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Incidence of complications of peripheral intravenous cannula use in children admitted to Port Moresby general hospital: A prospective, observational study

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Abstract
Peripheral intravenous cannulas (PIVCs) are used for administration of medications and fluids in sick children but their use can result in complications. This prospective study was conducted from June to October 2020 at Port Moresby General Hospital in Papua New Guinea. Children who were admitted to the paediatric wards requiring PIVC insertion were regularly monitored to check for complications. Three hundred and thirty PIVCs were inserted in 104 paediatric patients. Eighty six (83%) of the 104 children had at least one PIVC complication which occurred in 220 (67%) of the 330 PIVCs assessed. Tissue infiltration was the commonest complication, occurring in 60% of the PIVCs, followed by phlebitis (29%), cannula obstruction (6%) and leaking (4%). Skin ulceration occurred in 1%. Larger gauge cannulas were more than twice as likely to be associated with complications as smaller gauge cannulas and administration of both medications and fluids more likely to result in complications than administration of medications alone. The incidence of PIVC complications of 83% by patient and 67% by cannula is of major concern. Staff should be aware of the risks associated with PIVC, ensure that PIVS are carefully inserted and stabilized and regularly monitored to prevent, detect and manage complications appropriately.

Keywords: Peripheral intravenous cannula, children, complications

Introduction
Insertion of peripheral intravenous cannulas (PIVCs) is one of the most common procedures performed in hospitalised children. More than 80% of patients - both adult and children – undergo this procedure [1]. PIVCs are inserted for administration of intravenous (IV) fluids, drugs, blood and blood products and parenteral nutrition. PIVCs are also inserted in preparation for surgical or imaging procedures and in unstable patients who may require intravenous drugs or other therapy [2]. Complications associated with PIVC include phlebitis (the most common) infiltration/extravasation, obstruction, pain, leaking, dislodgement, local infection, hematoma, skin necrosis and tissue ulceration and blisters [3 -9]. Risk factors for complications include the use of drugs that have vesicant or pro-thrombotic properties. the duration of intravenous (IV) treatment, the use of volume-controlled burettes, inadequate dressing, PIVC in situ beyond 72 hours, insertion at the antecubital fossa and the use of polyvinyl, polyethylene or needle catheters [4-10].
Measures to reduce complications include aseptic skin preparation, dressing and stabilisation with sterile gauze or tape, saline infusion prior to infusion of medication frequent observation, to detect and manage problems and the use of good quality Teflon catheters [1, 9].
To our knowledge, there are no published studies on the complications of PIVCs in children in Papua New Guinea. The aim of the study was to determine the type and frequency of complications and adverse events associated with PIVC use in children admitted to Port Moresby General Hospital (PMGH).

Methods
This was a prospective, observational study conducted at the paediatric department of the PMGH between the 2nd of June 2020, and the 30th of October 2020. PMGH is the country's major referral centre. The paediatric department consists of two general wards, one TB ward, one malnutrition ward, one oncology ward and the special care nursery and children's emergency department (CED).

Excluding the Special Care Nursery the wards have a bed capacity of around 120 with around 3000 admissions annually. The study population comprised children aged from 8 days to 13 years admitted to the paediatric wards. Children who had a PIVC in situ on admission or had had IV treatment at CED for more than 24 hours before admission were excluded.

Convenience sampling was used to recruit either on the day of admission or within 24 hours of admission. The child's age, sex, diagnosis, nutritional status, and human immunodeficiency virus (HIV) status was recorded.

PIVC - related data gathered were the type and gauge of PIVC; date and site of insertion; type of plaster used; intravenous fluid (IVF), method and rate of administration; drugs, doses and method of administration (infusion or direct injection); date and reason for PIVC removal, and reinsertion site.

Patients were followed up daily until discharge, or until their PIVCs were removed. Each PIVC site was inspected for swelling, redness, necrosis and leaking; and was also palpated for pain. If a patient's PIVC was changed before the daily follow-up, the patient's guardian was asked why it was changed and the reason was documented. The patient's chart was then checked for documentation of the reason for PIVC removal, number of attempts at PIVC reinsertion, the new insertion site and time of insertion.

