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A Systematic Review of Complications from Pediatric Intraosseous Cannulation

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ABSTRACT

Introduction

Intraosseous (IO) infusion is a commonly-used method for obtaining vascular access in emergency situations. It involves insertion of a needle into the marrow cavity of long bones, with subsequent infusion of medications and fluids to achieve resuscitation. This procedure is known to be associated with certain complications. Despite the widespread, continued use of IO cannulation for pediatric subjects, a high-quality systematic review of the literature on pediatric IO complications remains lacking.

Materials & Methods

Several databases were searched for studies relating to IO infusion. Inclusion criteria included: English-language, original reports on the clinical treatment of human pediatric (<18 years old) patients, which reported the presence or absence of complications identified during the clinical care of the patient. Studies with IO cannulation performed under sterile operative settings were excluded. These studies were further processed on Covidence (www.covidence.org) systematic review software. Complications identified include, but are not limited to, pain, extravasation, compartment syndrome, local infections, osteomyelitis, embolism, fractures, and device failure. We are also collecting data on patient demographics, medications infused, injection site, and indication for cannulation.

Results

In total, 1,647 studies were imported for screening, with 762 duplicates removed. The remaining 885 studies were individually screened by abstract review, resulting in exclusion of 462 studies due to irrelevance. The remaining 423 studies are undergoing full-text review. Fifty-one studies have already been identified that appear to be suitable for inclusion and data extraction.

Conclusions

We anticipate this review to contribute to an improved understanding of complications associated with IO cannulation use in the pediatric population.

INTRODUCTION

According to the American Heart Association (AHA), the incidence of pediatric cardiac arrest is over 20,000 cases yearly, with 7000 cases occurring outside of hospitals in 2015¹. Intraosseous (IO) infusion is a commonly used method of acquiring vascular access in situations when emergent resuscitation is indicated. The technique involves insertion of a needle into the marrow cavity of a long bone and subsequent infusion of fluid and medications to achieve resuscitation (Figure 1). IO infusion is known to be associated with certain complications. In a 1985 review by Rosetti et al, the incidence of complications associated with pediatric IO infusion use in was described². Since then, IO infusion use has become more widespread. Despite the persistent use of IO infusion in children, there has yet to be a high-quality systematic review of pediatric IO complications published in the literature.

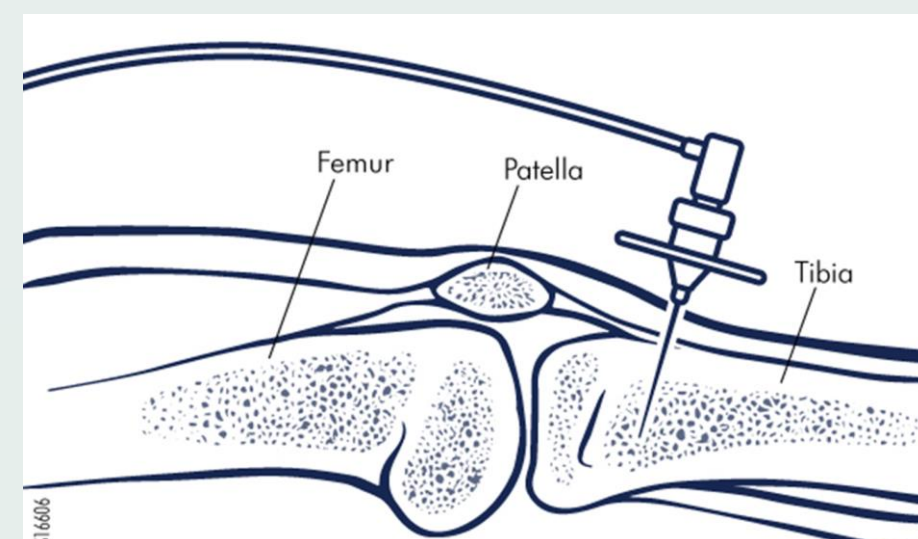


Figure 1. Depiction of the IO needle insertion process in the proximal tibia, the most common pediatric site... http://patientsafety.pa.gov/ADVISO/RIES/Pages/201609_114.aspx

