

Development of Evidence-based Nursing Practice Guidelines for Peripheral Intravenous Catheter Management in Hospitalized Children and Adult

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Abstract

Aims: The purpose of this study was to report on the development of evidence-based practice guidelines.

Design: Developmental research for practice guidelines.

Methods: The guidelines developmental process was designed according to a procedure provided by Scottish Intercollegiate Guidelines Network (SIGN). A first step, key clinical questions were selected. Next, 74 studies were selected from studies of 719 according to a search strategy, and then methodological quality of those studies was evaluated using assessment tool of SIGN. After the evaluation of draft guidelines including recommendations and their grades, the contents were modified. Last, definitive guidelines were evaluated using Appraisal of Guidelines for Research and Evaluation (AGREE) tool.

Result: The guidelines consist of three categories and 64 recommendations, i.e. nine recommendations for user before peripheral intravenous catheterization (PIVC), 26 recommendations during PIVC, and 29 recommendations after PIVC. Content validity was revealed to 70-78% by experts' agreement.

Conclusion: These guidelines were completed throughout systematic reviews and evaluations by clinical experts. Their contents are also included about overall managements for PIV therapy. Therefore these guidelines could help PIV practitioners to make evidence based decision.

Relevance to clinical practice: The method and result of this study are described specifically in figures, tables and appendix, which could give guidance to nurses who develop guidelines regarding other subjects.

Keywords: intravenous, peripheral catheterizations, guidelines, evidence based-nursing, evaluation research

1. Introduction

PIV therapy is frequently interrupted by complications (Ingram & Lavery, 2005). Studies performed in pediatric medical facilities found that approximately 74% of the patients underwent PIVC (Noonan, Quigley, & Curley, 2006).

Since it is important to maintain PIV therapies without complications, nurses should manage it in a standardized method (Kim JS, Lee YR, & NS., 2012; Noonan et al., 2006). When evidence-based guidelines for the prevention of intravascular catheter-related infections introduced by the U.S. Center for Disease Control and Prevention were checked up, those were focused on a wide range of catheter-related injections rather than on PIV or child-specific information (O'Grady et al., 2011; O'Grady et al., 2002). Previous systematic reviews had reported the optimized peripheral device intravenous replacement period of PIV devices (Idvall & Gunningberg, 2006; Webster, Osborne, Rickard, & Hall, 2010). When viewed as a whole, the researches focused on the specific situation of PIVC, and the provided information was fragmentary (Dalal et al., 2009; Doniger, Ishimine, Fox, & Kanegaye, 2009; Panebianco et al., 2009; Perry, Caviness, & Hsu, 2011; Rickard, McCann, Munnings, &

McGrail, 2010; Small et al., 2008). Therefore the PIVC management should be explained in the context of a series as guidelines.

2. Methods

2.1 Guidelines Users and Study Subjects

The intended users of these guidelines are clinical practitioners. The intended study subjects are adult and children scheduled to receive PIV therapy. Contents limited to children were based on below 7 years of age. Classifications of pediatric patients are somewhat different among nations. Puberty stage is included or not. Since puberty-related hormonal change causes a variety of physical and mental changes (McMahon, C., Stryjewski, & R., 2011) and it can vary considerably with age, only children ≤ 7 years of age were considered.

2.2 Ethical Approval

Ethical approval was not required.

2.3 Guidelines Development Process

Development process was accomplished according to the guidelines provided by SIGN (Scottish Intercollegiate Guidelines Network). The development process was consists of eight-step (Figures 1~ 2).

