Intravenous Infusion Route in Maternal Resuscitation: A Scoping Review

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Abstract

Background: The upper extremities can be used as an infusion route during cardiopulmonary resuscitation in pregnant women. This is a reasonable recommendation considering the characteristic circulation of pregnant women, but this method is not based on scientific evidence.

Objective of the Review: We conducted a scoping review to determine whether the infusion route should be established above the diaphragm during cardiopulmonary resuscitation in a pregnant woman.

Discussion: We included randomized controlled trials (RCTs) and non-RCTs on the infusion of fluids in pregnant women after 20 weeks of gestation requiring establishment of an infusion route due to cardiac arrest, massive bleeding, intra-abdominal bleeding, cesarean section, severe infection, or thrombosis. In total, 3150 articles from electronic database were extracted, respectively. After title and abstract review, 265 articles were extracted, and 116 articles were extracted by full-text screening, which were included in the final analysis. The 116 articles included 78 studies on infusion for pregnant women. The location of the intravenous infusion route could be confirmed in only 17 studies, all of which used the upper extremity to secure the venous route.

Conclusion: Pregnant women undergo significant physiological changes that differ from those of normal adults, because of pressure and drainage of the inferior vena cava and pelvic veins by the enlarged uterus. Therefore, despite a lack of evidence, it seems logical to secure the infusion route above the diaphragm when resuscitating a pregnant woman.

Introduction

The Japan Resuscitation Council (JRC) has published resuscitation guidelines in 2010 and 2015, and in the 2020 revision, they plan to create an algorithm for resuscitation of pregnant women. Hence, we decided to create an algorithm for resuscitation of pregnant women as a special situation of cardiac arrest.

Although the number of maternal deaths in Japan is approximately 4 per 100,000 deliveries [1], which is a small number compared to that reported worldwide, it is important to create an evidence-based maternal resuscitation algorithm because there are potentially many pregnancy-related maternal cardiac arrests.

Therefore, we created a clinical question (CQ) from algorithm and 2015 statements of the American Heart Association (AHA). This report is a scoping review of an articles, "In cardiopulmonary resuscitation of pregnant women, should the infusion route be taken above the diaphragm for massive infusion?"

The AHA developed and illustrated an algorithm based on the International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations (CoSTR) [2], which stated that intravenous access should be considered above the diaphragm [3]. This statement makes sense considering the special circulatory dynamics of pregnancy,

but we believe that it needs to be supported by evidence and not by a scientific recommendation based on evidence. Therefore, we decided to conduct a comprehensive review of the maintenance of the infusion route in pregnant women. The purpose of this study was to scientifically support whether the infusion route should be secured above the diaphragm during maternal resuscitation by scoping review.

Methods

The maternal group within the JRC of the Guideline Editorial Committee established the CQ. However, since there are no valid studies on the location of the infusion route during resuscitation of pregnant women, we thought that systematic review would be difficult and decided to conduct a scoping review of all studies on the infusion route for pregnant women.

Protocol and registration

This study was systematized and conducted concerning the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) extension for Scoping Reviews checklist [4].

Eligibility criteria

Only articles published in peer-reviewed journals were included in the review, and those with abstracts only were excluded. Only literatures published in English were included, while articles published in other languages were excluded. Literatures on animals were excluded, and only studies on humans were included. The types of studies included were randomized control trials (RCTs), non-RCTs (such as split time-series analyses, before-and-after comparative studies, cohort studies, case reports, and meta-analyses), case-concentration studies, reviews, and existing guidelines. By contrast, unpublished studies (e.g., conference abstracts and clinical trial protocols) were excluded.

Information sources

Articles published on or before December 07, 2019 were retrieved from MEDLINE/PubMed and Embase. The search strategy was constructed by Marie Furuta, PhD Health Studies, an expert in public health (co-author of this paper).

Search

The search strategy is shown in Supplementary Material 1.

Selection of sources of evidence

Data charting of each literature was performed independently by two reviewers. In pairs sequentially evaluated the titles and abstracts, while screening of full-text articles were performed independently.

