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INTRAMUSCULAR ADMINISTRATION OF MEDICATION IN PAEDIATRICS: INTEGRATIVE LITERATURE REVIEW

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ABSTRACT

Background: the administration of intramuscular therapy goes back a long time, being one of the techniques studied and practiced by nurses.

Objective: identify, in the literature, the specifics of the intramuscular administration technique in pediatric age.

Methodology: integrative review of the literature of articles on electronic platforms, B--on and ResearchGate®.

Results: the gauge of the needle, the maximum volume to be administered depending on the muscle and the muscle to be selected for intramuscular injection vary according to the age group, however there are differences between the various authors. It should be noted that studies do not identify the dorsogluteal muscle as the recommended site for pediatric age and recommend the use of the ventrogluteeal muscle.

Conclusion: more scientific evidence on this topic is needed in order to ensure safety in intramuscular injection in pediatric age.

Keywords: intramuscular injection; child; therapeutic administration.

INTRODUCTION

Intramuscular (IM) administration of medication goes way back and is one of the most studied and most applied techniques by nurses.

Injecting medication deep into the muscle has been the current choice, as studies state that absorption is faster than for subcutaneous (SC) injection. This is due to the rich blood supply of deep muscle tissue that allows for the administration of higher volumes of drugs. Moreover, the skeletal muscle is less sensitive to irritant medication[1].

Intramuscular injection is a viable option when medication cannot be delivered orally (because the child is intolerant to or unable to swallow medication) or the oral route is not appropriate (when treatment is adversely affected or inactivated by gastric secretions)[1,2].

Paediatric nurses have been concerned about the maximum volumes to deliver into each muscle and the selection of the right needle and proper sites for IM injection[3].

The subject 'Intramuscular administration of medication' was chosen because of its professional significance in terms of developing the best IM injection practices. The issues that arise from practice – the choice of administration site and proper syringe and needle – led to the following question that guided this research: How to deliver medication to children using the IM route?

This article aims at increasing knowledge of the state-of-the-art regarding the procedure of IM administration of medication to children in paediatric age. Its main goal is to identify in literature the specificities of the above technique.

The specific objectives of this article are gathering information about the material to use in IM administration of medication to each age range, site of administration in paediatrics and maximum volumes of medication to deliver to each muscle.

METHODOLOGY

This study is an integrative literature review[4]. Research was made using the all databases of B-on and ResearchGate® platforms for the years of 2013–2018. English Health Sciences descriptors (DeCS, edição 2017) used were: *intramuscular injection*, *children* and *medication administration*, and their intersections were made by using the Boolean operator '*and*'. Research delimitations were: full texts in Portuguese, English and Spanish.

Inclusion criteria were: studies whose object was the IM administration of medication that included paediatric age (0–17 years).

Exclusion criteria were: studies that did not address IM administration of medication and did not include paediatric age (0–17 years).

Twenty articles from B-on and 1 article from Research Gate® were then selected based on the criteria above. Six articles were analysed after the application of inclusion and exclusion criteria.

Selected articles were then analysed by three independent reviewers. *The Joanna Briggs Institute* assessment charts were applied and the articles that showed more than 50% of positive aspects were included in this study. Levels of evidence were rated according to the Joanna Briggs Institute Approach, 2014[5]: Level 1 – Experimental designs: 1.a – Systematic review of randomized controlled trials; 1.b – Systematic review of randomized controlled trials and other study designs; 1.c – Randomized controlled trials; 1.d – Pseudo-randomized controlled trials. Level 2 – Quasi-experimental designs: 2.a – Systematic re-

view of quasi-experimental studies; 2.b – Systematic review of quasi-experimental and other lower study designs 2.c – Quasi-experimental prospectively controlled study; 2.d – Pre-test and post-test or historic/retrospective control group study. Level 3 – Observational – analytic designs: 3.a – Systematic review of comparable cohort studies; 3.b – Systematic review of comparable cohort and other lower study designs; 3.c – Cohort study with control group; 3.d – Case-controlled study; 3.e – Observational study without a control group. Level 4 – Observational – descriptive studies 4.a – Systematic review of descriptive studies; 4.b – Cross-sectional study; 4.c – Case series; 4.d–Case study. Level 5 – Expert Opinion – Bench research: 5.a–Systematic review of expert opinion; 5.b – Expert consensus; 5.c – Bench research/single expert opinion.

This selection process was summarized according to the PRISMA model (Preferred Reporting Items for Systematic Review and Meta-Analyses)[6] and is represented by figure 1.

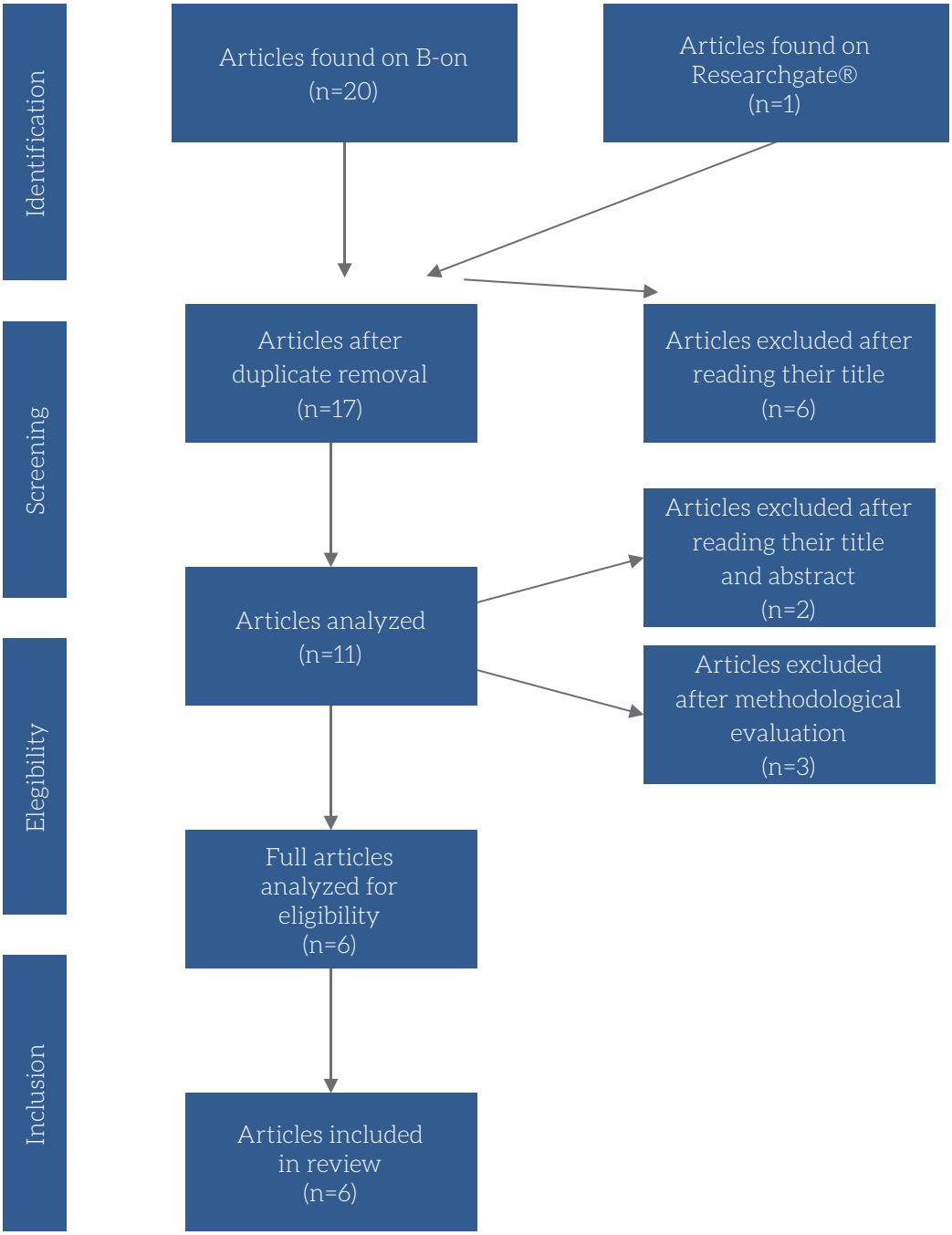

Figure 1 – Article selection process using the PRISMA model.