Complications were divided into mechanical (obstruction and leaking) and clinical (extravasation, phlebitis and ulceration or tissue necrosis). Dislodgement of the PIVC was not regarded as a complication. PIVCs that developed a complication noted by the primary researcher were removed and replaced if indicated.

The primary outcome was the incidence of complications associated with PIVC use. Secondary outcomes were the association of possible risk factors with complications.

The data were analysed using Epi Info version 7 and Open Epi. Percentages and frequencies were calculated for categorical data and mean and standard deviation for continuous data. Using univariable analysis, odds ratios with 95% confidence intervals assessed association between possible risk factors and complications.

Results

One hundred and four (23%) of the 447 admitted patients during the study period were recruited. Among these 104, 330 PIVCs were inserted. The gender and ages of the children are shown in Table 1.

Table 1: Age and gender of study participants. n = 104 patients.

		Number	%
Gender	Male	53	51
	Female	51	49
Age	< 29 days	10	10
	29 days – 1 year	50	48
	> 1 year – 5 years	27	26
	> 5 years	17	16

Many children had more than one diagnosis (e.g. malnutrition, acute gastroenteritis and dehydration). Malnutrition, acute lower respiratory infection, acute gastroenteritis, dehydration, tubercules, HIV and neonatal sepsis were the commonest indications for PIVC accounting for 63 of the documented diagnoses. Details of the PIVCs are shown in Table 2.

Table 2: Characteristics of inserted PIVCs, sites of insertion, type of plaster used, PIVC lifespan and PIVC outcome. n = 330

	No.	(%)
PIVCs inserted		
Total	330	
Mean (SD) per child	3.17±1.89	
Range	1 - 11	
PVC Gauge		
20 FG (pink)	2	1
22 FG (blue)	112	35
24 FG (yellow)	164	50
26 FG (purple)	52	16
Site of insertion		
Dorsum of foot	33	10
Ankle	46	14
Dorsum of hand	32	10
Wrist	176	53
Forearm	16	5
Antecubital fossa	20	6
Others	7	2
Plaster used to secure PIVC		
AcoPore	0	0
With reinforced gauze bandage	22	7
Without reinforced gauze bandage	5	1
Leukoplast		
With reinforced gauze bandage	240	73
Without reinforced gauze bandage		
Mediplast		
With reinforced gauze bandage	4	1
Without reinforced gauze bandage	27	8
Tensoplast		
With reinforced gauze bandage	0	0
Without reinforced gauze bandage	32	10
PIVC lifespan (days)		
Mean	1.72	
Range	0 – 7	
PIVC outcome		
Developed complication	222	67
No complication	108	33

Legend: FG = French gauge; PIVC=peripheral intravenous cannula; SD=standard deviation

The Plusflon™ brand of PIVC (Mediplus India Limited) was used in all cases. Four different brands of occlusive plasters were used to secure PIVCs: Leukoplast® (Beiersdorf Hamburg, Germany), Tensoplast® (BSN Medical Inc Charlotte, NC, USA), Mediplast® (Subham Pharmaceuticals Hooghly, West Bengal, India), and AcoPore® SMA Rouse Hill, NSW, Australia).

Size 24 French Gauge (FG) was the most common PIVC size used [n =164 (49%)]. As there were only 2 size 20 FG PIVCs inserted during the study period, they were not included in the calculations. 71% of the PIVCs were secured with Leukoplast without reinforced gauze bandage.

616 drug doses were administered through the 330 PIVCs. The mean (SD) number of drugs per PIVC was 1.88 (0.84). Gentamicin, benzyl penicillin, flucloxacillin and ceftriaxone accounted for 68% of the drug doses administered.

Normal saline, normal saline with 5% dextrose, normal saline with added KCl and Ringers Lactate with KCl were administered in 88% of infusions. Burettes were used in 75% and infusion pumps in 25% of infusions.