Data charting process

Population, concept, and context (PCC) frameworks were created [5], as shown in Table 1. The study was conducted in pregnant women who received fluid infusions after 20 weeks of gestation. As a Concept, RCTs and non-RCTs (split time-series analysis, before-and-after comparative studies, cohort studies, case reports, and meta-analysis) were included in studies of patients requiring intravenous infusion or intraosseous infusion due to cardiac arrest, massive bleeding, intra-abdominal hemorrhage, cesarean section, severe infection, and thrombosis. As a context, a literature search was performed, regardless of the region in which the study was conducted, race, or differences in healthcare systems by medical area. A data-charting form was jointly developed by two reviewers to determine the relevant articles that should be extracted.

Table 1
PCC (Population, Concept, Context) frameworks

Population: A study on the infusion of fluids in pregnant women after 20 weeks of gestation.
Concept: RCT and non-RCT (split time-series analysis, before-and-after comparative studies, cohort studies, case reports, and meta-analysis) were included in studies of patients requiring intravenous infusion or intraosseous infusion due to cardiac arrest, massive bleeding, intra-abdominal hemorrhage, cesarean section, severe infection, thrombosis.
Context: We searched the literature, regardless of the region in which the study was conducted, race, or differences in health care systems by medical area.

Results

Selection of sources of evidence

Figure 1 shows the PRISMA flowchart [6] for this scoping review.

Characteristics of sources evidence

The search for articles was performed on December 07, 2019 based on the search formula described above, and 1194 articles were extracted from MEDLINE/PubMed and 1956 articles were extracted from Embase. After title and abstract review, 265 articles met the eligibility criteria by deduplication and relevance screening. Supplementary Material 2 shows the list of references in which full text screening was conducted. Then, full-text screening was conducted, and 116 references were extracted for the final analysis.

Results of individual sources of evidence

Table 2 presents the details of the breakdown of the 116 articles.

Table 2
General characteristics of included articles.

		Types of literature (n = 116)			
		Caesarean section (n = 78)	Postpartum bleeding (n = 11)	Maternal cardiac arrest(n = 7)	Other complications in pregnancy†(n = 20)
Study design	RCT	54	5	0	6
	Prospective cohort study	15	0	0	2
	Retrospective cohort study	0	1	1	1
	Case control study	0	0	0	0
	Cross sectional study	0	0	0	3
	Case control study	0	0	0	0
	Case report and case series	0	0	4	0
	Meta analysis	3	0	0	0
	other	6	5	2	8
† Reports on the infusion route, including infections, thrombosis, and administration of pressure-boosting drugs in pregnant women					

The 116 articles included (1) 78 studies on the infusion of fluids during cesarean section in pregnant women (3 meta-analyses, 54 RCTs, 15 prospective cohort studies, and 6 others), (2) 11 studies on the infusion of fluids during hemorrhage in pregnant women (5 RCTs, 1 prospective cohort study, and 5 others) 5 RCTs, 1 backward cohort study, and 5 other studies; (3) 7 studies on the infusion of fluids during cardiac arrest in pregnant women (1 backward cohort study, 4 case reports, and 2 other studies); and (4) 20 studies on the infusion of fluids for infection, thrombosis, and other conditions in pregnant women (6 RCTs, 2 prospective cohort studies, 1 backward cohort study, 3 case reports, and 8 other studies). The location of the infusion route (upper or lower extremity) could be confirmed in only 17 studies, all of which used the upper extremity to secure the venous route. Table 3 shows a list of references that mention the infusion route.

Table 3
All references that mention the location of the infusion route

Author	Article type	Published year	Population	Location of the intravenous infusion route
Pouta et al. (13)	Randomized controled trial	1996	Pregnant woman undergoing a cesarean section	Upper extremities
King et al. (14)	Randomized controled trial	1998	Pregnant woman undergoing a cesarean section	Upper extremities
Ngan et al. (15)	Randomized controled trial	2000	Pregnant woman undergoing a cesarean section	Upper extremities
Desalu ei al. (16)	Randomized controled trial	2005	Pregnant woman undergoing a cesarean section	Upper extremities
Ngan et al. (17)	Randomized controled trial	2005	Pregnant woman undergoing a cesarean section	Upper extremities
Ngan et al. (18)	Randomized controled trial	2008	Pregnant woman undergoing a cesarean section	Upper extremities
Nuthalapaty et al. (19)	Retrospective study	2009	Study on infusion for pregnant and postpartum patients	Upper extremities
Chatterjee et al. (20)	Case report	2011	Massive obstetric haemorrhage	Upper extremities
El-Mekawy et al. (21)	Randomized controled trial	2012	Pregnant woman undergoing a cesarean section	Upper extremities
Romdhani et al. (22)	Randomized controled trial	2014	Pregnant woman undergoing a cesarean section	Upper extremities
Cape et al. (23)	Retrospective study	2014	Patients with peripherally inserted central catheter during pregnancy	Upper extremities
Zasa et al. (24)	Randomized controled trial	2015	Pregnant woman undergoing a cesarean section	Upper extremities
Onwochei et al. (25)	Prospective study	2017	Pregnant woman undergoing a cesarean section	Upper extremities
Ngan et al. (26)	Randomized controled trial	2017	Pregnant woman undergoing a cesarean section	Upper extremities