RESULTS

Table 1 is the result of article analysis and includes authors name, year and country; information about design; study goal; level of evidence; and where the relevant information arising from each study was compiled.

Table 1 – Data extracted from analysed articles.

Authors (year), Country	Study Design and Evidence Level	Study goal	Results
Walsh K, Schub T (2017), United States of America[1]	Review article. 5c	How to administer medication using the IM route in paediatric age by applying the straight-line technique.	– In children up to 36 months use needle with 16-22mm length and 23-25 gauge. In children older than 36 months use needle with 25 mm length and 23-25 gauge. A lengthier needle may be needed for children with thicker subcutaneous tissue. – In children with coagulopathy or who are taking medication use needle with 23 gauge or smaller. – The ventrogluteal muscle can be used in children older than 7 months. Maximum volume recommended is 0.5ml for infants and 2ml for children. – WHO does not recommend IM injection into the dorsogluteal muscle in children as there is a risk of trauma to the sciatic nerve and superior gluteal artery because of their variable location. – WHO recommends IM administration of medication into the deltoid muscle from 15 months, whereas other sources state 12 months. Maximum volume is 0.5ml-1ml for children. Used regularly for vaccination, but particularly susceptible to irritant solutions. – The vastus lateralis can be used in any age because it is easily accessible and has few blood vessels and main nerves. Maximum volume is 1-2ml for infants younger than 1 year. – Medication can be administered via the IM route by applying the straight-line or Z-track technique by using the thumb and index finger to keep the skin stretched and to stabilize and isolate the muscle to be able to insert the needle at a 90° angle. – If volume to deliver exceeds muscle capacity, it should be divided into multiple doses. – For IM administration of several medications into the same muscle, injection sites must be spaced 2.5cm apart to prevent local reactions from overlapping. – Aspiration is not recommended for deltoid and vastus lateralis muscles because these are poorly vascularized muscles. – When possible, encourage children to relax muscle to reduce pain and risk of bleeding. – Drug absorption is faster when the muscle into which the medication was delivered exercises, once heat and muscle activity dilate blood vessels and increase blood flow and absorption rate. – Wait at least 30 minutes in healthcare after IM administration of medication. This is the minimum timeframe required for medication to produce adverse effects such as allergic reactions.

Table 1 – Data extracted from analysed articles.

Authors (year), Country	Study Design and Evidence Level	Study goal	Results
Walsh K, Caple C (2017), United States of America[2]	Review article. 5c	How to administer medication using the IM route in new-borns by applying the straight-line technique.	– In new-borns use needle with 16 mm length and 23-25 gauge. – In children with coagulopathy or taking medication use needle with 23 gauge or smaller. Vastus lateralis muscle is preferred. – Maximum volume to deliver is 1ml, except for NB weighting less than 1.5kg. In this case, maximum volume is 0.5ml. – If volume to deliver exceeds 1ml, it should be divided into multiple doses. – The straight-line or Z-track technique can be used for IM administration of medication, by using the thumb and index finger to keep the skin stretched therefore stabilizing and isolating the muscle to insert the needle at a 90° angle. – For IM administration of several medications into the same muscle, injection sites must be spaced 2.5cm apart to prevent local reactions from overlapping. – Aspiration is not recommended for the vastus lateralis muscle because this muscle is poorly vascularized. – NB should have their muscle relaxed to reduce pain and risk of bleeding. – Wait at least 30 minutes in healthcare after IM administration of medication. This is the minimum timeframe required for medication to produce adverse effects as allergic reactions.
Brown J, Gillerpie M, Chard S (2015), United Kingdom[7]	Review article. 5c	Identify evidence for recommendations concerning IM administration of medication into the ventrogluteal muscle instead of the dorsogluteal.	– The vastus lateralis muscle can be used in children up to 2 years. – The deltoid muscle can be used in children older than 2 years. – The ventrogluteal muscle is easy to access, safe to use in children and its muscle mass has adequate size. – The dorsogluteal muscle is not recommended for children younger than 3 years. Complications are associated with this site, such as trauma to sciatic nerve or superior gluteal artery. – More evidence is needed to eradicate IM administration of medication into the dorsogluteal muscle.

