account the volume of medication within the entire unit, including the hub. The markings on the syringe barrel are accurate and should be used by the clinician to draw the proper amount of medication into the syringe. Drawing in a bubble of air will affect the dosage of medication by a factor of 5% to 100% (Chaplin, Shull, & Welk, 1985; Zenk, 1982, 1993). Likewise, when a pre-filled syringe unit is used (such as a Carpuject® device), the dosage in the syringe is accurate as provided by the manufacturer. An air bubble is not needed and can alter the correct dose.

View two, however, is based on the notion of sealing the medication in the muscle. The thought seems to be a recent innovation, which has likely come about with the advent of depot medications. Three studies could be identified that tested the theory that an air bubble would prevent backflow of medication into the subcutaneous tissue. Although one study showed that the air bubble did reduce seepage at the injection site (Quartermaine & Taylor, 1995), two other studies showed no beneficial effect of the technique (Ipp, Goldbach, Greenberg, & Gold, 1990; MacGabhann, 1998).

A procedure that has been shown to be effective in decreasing leakage through the subcutaneous tissue is the Z-track technique (Keen, 1981, 1986, 1990; Stokes et al., 1944). In this procedure, the skin is pulled downward or laterally before the injection. This has the effect of displacing the skin and subcutaneous tissue before the injection and uses the valve action of the skin and superficial fascia to prevent leakage (Beyea & Nicoll, 1995; Stokes et al., 1944). When the injection is completed, the displaced tissue returns to its normal position and overlaps the needle track. Use of this procedure has been shown to result in less discomfort for the patient and a decreased incidence of lesions at the injection site.

Based on this review, the recommendation made by Beyea and Nicoll (1995) continues to be true: drawing up an air bubble is an outdated or nonscientific recommendation and should be eliminated from the IM injection procedure. The clinician should use the markings on the syringe to determine the accurate dose of medication. To en-

sure that medication does not leak back along the needle track and into the subcutaneous tissue, the Z-track procedure should be routinely used for all IM injections.

THE INJECTION PROCEDURE

Positioning

Proper positioning ensures patient comfort and allows the clinician to correctly identify the site for injection. For an injection in the deltoid, a patient may sit or stand. A child may be held in an adult's lap. An infant or child receiving an injection in the VL may also be held by an adult. To position the child for an injection in the left VL, the adult's left arm should be around the child, supporting the head and holding the outside arm. The child's inside arm should be tucked around the adult's body. The adult's right hand should firmly hold the child's legs. These instructions can be reversed for an injection in the right VL site (WHO, 1998). Although injections in the VG can be given with a patient sitting, standing, or lying in a supine or lateral position (Haber et al., 2000; Hochstetter, 1954, 1955, 1956), having the patient lay down is safest for the patient and most advantageous for the clinician to visualize the site properly. In addition to helping the patient assume the correct position, the clinician should ask (or assist) the patient to remove any articles of clothing at the injection site so that it may be fully visualized and bony landmarks palpated (Hanson, 1963).

Positioning the patient so that the muscles are relaxed has been shown to decrease pain and discomfort from the injection. Placing the hand on the hip will relax the deltoid muscle. For the gluteal muscles, internal rotation of the femur relaxes the muscles (Kruszewski et al., 1979; Rettig & Southby, 1982). In a lateral position, the upper leg can be flexed 20° to ensure internal rotation. Flexing both knees, or at least the knee on the side of the injection, will relax the muscle when the patient is in a supine position.

Procedure

Once the patient has been positioned, the muscle relaxed, and the site properly identified by using bony landmarks, the final steps of giving the injection may begin. The site should be cleansed with a disinfecting agent such as alcohol or iodophor. Cleanse the skin in a circular fashion in an area of approximately 5 to 8 cm and allow the skin to dry

(Berger & Williams, 1992; Murphy, 1991). Use the nondominant hand to pull the skin downward or laterally at the injection site (Z-track technique).

At the moment of injection, the critical component of the procedure is the smooth, steady insertion of the needle through the skin and subcutaneous tissue into the muscle. Some authors recommend a dart technique (Dickerson, 1992; Kozier et al., 2000), but an interesting piece of anecdotal evidence suggests an alternate method that may decrease pain at the moment of injection. Jablecki (2000) suggests placing the point of the needle on the skin, and if there is no pain at the initial point of contact, the needle is pushed through the skin into the muscle. If there is pain at the initial point of contact, the needle is moved over 2 to 3 mm at a time until a painless point on the skin is found, at which point the needle is then inserted through the skin and into the muscle. This technique is based on the anatomy of the cutaneous innervation of the skin in which there are distinct points on the skin in which painful stimuli do not cause pain sensation because there are no pain receptors (Light & Perl, 1993). Jablecki (2000) reports that neurologists use this technique to perform relatively painless electromyography studies.

Barnhill, Holbert, Jackson, and Erickson (1996) reported that applying pressure to the site for 10 seconds prior to injection would reduce injection pain, based on their research with 93 subjects receiving immune globulin. There was a significant difference in pain perception between the experimental (pressure treatment) and control group subjects in the study. No further studies of this technique could be identified, although this procedure and the procedure described by Jablecki (2000) both seem to warrant further research.

The routine recommendation over the years has been to insert the needle at a 90 degree angle (Belanger-Annable, 1985; Dickerson, 1992; Grosswasser et al., 1997; McConnell, 1982) although Katsma and Smith (1997) found that both novice and experienced clinicians gave injections that deviated from this angle. Further research identified an injection is in the muscle (as opposed to the subcutaneous tissue) with angles of injection ranging between 72 and 90 degrees (Katsma & Katsma, 2000). Based on this, the clinician should endeavor to give an injection so that the needle is perpendicular to the patient's body which should ensure

that it is in the range of 72 and 90 degrees. Sharply angled injections (as are recommended for intradermal injections) are not appropriate for IM injections.

Once the needle has been inserted through the skin and into the muscle, aspirate by pulling back on the plunger for 5-10 seconds. This time is necessary to ensure that the needle is not in a low flow blood vessel (Keen, 1981; Stokes et al., 1944). There are reports in the literature of complications that occurred as a result of intra-arterial or intravenous injection of medication (Ozel et al., 1995; Talbert et al., 1967). If blood is aspirated in the syringe, the needle should be withdrawn, the syringe discarded and a new injection prepared using new equipment, which should be given in a different location (Workman, 1999).

After aspiration, the medication should be injected slowly at a rate of 10 seconds per milliliter of medication (Keen, 1981; Zelman, 1961). This slow rate of administration allows the muscle fibers to stretch and accommodate the injected volume while lessening the chance of leakage back through the needle track (Hahn, 1990; Stokes et al., 1944; Zelman, 1961). Once the syringe has been emptied of medication, wait 10 seconds before withdrawing the needle (Belanger-Annable, 1985; Keen, 1990). This allows the injected medication to begin to diffuse into the surrounding muscle tissue. Withdraw the needle with a smooth and steady movement and apply gentle pressure with a dry sponge. Use of an alcohol swab may cause pain or a burning sensation.

After injection, the site should be assessed for any signs of complication. If the patient is in a setting in which the site can be reassessed 2 to 4 hours postinjection, this should be done and any unusual findings should be documented (Roberts, 1975). Appropriate interventions, such as comfort measures or application of heat or cold, should be instituted. In the event of severe injury, referral to a physician should be made. In the outpatient setting, the patient or accompanying adult should be taught how to assess the site and when to report complications. Vaccines, in particular, are known to result in minor, local reactions or systemic reactions such as a low-grade fever. Patients should be instructed in proper self-management techniques (i.e., acetaminophen for fever) and when to report problems to the clinician (CDC, 1994).

Table 2. Clinical Practice Guideline

Intramuscular Injection
Guidelines for Evidence-Based Technique

Patient Population: Infants, toddlers, children, and adults receiving medication by the IM route for curative or prophylactic purposes.

Objective: Administration of medication to maximize its therapeutic effect for the patient and minimize or eliminate patient injury and discomfort associated with the procedure.

Key Points: "An injection should only be given if it is necessary—and each injection that is given must be safe" (WHO, 1998).

Justification for IM injection. Consider:

- Medication characteristics including formulation, onset and intensity of effect, and duration of effect.*
- Patient characteristics including compliance, uncooperativeness, reluctance, or inability to take medication via another route.*

Site selection. Site is the single most consistent factor associated with complications and injury. Consider:

Age of patient:

- Infants: vastus lateralis is the preferred site*
- Toddlers and children: vastus lateralis or deltoid*
- Adults: ventrogluteal or deltoid*

Medication type

- Biologicals (including immune globulins, vaccines, and toxoids): vastus lateralis (infants and young children); deltoid in older children and adults*
- Hepatitis B and rabies must be given in the deltoid; injection in other sites decreases the immunogenicity of the medication*
- Depot formulations: ventrogluteal site*
- Medications that are known to be irritating, viscous or in oily solutions should be administered at the ventrogluteal site*

Medication volume

- Small volumes of medication (2 mL or less) may be given in the deltoid site*
- Large volumes of medication (2-5 mL) should be given in the ventrogluteal site

*Always use bony landmarks to properly identify the site**

Preparation of the medication. Consider:

Equipment

Needle length corresponds to the site of injection and age of patient according to the following guidelines:

- Vastus lateralis: 16 mm to 25 mm²*
- Deltoid (children): 16 mm to 32 mm*
- Deltoid (adults): 25 mm to 38 mm*
- Ventrogluteal (adults): 38 mm*

Needle gauge: often dependent on needle length. In general, most biologicals and medications in aqueous solutions can be administered with a 20-25 gauge needle; medications in oil-based solutions require 18- to 25-gauge needles†

*Always use a new, sterile syringe and needle for every injection.**

Use a filter needle to withdraw medication from a glass ampule* or rubber-topped vial.§

With a filter needle, change needle before injection*

Use the markings on the syringe barrel to determine the correct dose*

*Do not include an air bubble in the syringe**

Patient preparation and positioning. Consider site of injection:

- Deltoid: patient may sit or stand.† A child may be held in an adult's lap.*
- Ventrogluteal: patient may stand, sit, or lay laterally or supine*
- Vastus lateralis: infants and young children may lay supine or be held in an adult's lap*
- Remove clothing at the site for adequate visualization and palpation of bony landmarks†
- Position patient to relax the muscle*

Injection procedure.

- Cleanse the site with alcohol and allow to dry†
- Insert needle into the muscle using a smooth, steady motion†
- Research on two alternate techniques to reduce pain at the moment of injection is inconclusive at this time, but warrants further study‡-§
- Aspirate for 5 to 10 seconds*
- Inject slowly at a rate of 10 sec/mL†
- After injection, wait 10 seconds before withdrawing the needle†
- Withdraw needle slowly, apply gentle pressure with a dry sponge†

Postinjection.

- Assess site for complications, both immediately and 2 to 4 hours later, if possible (A)
- Instruct patient regarding assessment, self-management of minor reactions, and when to report more serious problems*
- Properly and promptly dispose of all equipment*

Note. Needle sizes are provided in metric lengths to conform to the international standard; for US readers, corresponding needle sizes in " are as follows: 16 mm = 5/8"; 22 mm = 7/8"; 25 mm = 1"; 32 mm = 1¼"; 38 mm = 1½".

Criteria for grading of the evidence:

*Empirical data from published research reports, recommendations of established advisory panels, and generally accepted scientific principles.

†Surveys, reviews, consensus among clinicians, and expert opinion.

‡Published case reports.

§Anecdotal evidence and letters.

After injection, all equipment that was used (syringe, needle, filter needle, medication vials, and ampules) should be disposed of properly. A major cause of injection problems on a global scale is the lack of an adequate disposal infrastructure. In India, syringes are scavenged for reuse, whereas in Africa, syringes and needles are reused until they break because, culturally, waste is not acceptable (WHO, 1999). Although the United States has a better disposal infrastructure, we are still not immune to the problem, and clinicians must be alert to proper disposal of used equipment (Jackson, Mulherin, & Rickman, 1996).

CONCLUSION

Based on this review, a research based guideline for practice has been developed and is presented in Table 2. There is sufficient evidence for the majority of the steps of the guideline and the grading of the evidence is included for reference. However, there are some areas that warrant further research. Issues surrounding the use of filter needles and particulate matter in syringes should be studied so that more precise recommendations can be made. Minimizing pain at the moment of injection by using the techniques described by Barnhill (1996)

Use of this guideline along with clinical judgment should help to ensure that the practice of IM injections is evidence based and should assist the clinician to achieve the desired patient outcome (maximization of the therapeutic effect of the medication being administered while eliminating complications from the procedure of IM injection).

and Jablecki (2000) is also an area for further research. However, the need for further research is small when compared with the body of research that exists around IM injections. Use of this guideline along with clinical judgment should help to ensure that the practice of IM injections is evidence based and should assist the clinician to achieve the desired patient outcome: maximization of the therapeutic effect of the medication being administered while eliminating complications from the procedure of IM injection.

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