METHODS

Search Strategy

Literature searches were conducted in PubMed/MEDLINE, EMBASE, CINAHL Complete, Web of Science, Cochrane Library, and ClinicalTrials.gov from database conception to October 29, 2019. Search terms and phrases related to intraosseous injection ("intraosseous access" OR (intraosseous AND ("vascular access" OR "intravascular access" OR "drug administration") OR "intraosseous injection" OR "intraosseous infusion" OR "intraosseous administration" OR "intraosseous delivery" OR "intraosseous line" OR "intraosseous catheter" OR "intraosseous needle" OR "intraosseous device") and children (infant OR newborn OR baby OR neonatal OR perinatal OR child OR children OR boy OR girl OR kid OR adolescent OR pediatric OR juvenile OR teen OR youth) were combined to identify relevant studies. Keywords, keyword variants, and associated MeSH terms, Emtree terms, or CINAHL subject headings were used as appropriate. Search results were limited to English-language articles using built-in database filters. The search strategy was designed and implemented by a medical librarian. The complete process is depicted in Figure 2.

Inclusion/Exclusion Criteria

Inclusion Criteria

- English-Language
- Original data on IO use
- Human pediatric (<18 years old) patients
- Mention of presence or absence of complications identified during care of patient

Exclusion Criteria

- Postmortem, cadaver, or animal studies
- Dentistry, oral-maxillofacial surgery, or sterile operative settings

Study Screening

After de-duplicating the search results, studies underwent two rounds of screening based on their (1) title and abstract and (2) full text. In each round, studies were screened by two independent reviewers, and conflicts were resolved through discussion and consensus. Both rounds of screening were conducted using Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia).

Data Extraction

Data on article characteristics, patient characteristics, and reported complications were extracted from the included studies by two independent reviewers, and inconsistencies were resolved through discussion and consensus. Complications include, but are not limited to, pain, extravasation, compartment syndrome, skin and soft tissue infections, tissue necrosis, osteomyelitis, fat or marrow embolism, bone fractures, and device failure.

IO Review Process

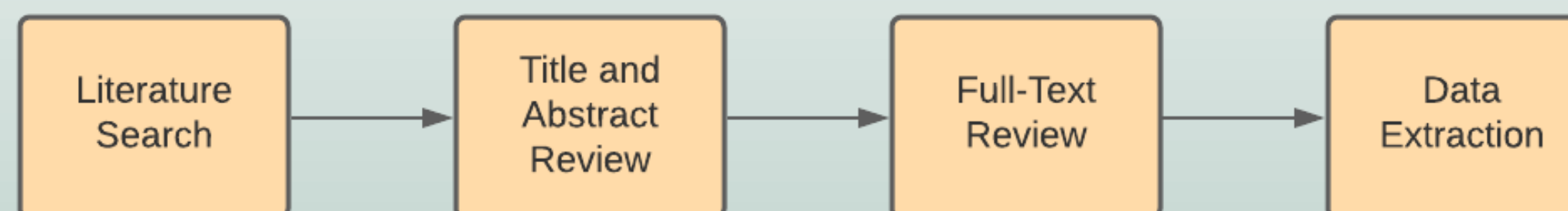


Figure 2. Flowchart depiction of the process implemented for the systematic review. All articles identified during the literature search were uploaded into Covidence, and duplicates were removed. Articles that met the inclusion criteria moved on to the full-text review phase. Articles that met the exclusion criteria did not move on. Articles similarly moved on to the data extraction phase based on the inclusion and exclusion criteria.

RESULTS

Our initial literature search yielded 1,647 studies which were imported into Covidence. 762 duplicates were automatically removed by Covidence. This left 885 studies for title and abstract screening. 462 studies were excluded based on the inclusion and exclusion criteria. The remaining 423 studies moved on to the full-text review phase, which is currently ongoing. Thus far, 66 additional studies have been excluded, and 102 studies have been identified for data extraction. 528 studies in total have been excluded (Figure 3). The most common reasons for exclusion thus far are lack of original data, no mention of complications, and mixed adult and pediatric data.

