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Complications Of Peripheral IV Catheterization In Neonates: A Systematic Review

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INFORMASI

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ABSTRACT

Peripheral intravenous catheterization in neonates often results in complications associated with their condition as vulnerable population. Common complications of IV catheterization include infiltration, extravasation, phlebitis, leakage, or even vascular infection which may lead to death among neonates. Complications of peripheral IV catheterization are still being investigated in studies in order to identify the incidence and risk factors.

Objective: This systematic review aimed to identify complications of peripheral intravenous catheterization in neonates and its risk factors

Methods: Literature searching involved databases such as Science Direct, Scopus, EBSCOhost and SAGE Journals for articles published between 2009-2018 with key words of peripheral intravenous; complication; phlebitis; neonates; risk factor; and infusion therapy.

Results: 7 articles addressing peripheral IV catheterization in neonates were included in analysis, revealing three most frequent complications include infiltration, extravasation, and phlebitis. Various factors may affect it.

Conclusion: Complication incidence (more than 60%) suggested that the phenomenon is an issue that should be immediately addressed since neonates are part of vulnerable population. It is imperative to continue investigating further in order to identify the incidence and factors affecting it.

BACKGROUND

Insertion of peripheral intravenous catheter (peripheral infusion) is the most common invasive procedure in neonatal care. Majority of neonates, especially those with high risk and are admitted in intensive unit, require intravenous access which is regarded as fundamental instrument (Beall, Hall, Mulholland, & Gephart, 2013; Danski, Mingorance, Johann, Vayego, & Lind, 2016; Ramasethu, 2008; Stok & Wieringa, 2016; Unbeck, Förberg, Ygge, Ehrenberg, & Petzold, 2015; Van Haltren et al., 2018). Intravenous catheterization in neonates are mostly aimed for administration of medications, nutrition, and blood sampling (Unbeck, Förberg, Ygge, Ehrenberg, & Petzold, 2015; Beall et al., 2013). Peripheral intravenous catheterization may lead to a number of local complications including infiltration, extravasation, thrombosis, phlebitis, thrombophlebitis, hematoma, and local infection (Danski et al., 2016). Complications associated with peripheral IV catheterization may result in a serious health issue, tissue injury, pain, infection, and loss of more tissues or even higher morbidity (Danski et al., 2016, Unbeck, Förberg, Ygge, Ehrenberg, & Petzold, 2015, Beall et al., 2013).