Author	Article type	Published year	Population	Location of the intravenous infusion route
Ngan et al. (27)	Randomized controlled trial	2017	Pregnant woman undergoing a cesarean section	Upper extremities
Ngan et al. (28)	Randomized controlled trial	2018	Pregnant woman undergoing a cesarean section	Upper extremities
Webster et al. (29)	Retrospective study	2018	massive obstetric hemorrhage	Upper extremities

We also conducted a comprehensive search for studies on maternal bone marrow tracts, but no relevant studies were identified. We also conducted a comprehensive search for studies on the maternal intraosseous infusion route, but no relevant studies were identified.

Summary of evidence

As it was difficult to conduct a systematic review, a scoping review was performed. We found some literatures related to the infusion of fluids during surgery and bleeding in pregnant women, including RCTs, but did not find any valid studies related to the infusion route in pregnant women.

Discussion

There are no RCTs on maternal infusion routes; therefore, a systematic review was not possible. This comprehensive scoping review revealed the number of studies mentioning the infusion route in detail is scarce, and the level of evidence for securing the infusion route above the diaphragm is considered small. However, there is no evidence of the adverse effects of securing the infusion route above the diaphragm. Furthermore, the AHA recommendations are supportive, considering the pressure drainage of the inferior vena cava caused by an enlarged uterus in pregnant and nursing women, as mentioned above.

In the 2010 AHA Guideline, Part 12: Cardiac arrest in special situations, it was recommended that the infusion route be secured above the diaphragm [2]. The AHA likely came to this view considering the following special circulatory dynamics of pregnant and nursing women. Significant physiological changes occur in pregnant and nursing women, which differ from those in normal adults. In addition to increasing circulating blood volume up to 50%, decreasing peripheral vascular resistance, and increasing in cardiac output, the enlarged uterus causes pressure drainage of the inferior vena cava and pelvic veins, resulting in partial venous hypertension and edema [7].

It makes sense to secure an infusion route above the diaphragm so that infusions and administered drugs can reach the heart without passing through the distended inferior vena cava [8], and the AHA

recommendation seems reasonable considering the unique circulatory dynamics of pregnant and nursing women.

The problem is that these recommendations are reasonable based on the special circulatory dynamics of pregnant and nursing women, but they are not based on evidence from the literature. Although some studies have suggested that an infusion route below the diaphragm should be avoided because an enlarged uterus pressurizes and inhibits venous return [9], a high-quality RCT of infusion routes during maternal resuscitation seems impossible due to the ethical difficulties of randomization and blinding.

In non-pregnant women, there were three observational studies of adult out-of-hospital cardiac arrest with a total of 34,868 patients comparing the upper and lower extremity infusion routes [10–12]. Compared to the use of the venous route in the upper extremities, the use of the bone marrow route in the lower extremities was associated with worse outcomes such as poor survival, with < 17 patients discharged alive per 1,000 cardiac arrest patients. Thus, although indirect, it is possible that the outcome of cardiac arrest may be better if the infusion route is secured through the upper arm.

Conclusion

Pregnant women undergo significant physiological changes that differ from those of normal adults, because of pressure and drainage of the inferior vena cava and pelvic veins by the enlarged uterus. Therefore, despite a lack of evidence, it seems logical to secure the infusion route above the diaphragm when resuscitating a pregnant woman.

Declarations

Ethics approval and consent to participate

Not applicable.

Concent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interest.

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Author contributions

EN, ST, SM, HT, and AS are conceived the study design.

Methodology are constructed by MF and AS.

Formal analysis and investigation were performed by EN, ST, and MF.

Review and editing were performed by EN and ST.

All authors read and approved the final manuscript.

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Figures

Figure 1

PRISMA flowchart of the study

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