Table 1 – Data extracted from analysed articles.

Authors (year), Country	Study Design and Evidence Level	Study goal	Results
Ogston-Tuck S (2014), United States of America[8]	Review article. 5c	Analyse scientific--based data concerning safe IM administration of medication.	– The vastus lateralis muscle is recommended for IM administration of medication in all age ranges. Recommended volume in children is 1 to 3ml. – Ventrogluteal muscle is preferred to the dorsogluteal muscle because it is far from nerves and large vessels and fat tissue is less thick. Moreover, the dorsogluteal muscle absorbs medication slower. Maximum volume to deliver is 2.5ml to 3ml. – The deltoid muscle is recommended for vaccines and in older children. Maximum volume up to 1ml. – Use needle with length: 25 to 38mm in adults, 16 mm in children. – Recommended angle for needle insertion is 90°. – Aspiration is only needed for highly vascularized muscles, such as the dorsogluteal. – Pain is less when the muscle is relaxed.
Yapucu G, Ceylan B, Bayindir P (2015), Turkey[9]	Descriptive study. 4b	Determine whether the ventrogluteal muscle can be used for IM administration of medication in children younger than 3 years and compare deltoid, vastus lateralis and ventrogluteal subcutaneous and muscle layers for different age ranges and both genders.	– The dorsogluteal muscle is not recommended for IM administration of medication in children. – The ventrogluteal muscle can be an alternative site for children ≤12 months and is safe in all age ranges. – The ventrogluteal muscle in children younger than 3 years shows proper development. It was thicker than the vastus lateralis, particularly for the 1-year-old group. – The ventrogluteal muscle is more developed than vastus lateralis in children from 12 to 36 months old. – By administrating into the ventrogluteal muscle, children will not see the injection site and will be easier to distract, which will lead to lower anxiety levels. Positioning the child for administration into the ventrogluteal muscle is also easier.

Table 1 – Data extracted from analysed articles.

Authors (year), Country	Study Design and Evidence Level	Study goal	Results
Dilek, K, Uzelli, D, & Karaman, D (2015), Turkey[10]	Review article. 5c	Identify the advantages of using the ventrogluteal muscle instead of the dorsogluteal muscle in paediatric age and contribute to improving the IM administration of medication by nurses.	– Administration sites: dorsogluteal, ventrogluteal, deltoid, vastus lateralis, and rectus femoris. – Dorsogluteal muscle disadvantages: highly vascularized; close to sciatic nerve; thicker subcutaneous tissue when compared to others, with medication often being delivered to subcutaneous fat tissue instead of muscle tissue. – Ventrogluteal muscle advantages: far from sciatic nerve and large vessels; subcutaneous tissue is less thick and muscle mass is more developed; can be used in children older than seven months; is also appropriate for more aggressive medication; delivery can be easily made with children in supination; and is less painful, so it should be indicated as priority site for IM administration of medication.

DISCUSSION

Selected data were analysed by thoroughly reading results and comparing them with reference works in child and paediatric health. To achieve the objectives of this review, results were grouped into four categories that analysed IM administration of medicine in paediatric age with respect to: 1) Selecting the needle; 2) Determining the IM administration site; 3) Amount of medicine to be delivered; and 4) Considerations about IM administration of medication.