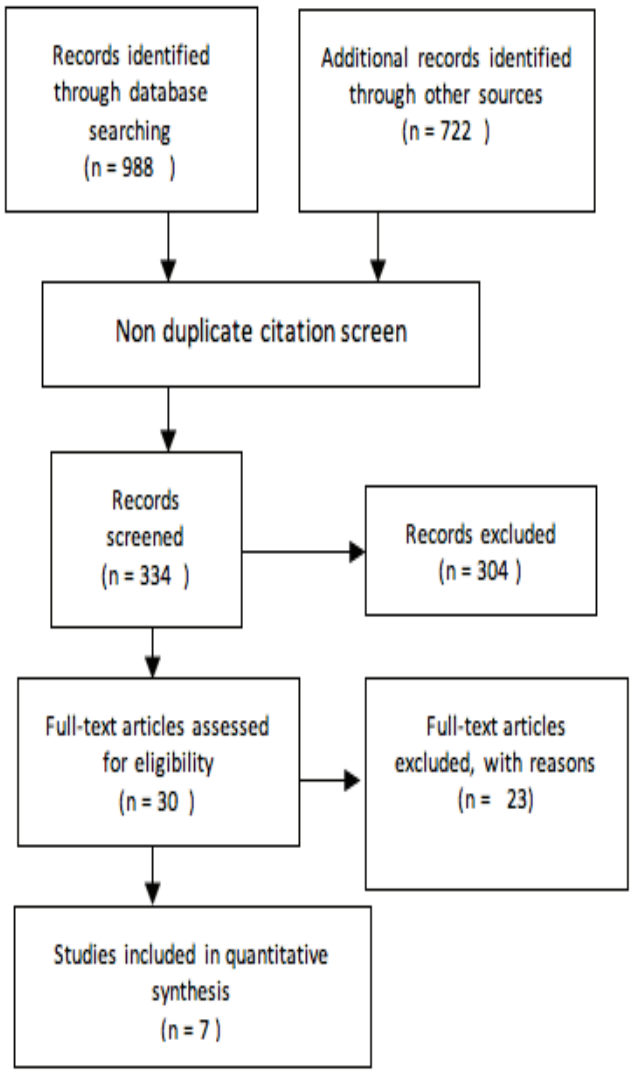
Insertion of peripheral intravenous catheter in newborns offers a complex challenge for nurses due to distinctive features of vein in newborns in comparison to child's and adult's vein. Newborn's veins are rather delicate, less flexible, sensitive, smaller in size, and more vulnerable in terms of physiological and clinical (Danski et al., 2016; Unbeck et al., 2015; Van Haltren et al., 2018). Neonate's small and delicate vein may complicate in catheter insertion and is susceptible to change in pH and osmolality (Tandale, Dave, Garasia, Patil, & Parelkar, 2017). There is a greater risk for complications associated with peripheral IV catheterization among low birth weight infants due to poor quality of vein integrity and flexible subcutaneous tissues (Van Haltren et al., 2018). It demands greater concern in its implementation to prevent undesirable effects. Therefore, it is imperative to conduct a review in order to identify complications associated with peripheral intravenous catheterization and its risk factors.

METHOD

Literature searching was performed from October, 25th to Oktober, 30th 2018 by involving several electronic databases. The searching process involved Science Direct, Scopus, EBSCOhost and SAGE Journals for literatures published in English by using following key words: *peripheral intravenous; complication; phlebitis; neonates; risk factor; infusion therapy.* Articles addressing insertion of peripheral infusion were included; however, only studies addressing complications of IV catheterization were reviewed. Time of article publication was limited within last 10 years, 2009-2018. The inclusion criteria of this review were neonates with IV catheter and admitted in hospital. The exclusion criteria were neonates with congenital malformation.

Seven articles pertinent to the topic were identified following the searching process which involved Science Direct, Scopus, EBSCOhost, and SAGE Journals databases. Three out of seven articles applied prospective observational study approach; two studies applied cohort method; one study applied randomized control trial; and one study applied cross-sectional method.

Figure 1. PRISMA Flow Diagram



RESULT

Complications of IV Catheterization

Most of studies described common complications of IV catheterization are extravasation/infiltration and phlebitis with various factors affecting it. Several articles did not exclude infiltration and extravasation incidence in calculating the incidence since their clinical manifestations were difficult to distinguish. The complications of intravenous catheterization were more common in newborns rather than pediatrics (Unbeck et al., 2015).

Legemaat et al., (2016) revealed that complications of intravenous catheterization in neonates were mostly infiltration (56%) (n = 193; 67%), leakage (18%), and occlusion (5,2%) with unknown causes (29%). Unbeck et al., (2015) reported that one third out of 484 neonates (35,4%) had their IV catheter removed due to complications. The most frequent complications include infiltration (51.9%) and occlusion (48.9%). A study conducted by Serane and Kothendaraman (2015) reported that there were 60% cases of local complications associated with IV catheter insertion and 3.2% cases of phlebitis. Danski et al. (2016) revealed that 63.15% of neonates involved in their study were affected by complications associated with IV catheterization The complications included infiltration/extravasation (69.9%), phlebitis (17.84%) and occlusion (12.27%). Chin et al. (2018) conducted a study on 113 newborns and presented that 60% of neonates with peripheral IV catheterization were affected by extravasation. The incidence of complications associated with IV catheterization in neonates were up to 28,7% (Birhane et al., 2017). Stok and Wieringa (2016)described that complications related to continuous peripheral intravenous catheterization are infiltration (27%), phlebitis (8%), occlusion (6%), and removed due to manipulation (2%). Based on the previous studies, it can be assumed that the complication incidence ranges between 35.4% and 63.15%.