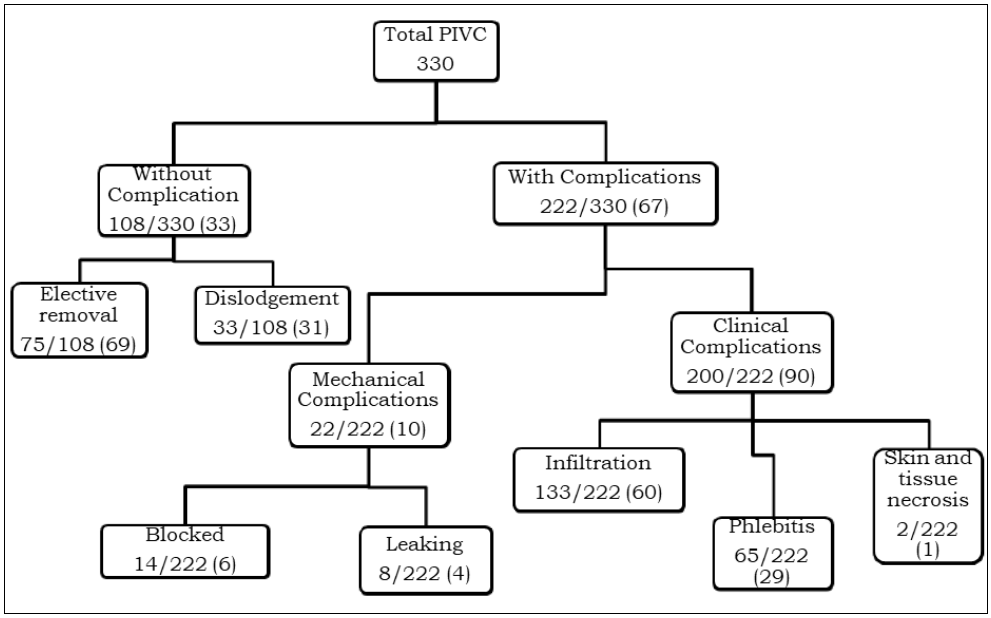

Fig 1: (below) shows the complications of the PIVCs studied.

Cannula related complications occurred in 83% of the 104 children, and 220 (67%) of the PIVCs developed complications. Twenty-two (10%) PIVCs had a mechanical complication - 6% developed blockage, and 4% developed leaking. 200 (90%) developed a clinical complication; skin or soft tissue infiltration or extravasation was the most common occurring in 133 (60%). Sixty five (29%) were removed because of phlebitis and 2 (1%) were removed due to tissue necrosis. Of the 222 PIVCs that had complications, 156 (71%) were identified by the respective home teams while 64 (29%) were identified by the primary researcher.

Table 3 shows the data for the association of possible factors with

Table 3: Possible risk factors for complications of PIVC.

Factor	Comparison	Odds Ratio	95% Confidence interval
Gender	Males vs Females	0.8	0.23-2.26
Age	≤12months vs >12months	0.49	0.15-1.63
Nutritional Status	Under vs Well nourished	2.68	0.76-12.3
PIVC Gauge	22 vs 24*	2.06	1.2-3.6
	22 vs 26**	2.54	1.24-5.2
Insertion Site	Upper vs lower limb	1.5	0.85-2.52
	Wrist vs antecubital fossa	0.53	0.15-1.6
Plaster type	Leukoplast vs others	1.38	0.84-2.27
Infusion Method	Burette vs infusion pump	0.51	0.14-1.60
Number of Drugs	≤2 vs ≥3***	0.55	0.27-1.08
PIVC Order	First vs Second	1.16	0.62-2.14
	First vs Third	1.61	0.82-3.16
	First vs Subsequent	1.09	0.57-2.06
PIVC duration	≤ 1 day vs 2 days	1.09	0.64-1.84
	≤ 1 day vs 3 days	1.33	0.61-2.85
	≤ 1 day vs ≥ 4days.	1.86	0.76-4.41
IV Fluid	N. saline/5% dextrose vs others	1.66	0.66-4.15
Drugs administered	Drugs vs Drugs + Fluids****	0.5	0.28-0.86

Fisher Exact *p=0.01 **p=0.02 ***p=0.11 ****p=0.01

Size 22 FG catheters were significantly more likely than either size 24 or 26 to be associated with complications. Compared with size 26 gauge PIVCs they were more likely to develop clinical complications (tissue infiltration, phlebitis or tissue or skin necrosis (OR 3.24 [1.64-6.50]).The number of drugs administered (less than 3 compared with 3 of more) appeared to be important although the difference did not quite reach significance (OR 0.55 [0.27-1.08]). PIVCs used for administration of both drugs and IV fluids were more likely to develop complications than those used for drug administration alone.

Discussion

Comparing PIVC complication rates between studies is difficult because of different definitions, different methods of ascertaining and reporting complications, and different patient populations, ages and settings. Complications occurred in 83% of the children cannulated with one or more PIVCs. This alarmingly high incidence is approximately 2.5 times higher than the 34% found in a recent systematic review and meta-analysis of 32 studies [1]). Similarly, the incidence of complications per PIVC inserted was higher (67%) compared with other studies on paediatric populations which reported incidences of 16% -51.9% [12-14]

Infiltration of the skin or subcutaneous tissue with intravenous fluid or drugs comprised 60% of the clinical complications, higher than the 10% to 33% found in other studies [7, 8, 12, 13].

Phlebitis was the second most common clinical complication with an incidence of 29%. This is approximately 6 times higher than the Infusion Nurse Society's recommended benchmark rate of no more than 5% [15].

There were two cases of skin necrosis, the most severe complication observed.

Obstruction was the commonest mechanical complication in our study, with an incidence of 6% - the same as that found in a systemic review and meta-analysis [11] but approximately twice that reported from an Australian children's emergency department [3].

Leaking from the catheter or insertion site without tissue extravasation made up 4% of the complications in our study. Only one other study reported leaking as a PIVC complication [11].

PIVC gauge was significantly associated with complications. The FG22 gauge PIVC had a greater risk of complications than either the FG24 or FG26. This was a surprising finding for which there may be several explanations. There were several potential confounders, such as the duration of insertion and specific drugs administered but our study data did not allow for multivariate analysis. The larger gauge PIVCs are less flexible and perhaps more likely to traumatize the veins than the smaller gauge. Older children with the larger catheters may have moved more than smaller children with an increased chance of dislodgement In contrast to our findings other studies have reported an increased risk of complications with smaller than with larger catheter size [7, 13].

Administering less than 3 drugs was associated with a lower risk of complications than administering 3 or more – although this did not quite reach statistical significance (OR 0.55 [0.29-1.08]). PIVCs used for administering of both medication and fluids were more likely to develop complications than those used solely for administration of medication.

Age, nutritional status, PIVC insertion site, IV fluid type, infusion rate and infusion method, and PIVC indwell time were not associated with development of complications. These findings are consistent with some but not all similar studies. The risk of developing a complication with the first PIVC inserted was the same as that of the second, third and subsequent PIVCs a finding similar to the CATHEVAL study [4]. Other studies, however, reported that the risk of PIVC complications increased with the number of PIVCs inserted [7, 10].

Limitations

There were several limitations to this study. Data were missing from some of the patients' charts. Most of the PIVCs were inserted by nurses. Nurse to patient ratio varied from 1:10 during morning shifts to 1:30 or 1:40 during night shifts. It is unrealistic to expect detailed documentation of every procedure or meticulous attention to PIVCs in these circumstances; PIVCs were inserted by different cadres of health workers, including medical students, with varying experience. Whilst this might be expected to affect the outcome we have no evidence from this study that this was the case.

Some patients were not followed up for 24-48 hrs after PIVC removal; thus, the true incidence of post PIVC removal phlebitis could not be determined.