1) Selecting the syringe and needle

Syringe size is generally consensual and does not raise serious doubts, but proper needle length may not be as consensual. Evidence recommends the use of needles with the same gauge but different lengths depending on age range. The most appropriate needles to use in paediatric age are be between 23G and 25G[1,2]. However, in terms of length, one study argued that needles with 16mm should be used in new-borns (NB)[2]; between 16 and 22mm in children up to 36 months; and with 25mm in children older than 36 months[1]. Another study[8] stated that needle length should be 16mm, but did not specify any age range.

In the scope of children and paediatric health references, Brown[3] recommended the use of needles with 22G to 25G in paediatric age. Length, however, varied depending on selected muscle: between 15 and 25mm for the vastus lateralis and between 16 to 25mm for the ventrogluteal and deltoid muscles. On the other side, Wilson[12] argued that needle length between 16 and 25mm was more appropriate in preterm NBs or emaciated infants; between 25 and 32mm in toddlers; and between 38 and 51mm in older children. The only disadvantage was that higher-gauge needles could complicate the delivery of thicker medication[4]. This author also showed other needle lengths that pertained to studies conducted to minimize vaccine reactions: 16 mm in NB and infants up to 2 months; 25mm in infants; 16 to 25mm for the deltoid muscle or 25 to 32mm for the vastus lateralis in toddlers and older children; 25 to 51mm for the deltoid or vastus lateralis muscles in adolescents[12].

Most authors also referred the fact that the subcutaneous layer should be considered in addition to children's age range. A lengthier needle might be needed for children with thicker subcutaneous layers[1,2,5]. Needles should be long enough to penetrate muscle tissue[1,2,5].

For children with coagulopathy or who are taking anticoagulants, the use of a 23 gauge needle or smaller should be considered to avoid bleeding complications[1,2].

This study has considered the differences presented by the authors above as to proper needle selection that takes into account needle gauge and length and is influenced by several factors, such as type of drug to deliver, thickness of subcutaneous tissue, children's age range, administration muscle and former pathologies. This way, Table 2 shows our selection of needle gauges and lengths according to the most up-to-date scientific evidence, always bearing in mind that gauges and lengths are only references.

Table 2 – Needle gauge and length per age range.

Age Range	Gauge	Length
NB	23G to 25G	16mm
Infants and Toddlers	23G to 25G	16 to 22mm
Pre-school, School and Adolescents	23G to 25G	25mm

2) Determining the IM administration site

Nurses must follow certain criteria and consider multiple factors when determining IM administration site, such as: child size and age; child age/weight ratio; child's ability to stay in the required position safely; muscle size and accessibility (muscle must be well-developed and able to tolerate the amount of medication to be administered); type of medication to be administered; and laboratory instructions[3,7].

Selecting the muscle is a controversial decision, however, determining administration site should consider age range and muscle development[3].

The vastus lateralis muscle is one of the most used muscles in paediatrics for IM administration of medicine, because it is a muscle that is easy to access and locates in a poorly vascularized area with few main nerves[1,3,7,8]. That is why the vastus lateralis is usually the muscle of choice in children younger than 2 years[7,8]. However, Walsh & Schub[1] and Ogston-Tuck, S[8] argued that this muscle could be used at any age.

Previous studies showed that priority should be given to the ventrogluteal muscle, as this muscle is far from main nerves and blood vessels, making it quite safe[1,3,7,8,9,10]. Another advantage was the less thick subcutaneous layer and the subsequent lower probability of administering medication into the subcutaneous region[9]. It was also less painful[10] and easy to access when the child was in the dorsal, ventral or lateral decubitus position[1,3]. Further, positioning the child was easy and because they could see administration site and distracting them became easier. This muscle is properly developed in children between 12 and 26 months, is thicker than the vastus lateralis and should be preferred to the latter[9]. Other authors argued that this muscle could be used from 7 months of age[1,10].

The deltoid muscle was recommended for small volumes of medication and was preferred for vaccines[1,8] and older children[8], despite age recommended for its use still being contradictory[1,3,7].

Table 3 shows the most appropriate sites for IM administration of medication per age range, according to the studies and literature analysed.

Table 3 – Determining administration site per age range.