Table 1. Complications associated with IV catheter insertion in neonates

Characteristic	Frequency (%)
Infiltration	27 – 67
Extravasation	6 – 69,9
Phlebitis	3,2 – 17,84
Occlusion	12,27 – 48,9
Germs colonization	14,2

Factors affecting complications of IV catheterization in neonates

Age is among the factors affecting complications of IV catheterization in neonates. The younger a newborn during IV catheterization, the higher his risk for complication (Unbeck et al., 2015). Unbeck et al. (2015) reported that the complication incidence in neonates (49,4%) was significantly higher than pediatrics (31%). Age factor was also correlated with body weight, in which newborn with weight lower than 1500 gram was more likely to be affected by the complication than newborn with weight over 1500 gram (30,11%), (Danski et al., 2016).

Site of insertion is another factor affecting complications of IV catheterization. Two studies indicated the role of insertion site on complications associated with peripheral infusion in neonates. Unbeck et al., (2015) concluded that complication incidence was significantly correlated with insertion in ankle (OR 5.00 dan 3.50) or feet (OR 3.47 dan 1.99). Birhane et al. (2017) indicated that insertion through arms was able to significantly reduce duration of IV catheter durability without causing any complication. On the other hand, a study conducted by (Serane & Kothendaraman, 2015) suggested that insertion site had no significant association with complication of infection among newborns with peripheral infusion.

Periodical replacement of IV catheter is widely recognized to be able to reduce complications of IV catheterization. However, Chin et al. (2018) reported that periodical replacement (following IV catheterization for 72 to 96 hours) did not significantly reduce complications associated with IV catheterization, in fact, the risk for leakage somehow increased. The result confirmed the previous notion stating that effectiveness of regular replacement of IV catheter as a strategy to reduce intravascular infection is yet to be proven (Rickard, C., 2012).

The influence of health professional's clinical experience in IV catheterization on durability of infusion without resulting any complication is an intriguing variable to be investigated. Nurses with clinical experience 3 to 5 years were reported to affect longer durability of IV catheterization without causing any complication (Birhane et al., 2017). Another study reported different conclusion suggesting that there was no significant correlation between complications of peripheral IV catheterization and the subject's discipline (intravenous therapy nurses, medical specialist or resident). The resident group (individual attending medical specialty education and lacking in experience) was reported to have a significant association with success rate of IV catheterization (Legemaat et al., 2016). Furthermore, Serane & Kothendaraman, (2015) revealed that any health professionals performing IV catheterization were not correlated with infection incidence in insertion site.

Table 2. Factors affecting complication incidence in neonates

Characteristics	Note
Young gestational age	(OR= 0,97),
Infant's body weight during insertion	p=0,0093
Insertion through ankle	OR 5.00 dan 3.50)
Insertion through feet	(OR 3.47 dan 1.99).
Elective replacement of IV catheterization	P=0,21
Systemic infection	p=0,0192
Type of IV catheter placement: intermittent or continuous	p< 0,0001
Endotracheal tube-inserted	p = 0,0008
Total parenteral nutrition	p=0,0002
Blood transfusion in the same IV line	p=0,0003
Longer duration of catheterization	(OR 1,32),

DISCUSSION

Neonates, as part of vulnerable population, are not capable of verbally communicating their own conditions when afflicted by a disease. Hence, they are very vulnerable to skin injury and complications such as extravasation during IV cannulation procedure within their first two weeks (Beall et al., 2013; Ramasethu, 2008). Intravenous catheterization for newborns admitted in NICU is a common procedure, however, there are only few study studies addressing its process and complication (Legemaat et al., 2016). Study findings indicated several complications associated with IV cannulation including infiltration, phlebitis, and occlusion (Table 1.). These three are the most frequent complications according to various study reports. It confirms Ramasethu's (2008) report that complications of peripheral intravenous cannulation included thrombophlebitis, infection, extravasation, or infiltration of intravenous fluids into subcutaneous tissue.

The consequence of complications associated with IV catheterization in neonates is rather problematic. Infiltration, extravasation, and phlebitis that are not immediately treated may lead to tissue and nerve damage, contracture, necrosis, higher morbidity, longer hospital stay, and higher cost of care (Legemaat et al., 2016; Van Haltren et al., 2018). Mitigating the complications is the only solution to prevent its extensive damage. Nurses are expected to able to provide care and prevent complications associated with peripheral IV cannulation in neonates through comprehensive understanding of its risk factors. There are diverse factors affecting complications of peripheral IV cannulation according to study findings. There are no more than two studies reporting similar factors affecting complications of peripheral IV catheterization in newborns. Hence, this systematic review is unable to complete systematic grouping of all risk factors for comparison purposes.

Factors affecting complications related to PIVC in neonates are quite thought-provoking; however, it is yet to be extensively explored in Indonesia. Among its factors is individual who performs IV catheter insertion; three studies revealed different results. Birhane et al. (2017) reported significant correlation between individual's clinical experience in IV catheterization and lifespan of IV cannula without causing any complication. Contrarily, Serane and Kothendaraman (2015) revealed that individual's experience in IV catheterization did not significantly affect duration of IV cannula placement without resulting any complications. Risk for complications can be reduced through improving clinical experience in IV cannulation. Forming a particular team consisting of professionals from multidiscipline for IV catheterization should be considered (Legemaat et al., 2016).

CONCLUSION

Complications related to peripheral intravenous cannulation in neonates are still a challenging issue in perinatology field. High complication incidence suggests that this issue should be immediately addressed since neonates are part of vulnerable population. There are diverse factors affecting complications associated with peripheral intravenous catheterization; hence, it cannot be systematically assembled for comparison purposes. The reviewed studies indicate discrepancy in findings regarding factors affecting complications. The phenomenon requires further analysis in order to identify specific factor which can be mutually agreed as the factor affecting complication of IV cannulation in neonates. Knowledge regarding risk factors of complication related to IV cannulation in neonates may be applied to prevent such complications. Incidence reporting should be encouraged.

Table 3. List of studies on complications associated with peripheral IV catheterization and its risk factors