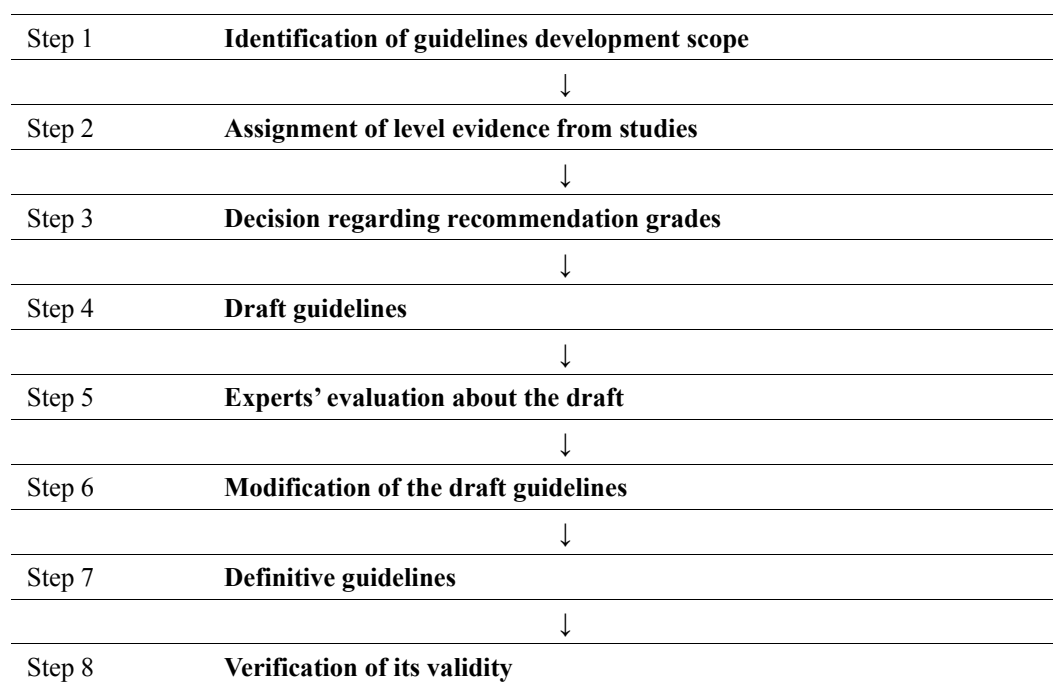


Figure 1. Process of developing guidelines

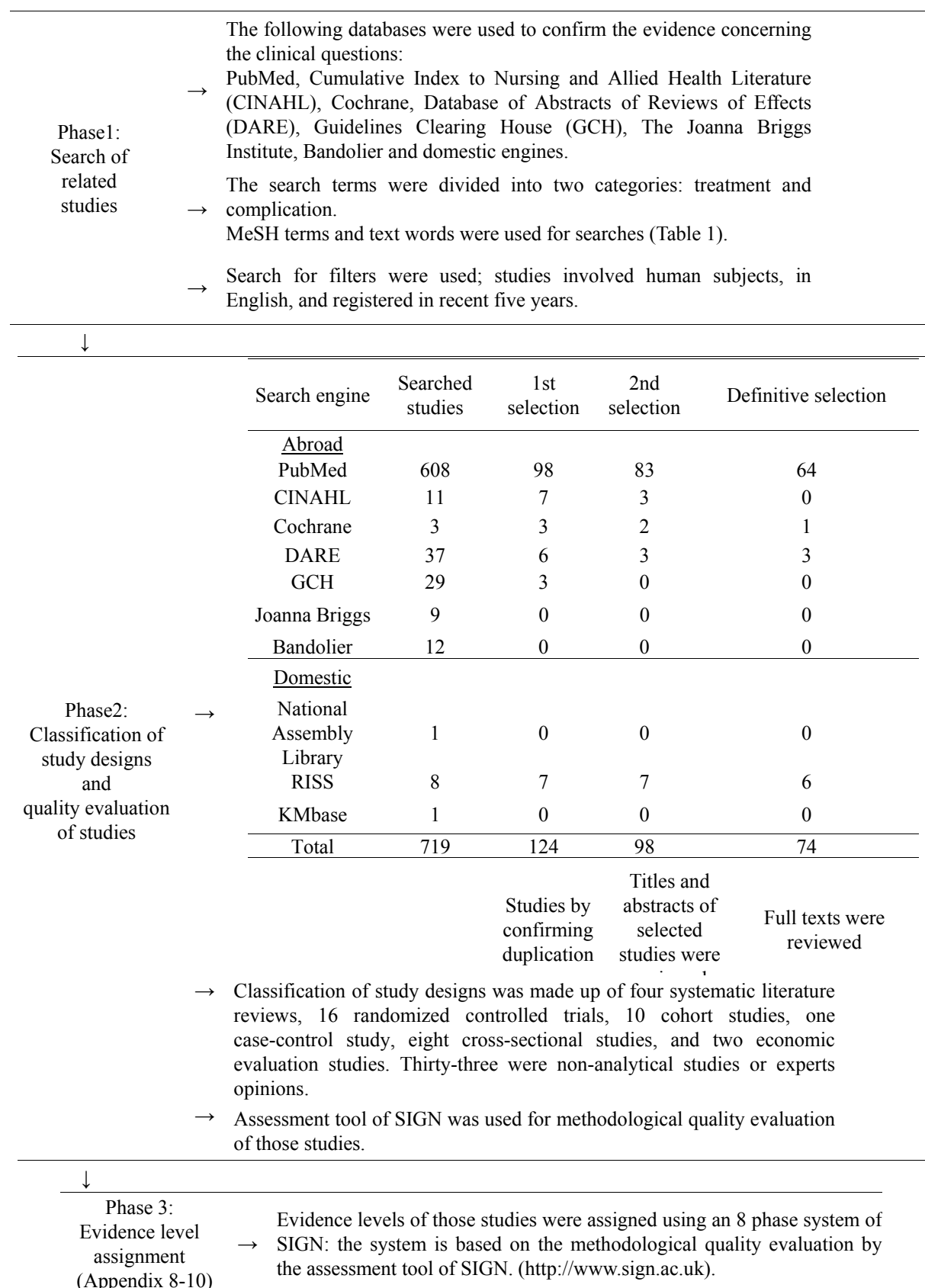


Figure 2. Three phases of the step 2

Step 1. Identification of the guidelines development scope

To identify of contents and scope that would be included in guidelines, the key clinical questions were taken from comments of 15 nurses, including 10 pediatric ward nurses and five neonatal ward nurses, all of whom had more than two years of clinical experience in their respective clinical ward.

Twenty-two clinical questions were formulated, based on practitioner experience, literature search in order to identify the scope of guidelines. The PICO (P; Patient or Problem, I; Intervention, C; Comparison, O; Outcome) form was used ("Establish of Guidelines development plan," 2010) to present clinical questions (Appendix 1).

Step 2. Assignment of evidence levels from studies

This step was consisted of three phases. Medical Subject Headings (MeSH) terms and text words were used according to the designed search strategy at phase 1. (Table 1). The following search sources were used to confirm the evidence about the clinical questions; PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane, Database of Abstracts of Reviews of Effects (DARE), Guidelines Clearing House (GCH), and The Joanna Briggs Institute, Bandolier and domestic engines. Total number of searched studies was 719. Next 124 studies were selected by confirming duplication. 98 studies were selected through title and abstract review. 74 studies were selected through second full text review (Figure 2). Their study designs were classified and then methodological quality was evaluated at phase 2. Two nurses pursuing a nursing master's degree evaluated methodological quality of the selected studies that excluded non-analytical studies and expert opinions using an assessment tool of SIGN. To ensure objectivity, they conducted in separate rooms. As a result, evaluation about three studies did not coincide, so that issues were discussed by another evaluator pursuing a nursing master's degree. There were different opinions about confused variables; using of antibiotics, sample size (RCT-11, RCT-9; Appendix 2-2), and blinded control (CS-29; Appendix 2-3). At phase 3, evidence levels from those studies were assigned using an 8 phase system of SIGN.

Table 1. Search strategy; MeSH terms (1~6, 16~23), text words (7~10, 24)

1) Intravenous (Intravenous In*)	
Intravenous Injections	Drip, