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Are techniques used for intramuscular injection based on research evidence?

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This article debates the evidence surrounding the nursing procedure of administering intramuscular injections

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Abstract

The technique for delivering intramuscular injection remains rooted in custom and practice. This literature review examines the evidence on this commonly performed nursing procedure covering all aspects including site and needle selection.

Practice points

- The technique for IMI needs to be reviewed in the light of existing evidence.
- Evidence supports the use of Z track technique and stretching the skin of the injection site.
- Evidence supports the use of the ventrogluteal site for all ages.
- The dorsogluteal site should not be used for injection as it poses unnecessary and unacceptable risk for patients.
- Needle length and tissue depth are linked to adverse events as obesity has increased. Patients should be weighed and assessed for the required needle length with needles inserted up to the hub to ensure the full length is used.
- Aspiration should be undertaken with dorsogluteal procedures as needle insertion is close to the gluteal artery but is not necessary with other sites.

Background

Intramuscular injections (IMI) are frequently referred to as a 'basic skill' but involve a complex series of considerations and decisions relating to:

- Volume of injectate;
- Medication to be given;
- Technique;
- Site selection;
- Equipment.

Other considerations are patients' age, physical build and pre-existing conditions such as bleeding disorders, and the environment where the injection is given (Plotkin et al, 2008).

The administration of IMI has been a fundamental nursing skill since the 1960s (Beyea and Nicholl, 1995) and there is evidence that educating student nurses on injection techniques leads to improved and safer practice (Bandolier, 2003). In reality the procedure is usually taught once during pre-registration education and may not be formally revisited. This has resulted in poor practice including the increased incidence of needle-stick injuries.

Healthcare interventions can be undertaken on the basis of customs and habits that practitioners no longer critically question.

The term 'custom and practice' is a commonly used to describe this phenomenon (Pippard, 2008). While not all custom and practice is 'bad practice', some aspects need to be changed in the light of evidence-based research.

Moving practitioners from custom and practice to evidence-based practice was a key driver for the NHS modernisation programme (Department of Health, 2002). However, custom and practice seems to remain entrenched in IMI techniques.

Reasons for using the IM route for administration of drugs, and the technique adopted, vary worldwide. In the UK the growing incidence of obesity has highlighted the need to review site selection, needle length and technique to ensure correct administration of medicines by IMI.

Another key element in IMI technique is aspiration of the syringe plunger after needle insertion, for which there is little supporting evidence.

Literature review

There have been many articles about IMI techniques in the nursing literature over the last four decades (for example Hunter, 2008; Greenway, 2004; Workman, 1999; Beyea and Nicholl, 1995; Hahn, 1990; Torrance, 1989; Hanson, 1963), which are frequently cited. However, the past decade has seen a shift in both medical and nursing literature on changing practice in administration of drugs via IMI (for example Hunter, 2008; Nisbet, 2006; Wynaden et al, 2005).

The specific changes debated include site, needle size and injection depth. The debates have been driven by new technologies, advances in drug design and changing populations. However, clinical practice does not seem to follow the evidence base underpinning some aspects of IMI.

Few articles appear to re-examine the evidence for IMI; they often repeat opinions and anecdotes with little supporting evidence.

A literature review of Medline, Cinahl and Cochrane databases found little evidence on injection theory and no evidence for aspiration of the syringe plunger. Studies have been undertaken on steps such as site selection and needle depth but have not always been rigorous comparative studies; this indicates the need for further research.

Recent studies are predominantly linked to aspects of vaccine administration. There is a perception that vaccines are associated with small volumes and childhood immunisations. However, the volume of vaccine injectate can be up to 4ml and vaccines are administered to all age groups (Plotkin et al, 2008). Evidence of reactogenicity associated with vaccines following superficial administration is well documented (for example Diggle and Deeks, 2000).

Limited opportunities for both student and registered nurses to perform injections in practice are associated with deteriorating knowledge and skills (Hemsworth, 2000). Existing poor practice may be compounded by new technologies, for example auto-disable injection devices, that may require new techniques.

Implications of poor practice

Poor practices can create adverse risks for patients and healthcare workers (National Patient [Safety](#) Agency, 2007). Adverse events for patients include:

- Haemorrhage in those with bleeding disorders (Plotkin et al, 2008);
- Pain;
- Sciatic nerve injury;
- Injection fibrosis;
- Infection.

Failure to ensure correct siting, depth or rate of delivery are linked to complications.

Significantly it is the muscle group chosen – with or without appropriate technique – that increases the risk of adverse events for patients (Wynaden et al, 2006). The medication and volume of injectate influences the site chosen.

Although there are identified risks associated with IMI the number of reported injuries has fallen in recent years (NELH, 2008).

This may be due to changes including: delivering medicines by other routes; fewer inappropriate injections; use of patient-controlled analgesia; introduction of best-practice guidelines; advances in [technology](#); and pharmaceutical developments (Small, 2004; Hutin, 2003; Avidan et al, 2003).

Medication volumes

Five muscles are currently advocated as possible sites for IMI (Tortora and Derrickson, 2008):

- Deltoid;
- Dorsogluteal;
- Ventrogluteal;
- Vastus lateralis;
- Rectus femoris.

All muscles have blood supply and are innervated, although only the dorsogluteal injection site has close proximity to a major nerve and blood vessel.

Historically the volumes of fluid recommended for each muscle group are:

- Deltoid – 1ml (Covington and Trattler, 1997);
- Dorsogluteal – 4ml (Rodger and King, 2000);
- Ventrogluteal – 2.5ml (Rodger and King, 2000), 4ml (Workman, 1999);
- Rectus femoris – 5ml adults, 1–3ml children (Workman, 1999);
- Vastus lateralis – 1ml (Covington and Trattler, 1997), 5ml (Rodger and King, 2000).

These figures appear to be based on muscle size, with larger muscles tolerating greater volumes. However, the volume of fluid that can be tolerated by the muscle groups is poorly researched and these figures are

derived from personal viewpoints or descriptive studies. Patient tolerance is affected by factors associated with the medicine, for example, oil-based formulations, antibiotic or pH of the drug.

Cosmetic procedures using Botox, for example involve injecting 1–3ml into facial muscle groups, which supports the view that tolerance of the drug is probably more important than the volume (Butterwick-Kimberley, 2005). There is evidence that using smaller volumes aids absorption and reduces reactions (John and Stevenson, 1995) while the DH (2006) recommends dose division for volumes above 3ml or 4ml.

Siting

Selecting the injection site requires correct identification of muscle groups by land-marking correct anatomical features (Hunter, 2008). This requires complete exposure of the selected site.

While dorsogluteal muscle is associated with sciatic nerve injury it remains an option in practice (Wynaden et al, 2006; Small, 2004). Land-marking by palpating the ilium and trochanter is considered essential to reduce risk of injury. Commonly used land-marking methods including 'upper outer quadrant' or 'diagonal' are controversial and are not supported by evidence (Small, 2004).

Covington and Trattler (1997) contributed a practice adaptation to support ventrogluteal land-marking by practitioners with small hands. They recommend placing the index finger on the anterior superior iliac spine and the palm as near to trochanter as possible. However, this is still considered difficult (Greenway, 2004).

Selection of sites

The World Health Organization (2004) and DH (2006) do not advocate the dorsogluteal site for routine immunisation, because of poor absorption of vaccines and the risk of sciatic nerve injury (Plotkin et al, 2008). Anterolateral thigh and deltoid are recommended sites for vaccines in infants and children (Plotkin et al, 2008).

Developmentally, infants and children have larger ventrogluteal than dorsogluteal muscle mass with minimal change in deltoid thickness from infant to child. Cook and Murtagh's (2003) randomised comparative study of ventrogluteal and anterolateral thigh injections in children aged two, four, six and 18 months indicated significantly fewer adverse events and better parent acceptance of the ventrogluteal site than anterolateral thigh. This supported an earlier study indicating the efficacy of immunological response using the ventrogluteal site (Cook and Murtagh, 2002).

All sites are options for adult injections. The ventrogluteal is advocated as first choice (Rodger and King, 2000) but traditionally the dorsogluteal is chosen (Wynaden et al, 2006). Employers often designate sites to be used while complying with drug manufacturers' guidance.

Technique

UK nurses running immunisation clinics must receive specific training with regular annual updates (Diggle and Richards, 2007; [Health Protection Agency](#), 2005).

Groswasser et al (1997) differentiated between 'bunching' (pinching), and stretching of the skin, recommended by the WHO. Bunching increases the risk of the drug being delivered into the subcutaneous tissue, particularly when a short needle was used (16mm rather than 25mm). Emaciated patients are the exception to this.

Stretching is the most **reliable** technique for IMI delivery (Groswasser et al, 1997). It was found to consistently deliver injectate to muscle layer in children.

Keen (1986) combined the Z track technique with the ventrogluteal site, resulting in reduced pain and fewer injection site lesions. Rodger and King (2000) noted that Z track is appropriate in any muscle group. This requires the overlying skin and subcutaneous tissue to be displaced by 2.5–3.75cm before injection and released immediately after. It prevents leakage of the drug and locks it into target muscle tissue. However, Macgabhann (1996) recorded more pain and bleeding with this technique.

Patient position

Patient position affects perceptions of pain, choice of technique and administration. Ensuring patients are correctly positioned also facilitates correct land-marking.

The dorsogluteal site should only be used when the patient can lie in a prone or lateral position. Research still supports the 'toe in' position (patient points toes inwards, so internally rotates hip) for prone administration or flexing the knee 20° in the side lying position (Bolander, 1994). Anecdotally, dorsogluteal injection in busy clinical areas often involves using the standing position with the patient flexing the knee slightly. This adaptation (Zelman, 1961) requires research to support/refute the practice.

Accurate land-marking of the ventrogluteal is achieved from a side-lying position, although the injection can be administered in a seated position as long as land-marking has been done correctly (Greenway, 2004).

IMI into the deltoid, rectus femoris or lateralis can be administered while the patient is seated and muscles relaxed.

Research indicates skin cleansing is only needed if patients are immunocompromised or their skin is visibly dirty. Alcohol swab is appropriate (Royal College of Paediatrics and Child Health, 2002).

Tissue depth and needle selection

Injectates must be delivered to the correct tissue layer. IMI are formulated to be activated within the muscle. Correct delivery associated with use of a needle length that penetrates the muscle layer has been shown to reduce complications of abscess, pain and bruising (Zaybak et al, 2007; Cook and Murtagh, 2005).

Moshe et al (1989) identified that using a longer needle length within the anterolateral thigh muscle resulted in significantly fewer adverse reactions compared with the deltoid. However, more recent studies have highlighted the use of ventrogluteal sites with fewer adverse effects than the thigh (Cook and Murtagh, 2003).

Consistently, studies indicate the need for longer needles due to increased fat layer depth at all sites including ventrogluteal. In the past studies of fat layers at injection sites were undertaken on cadavers and these showed less fat compared with recent studies on living subjects (for example Zaybak et al, 2007; Nisbet, 2006; King, 2003).

The success rate for IMIs in women is consistently lower than in men as women typically have more adipose tissue around the buttocks (Zaybak et al, 2007). This also applies to deltoid fat pad, with 50% of injections not reaching IM depth in women.

Recommendations for longer needles included – 25mm for women weighing between 60–90kg and 38mm for women who weigh over 90kg to penetrate the deltoid muscle (Poland et al, 1997).

Current DH (2006) recommendations are that needle length must be sufficient to penetrate the subcutaneous fat layer using at least 25mm (23 gauge) blue needles or 38mm (21gauge) green needles for adults. For children 16mm is recommended, although decisions depend on other factors such as age and subcutaneous fat. Recent studies have recommended calculating patients' BMI to assist assessment of body fat (Nisbet, 2006). For details on needle angle, see Box 1.

Box 1. needle angle

- The needle angle recommended for IMI is 90° (DH, 2006).
- Research has proposed varying angles from 45–60° or 72°.
- However, the lack of consistent depth of delivery supports 90° and further studies concur (Warren, 2002).
- Practitioners should hold the syringe like a pen to insert in a dart-like motion, to reduce accidental depression of plunger and inadvertent deposition of injectate as the needle is being inserted (Plotkin et al, 2008).

Aspiration

Aspiration of the syringe plunger once the needle has been inserted into the muscle is an accepted part of IMI procedure but there is no evidence of the need to do this. Justification includes to ensure the drug does not enter the capillaries (Hunter, 2008) or to avoid inadvertent IV administration (Workman, 1999).

Aspiration may be relevant to detect possible penetration of gluteal artery when the dorsogluteal muscle is used – this would indicate incorrect initial land-marking. However, official guidance (DH, 2006; WHO, 2004) does not recommend routine use of the dorsogluteal muscle, and this should be sufficient to justify changing practice. If this site were removed from routine practice, aspiration could be removed from the procedure, simplifying it and reducing the risk of adverse events. Pharmaceutical developments including reduced volume and less caustic injectates, along with prescribing changes, now support its removal from selected injection sites.

Some auto-disable devices (syringes where the needle retracts automatically after IMI administration to prevent needle-stick injuries) are triggered by the 'aspiration' type manoeuvre, so the technique has already changed in many countries.

Administration rate

Mitchell and Whitney (2001) recommend plunger depression at a rate of 10 seconds per ml. They found no reduction in pain with administration at 20 seconds per ml. Box 2 gives details on drug absorption.

Box 2. Absorption

- Varying absorption rates are accredited to different muscles.
- The dorsogluteal rate of absorption and efficacy is consistently less than other sites (Diggle and Richards, 2007), with opiates particularly identified as a risk for depot type effect. This results in slow absorption and the drug can build up in the tissues with an associated risk of creating an overdose. Responses to some immunoglobulins is also less effective so the IM route is not recommended for these drugs (Plotkin et al, 2008).
- Increased muscle warmth and activity have been equated with higher absorption (King, 2003).

Pain during injection

Pain receptors are located within the subcutaneous layer and not in muscle tissue, thus needles need to be long enough to reach this muscle layer (Diggle and Deeks, 2000).

Barnhill et al (1996) examined the effect of manual pressure on perceptions of pain from IMIs and the study was repeated and refined by Chung and Wong (2002). These studies advocated the use of manual pressure on the injection site for 10 seconds before needle insertion, to reduce pain. This correlates with the gate theory of pain control (Tortora and Derrickson, 2008).

Women consistently report more pain from all IMIs (Chan et al, 2003), while parents report more crying from children having thigh injections compared with deltoid (RCPCH, 2002).

Larger-bore needles reduce pain and swelling/redness after injection as less pressure is required to depress the plunger (King, 2003). Nurses' skill in relaxing patients beforehand should not be underestimated in reducing anxiety-heightened pain.

New technologies and techniques

Needle-less injection systems have had varied success for IM and subcutaneous jet injections. Debate continues about their effectiveness to deliver to the required tissue layers (Plotkin et al, 2008).

Questionable safety of multi-use nozzle jet injectors led to them being withdrawn in the 1990s, when they were linked to the spread of pathogens between patients during vaccination programmes (Plotkin et al, 2008). However, needle-less system development is ongoing to meet the needs of developing countries (Plotkin et al, 2008) and will require different administration technique.

Conclusion

The technique for IMI needs to be reviewed in the light of existing evidence. Several administration techniques are available: comparative research is limited but compelling for both the Z track and stretching method, as is the use of the ventrogluteal site for all age ranges. Use of the dorsogluteal site should be removed from injection practice as an unnecessary and unacceptable risk for patients.

Needle length and tissue depth are undoubtedly linked to adverse events as obesity has increased. Women in particular are more likely to experience pain and failure of correct delivery of medication. Patients should be weighed and assessed for required needle length, and needles should be inserted up to the hub. Until use of the dorsogluteal site is removed, aspiration should be undertaken with dorsogluteal procedures as needle insertion is anatomically close to the gluteal artery, but is not necessary with other sites.

Information about IMI technique should be considered in relation to best practice and patient safety, and evidence should be used in order to support professional decision and policymaking, rather than simply relying on custom and practice. However, the debate on techniques used for IMI may be negated by advanced technologies and the commitment worldwide to a needle-less system.

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