No	Title	Author	Publication Year	Location	Objective	Method	Inclusion Criteria	Exclusion Criteria	Result	Conclusion
1	Peripheral venous catheter related complications are common among paediatric and neonatal patients	M Unbeck, U F € o r b e r g , B-M Ygge, A E h r e n b e r g , M Petzold, E Johansson	2014	Sweden	To describe characteristics of peripheral venous catheter, time of insertion, causes of removal and explore causes of complications associated with p e r i p h e r a l i n t r a v e n o u s catheterization	P r o s p e c t i v e observational study	N e o n a t e s with IV catheterization who were a d m i t t e d in various pediatric units	Neonatus with more than one IV cannula or i n c o m p l e t e documentation	35,4% of cannula were removed due to complications of insertion (infiltration and occlusion). Lifespan of cannulation among neonates was shorter than among pediatrics. Infiltration mostly occurred among younger newborns	C o m p l i c a t i o n s associated with PVC, especially infiltration and occlusion, most likely to affect hospitalized children, however, the risk decreases as the age increases
2	P e r i p h e r a l i n t r a v e n o u s c a n n u l a t i o n : c o m p l i c a t i o n rates in the n e o n a t a l p o p u l a t i o n : a multicenter o b s e r v a t i o n a l study	Legemaat, M., Carr, P. J., Rens, R. M., Dijk, M.	2016	Netherlands	To describe i n c i d e n c e , complications, and factors related to p e r i p h e r a l i n t r a v e n o u s cannulation	P r o s p e c t i v e observational study	Neonates with PIVC in NICU	Neonates with c o n g e n i t a l v a s c u l a r malformation and total body cooling for HIE which interfered with venous access	The main cause of PVC removal prior to the due time was infiltration.	P r i m a r y complications of PVC placement was infiltration. It requires strategy to identify and prevent infiltration during PVC placement in NICU.
3	Incidence of local c o m p l i c a t i o n s and risk factors associated with p e r i p h e r a l i n t r a v e n o u s catheter in neonates	Mitzy Tannia R e i c h e m b a c h Danski1 , Priscila M i n g o r a n c e 1 , Derdried A t h a n a s i o Johann1 , Stela Adami Vayego1 , Jolline Lind	2013	Brazil	To evaluate the c o m p l i c a t i o n incidence related to peripheral i n t r a v e n o u s catheterization in neonates and identify its risk factors	Observational, cohort study	Newborns with PIVC who were admitted in NICU	Newborns with PIVC who were just discharged or had its IV catheter removed after the study was over	63,15% of complications were infiltration/ extravasation, 17,8% were phlebitis, and 12,27% were obstruction. The risk factors included infection, body weight during cannula insertion, type of infusion, endotracheal intubation, total parenteral nutrition, and blood transfusion	C o m p l i c a t i o n s frequently occurred due to peripheral i n t r a v e n o u s cannulation. Its risk factors included infection, body weight, medication and fluid for infusion, and type of infusion.

4	Elective replacement of intravenous cannula in neonates—a randomised trial	Li Yen Chin1 & Timothy A. Walsh1 & Karen Van Haltren1 & Laura Hayden1 & Miranda Davies-Tuck2 & Atul Malhotra	2018	Australia	To identify extravasation rate among neonates with elective replacement of PIVC compared with standard practice	Randomized Control Trial	Infants who were born at > 32 weeks and had IV cannulation > 72 hours	Newborn who required more than one PIVC simultaneously, central venous catheter, or did not require PIVC for 72 hours	Newborns with elective PIVC had lower complication incidence than newborns in control group.	Elective replacement of PIVC in neonates had no significant correlation with lower extravasation rate
5	Lifespan and associated factors of peripheral intravenous Cannula among infants admitted in public hospitals of Mekelle City, Tigray, Ethiopia	Birhane, E., Kidanu, K., Kassa, M., Gerezgiher, D., Tsegay, L., Weldu, B., … Gerensea, H	2017	Birhane	Duration of peripheral intravenous cannulation and factors affecting PIVC in neonates.	Cross sectional	178 newborns admitted in 2 hospitals	Newborns with non-peripheral infusion	More than 50% newborns with PIVC had shorter duration of cannulation (< 30 hours) due to complications. The associated factors included medication, user's experience in IV cannulation, blood transfusion, and insertion site.	There was a high incidence of untimely cannula removal in newborns. User and cannula factors affect duration of IV catheterization.
6	Continuous infusion versus intermittent flushing: maintaining peripheral intravenous access in newborn infants	D Stok and JW Wieringa	2016	Netherlands	To compare duration of peripheral intravenous cannula (PIVC) patency by using continuous infusion with dextrose 5% or intermittent flushing with saline 0,9% and how it affect complication incidence.	Prospective comparative cohort study	Full term infant with PIVC for antibiotic medication and consent from the parents.	Neonates with central venous catheter and had another type of antibiotics	PIVC patency was similar in duration. Although, the complication incidence was significantly higher in continuous infusion.	Intermittent flushing and continuous infusion had similar PIVC patency; However, complications mostly occurred in continuous infusion.
7	Incidence and Risk factors of infections associated with peripheral intravenous catheters	Serane, T., & Kothendaraman, B. Serane	2016	India	To evaluate bacterial colonization in peripheral IV catheterization and its risk factors	Prospective observational clinical study	Newborns with peripheral infusion and minimal duration of 12 hours	Newborns with non-peripheral infusion (central) and parents who refused to let their infants being involved in the study	134 out of 154 cases of IV cannulation were removed due to swelling. 22 of it contained germs in the insertion site. Systemic infection was the primary factor affecting the complication.	Proper peripheral intravenous catheterization may reduce complication incidence.

REFERENCES

Beall, V., Hall, B., Mulholland, J. T., & Gephart, S. M. (2013). Neonatal extravasation: An overview and algorithm for evidence-based treatment. *Newborn and Infant Nursing Reviews*, *13*(4), 189–195. https://doi.org/10.1053/j.nainr.2013.09.001

Birhane, E., Kidanu, K., Kassa, M., Gerezgiher, D., Tsegay, L., Weldu, B., … Gerensea, H. (2017). Lifespan and associated factors of peripheral intravenous Cannula among infants admitted in public hospitals of Mekelle City, Tigray, Ethiopia, 2016. *BMC Nursing*, *16*(1), 1–8. https://doi.org/10.1186/s12912-017-0227-1

Danski, M. T. R., Mingorance, P., Johann, D. A., Vayego, S. A., & Lind, J. (2016). Incidence of local complications and risk factors associated with peripheral intravenous catheter in neonates. *Revista Da Escola de Enfermagem*, *50*(1), 22–28. https://doi.org/10.1590/S0080-623420160000100003

Legemaat, M., Carr, P. J., Van Rens, R. M., Van Dijk, M., Poslawsky, I. E., & Van den Hoogen, A. (2016). Peripheral intravenous cannulation: Complication rates in the neonatal population: A multicenter observational study. *Journal of Vascular Access*, *17*(4), 360–365. https://doi.org/10.5301/jva.5000558

Ramasethu, J. (2008). Complications of vascular catheters in the neonatal intensive care unit. *Clinics in Perinatology*, *35*(1), 199–222. https://doi.org/10.1016/j.clp.2007.11.007

Rickard, C. M., Webster, J., Wallis, M. C., Marsh, N., McGrail, M. R., French, V., … Whitby, M. (2012). Routine versus clinically indicated replacement of peripheral intravenous catheters: a randomised controlled equivalence trial. *The Lancet*, 380(9847), 1066–1074. doi:10.1016/s0140-6736(12)61082-4

Serane, T., & Kothendaraman, B. (2015). Incidence and risk factors of infections associated with peripheral intravenous catheters. *Journal of Infection Prevention*, *17*(3), 115–120. https://doi.org/10.1177/1757177416631415

Stok, D., & Wieringa, J. W. (2016). Continuous infusion versus intermittent flushing: Maintaining peripheral intravenous access in newborn infants. *Journal of Perinatology*, *36*(10), 870–873. https://doi.org/10.1038/jp.2016.94

Tsai, M.-H., Chu, S.-M., Lien, R., Huang, H.-R., Wang, J.-W., Chiang, C.-C., … Huang, Y.-C. (2011). Complications Associated with 2 Different Types of Percutaneously Inserted Central Venous Catheters in Very Low Birth Weight Infants. *Infection Control & Hospital Epidemiology*, *32*(03), 258–266. https://doi.org/10.1086/658335

Unbeck, M., Förberg, U., Ygge, B. M., Ehrenberg, A., & Petzold, M. (2015). Peripheral venous catheter related complications are common among paediatric and neonatal patients. *Acta Paediatrica, International Journal of Paediatrics*, *104*(6), 566–574. https://doi.org/10.1111/apa.12963

Van Haltren, K., Malhotra, A., Walsh, T. A., Chin, L. Y., Davies-Tuck, M., & Hayden, L. (2018). Elective replacement of intravenous cannula in neonates—a randomised trial. *European Journal of Pediatrics*, *177*(11), 1719–1726. https://doi.org/10.1007/s00431-018-3234-7