IO Review Results

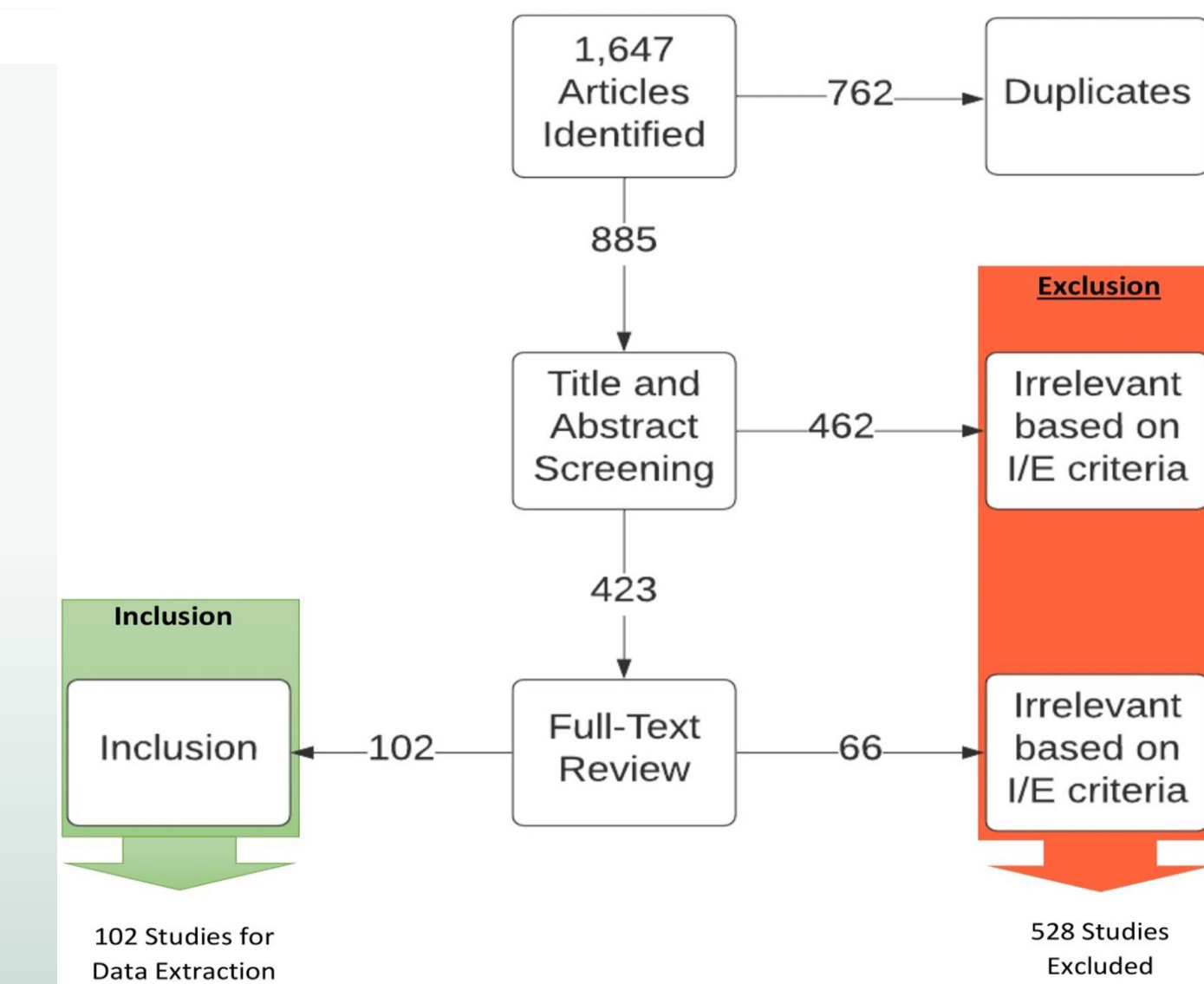


Figure 3. Current progress of the review. Numbers above arrows indicate how many articles fell into the following category. The left side of the image enclosed in the green box and arrow indicates the total number of articles ready for data extraction. The right side of the image enclosed in the red box and arrow indicates the total number of articles that have been excluded. I/E = inclusion/exclusion.

CONCLUSION

Based upon our preliminary results, there appear to be adequate published reports in the medical literature to support the completion of this project. We expect this systematic review to contribute to an improved understanding of complications associated with pediatric IO infusion.

REFERENCES

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