Age Range	Administration site
New-borns and Infants	Vastus Lateralis
From 12 months	Deltoid muscle (vaccination)
From 7 months	Ventrogluteal muscle

3) Amount of medication that can be administered via IM injection

Amounts recommended vary according to age range and subsequently selected administration site[1,3,8].

Some authors argued that the maximum volume of medicine to administrate into the vastus lateralis in new-borns was 1ml, in new-borns below 1.5kg was 0.5ml[2], and in infants younger than 1 year was between 1-2ml[1]. A maximum volume of 1 to 3ml in children was mentioned by another author[8], who did not specify any age range. As to the ventrogluteal muscle, maximum volume recommended was 0.5ml in infants and 2ml

in children[1]. Another study claimed the maximum volume for the ventrogluteal muscle was 2.5 to 3ml, but did not specify any age range[8]. For the deltoid muscle, the maximum volume in children was 0.5ml and 1ml[1].

Most studies equated adolescence to adulthood and did not mention any volumes. A new research was conducted to find maximum volumes to administer in adolescence. This research included only adults and concluded that the maximum volume to administer into the vastus lateralis and deltoid muscles in adolescents was 1-2ml, into the ventrogluteal 2.5-4ml and into the dorsogluteal 4ml[11].

For higher volumes, doses should be divided and spaced 2.5cm apart if administered into the same muscle[1,2]. The Portuguese Directorate-General of Health (DGS)[13] recommends such distance is between 2.5 and 5cm.

This study shows that other authors disagreed as to the maximum volumes to administer, particularly the maximum amount to administer into the vastus lateralis in infants and did not mention the maximum volume to administer in adolescents.

Table 4 shows a compilation of results from various studies concerning the administration site and volumes to administer in each age range.

Table 4 – Administration site and volumes per age range.

Age Range	Administration site	Volumes
Preterm below 1.5 kg	Vastus Lateralis	Maximum 0.5ml
New-borns	Vastus Lateralis	Maximum 1ml
Infants	Ventrogluteal	Maximum 0.5ml
	Vastus Lateralis	Maximum 1 to 2ml
Toddlers to School Age	Ventrogluteal	Maximum 2ml
	Deltoid	Maximum 0.5ml and 1ml
Adolescents	Vastus Lateralis	1 to 2ml
	Deltoid	1 to 2ml
	Ventrogluteal	2.5ml to 4ml
	Dorsogluteal	4ml

4) Considerations about IM administration of medication

Intramuscular administration of medication must consider multiple aspects. The IM injection must be made at a 90° angle to make sure it reaches deep muscle and avoids cutaneous tissue. The muscle is immobilized to isolate and stabilize the administration site[1,2,8] via the straight-line or the Z-track technique[1,2].

Aspirating when inserting the needle into the muscle was recommended by some authors for administrations in vascularized areas, but was not mandatory, especially for the deltoid and vastus lateralis muscles[1,2,8].

Parents should be informed about the importance of their children waiting at least 30 minutes in healthcare after IM administration of medication, because this is the minimum timeframe required for medication to produce adverse effects as allergic reactions[1,2].

It is important to note that sedation was highlighted by the authors mentioned in this study as an integral element to IM administration of medication and should be associated with pharmacological and non-pharmacological measures[1,2,8].

FINAL CONSIDERATIONS

This review showed that IM administration of medication is fairly common in nursing. Moreover, it highlighted this technique's specificities to each age range.

The main limitations of this study were the struggle to find standardized evidence that supported the several aspects to consider when using this technique, such as proper needle and muscle selection and maximum volumes to administer in each age range. The several authors mentioned in this study agreed on preferring the ventrogluteal to the dorsogluteal muscle. However, these studies presented low levels of evidence and reliable, effective and safe recommendations to clinical practice could not be inferred from them. Moreover, by not specifying age ranges and using different nomenclatures, those authors made it more complicated to understand which were the age limits they were referring to. Adolescence was hardly addressed and was deemed similar to adulthood.

This way, this review highlights the need for more data resulting from primary research in order to standardize the aspects inherent to IM administration of medication in the several age ranges.

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