Conclusion

The incidence of PIVC complications in the paediatric department of PMGH is unacceptably high. It is the responsibility of the clinical team to ensure that the PIVC is inserted correctly, to observe it closely for the development of complications, and to ensure it is not left in situ unnecessarily.

Recommendation

Inspection of the PIVC site should be a routine and regular part of the assessment of each child for both Nursing and Medical staff. PIVCs which have developed complications should be immediately removed. Decisions to reinsert a PIVC will depend on the requirements for continuous placement.

References

1. Waitt C, Waitt P, Pirmohamed M. Intravenous therapy. Postgraduate Medical Journal 2004;80:1- 6.
2. Datta S. Hanning CD. How to inset a peripheral venous cannula, Br J Hosp Med 1990;43:67-69.
3. Simin D, Milutinovic D, Turkulov V, Brkic S. Incidence, severity and risk factors of peripheral intravenous cannula-induced complications: An observational prospective study. J Clin Nurs 2019;28:1585-1599.
4. Danski MTR, Minogrance P, Johann DA, Vayego SA, Lind J. Incidence of local complications and risk factors associated with peripheral intravenous catheter in neonates. Rev Esc Enferm USP 2016;50(1):22-28. Doi: http://dx.doi.org/10.1590/S0080-623420160000100003.
5. Abolfotouh MA, Salam M, Bani-Mustafa A, White D, Balkhy H. Prospective study of incidence and predictors of peripheral intravenous catheter-induced complications. Ther Clin rRsk Manag 2014;10:993-1001. https//doi:10.2147/TCRM.S74685
6. Machado AF, Pedeira MLG, Chaud MN. Adverse events related to the use of peripheral intravenous catheter in children according to dressing regimen. Rev Latino-am Enfermagem 2008;16(3):362-367.
7. Ben Abdelaziz R, Hafsi H, Hajji H, Boudabous H, Chehida AB, Mrabet A *et al.* Peripheral venous catheter complications in children: predisposing factors in a multicentre prospective cohort study, BMC Pediatr 2017. doi.org/10.1186/s12887-017-0965-y
8. Malyon L, Ullman AJ, Phillips N, Young J, Kleidon T, Murfield J, Rickard CM Peripheral intravenous catheter duration and failure in pediatric acute care: a prospective cohort study. Emergency Medicine Australasia 2014;26:602-608. https://doi.org/10.1111/1742-6723.12305
9. Miliani K, Thillard D, Chauvin V, Martin E, Astagneau P. CATHEVAL study group, Peripheral venous catheter-related adverse events: evaluation from a multicentre epidemiological study in France (the CATHEVAL project), PLoS ONE 2017;12:1-17.
10. Chan C, Leung S, Ho S, Choi K, Ip W. Dwell time of peripheral intravenous catheter and its association with the risk of infiltration, phlebitis, and pain in pediatric

patients, The Journal of Pain 2012. https://doi.org/10.1016/j.pain.2012.01.030.
11. Indarwati F, Matthew S, Munday J, Keogh S. Incidence of peripheral intravenous catheter failure and complications in paediatric patients: systematic review and meta-analysis. Intl J Nurs Stud 2019. https://doi.org/10.1016/j.ijnurstu.2019.103488.
12. Jacinto AKL, Avelar AFM, Pedreira MLG. Predisposing factors for infiltration in children submitted to peripheral venous catheterization. Journal of Infusion Nursing 2011;34(6):391-398.
13. Tripi PA, Thomas S, Clebone A, Goldfinger MM and Tobias JD. Peripheral intravenous catheter problems in infants and children presenting for anesthesia and surgery. Middle East Journal of Anaesthesiology 2016;23:411-414.
14. Santos LM, Silva CSG, Machado ES, Almeida AHV, Silva BSM, Avelar AFM. Risk factors for site complications of intravenous therapy in children and adolescents with cancer4, 2020, Revista Brasileira de Enfermagem 2020. https://doi.org/10.1590/0034-7167-2019-0471.
15. Gorski LA. Phlebitis. Infusion Nurses Society, Journal of Infusion Nursing 2006;29:58-59.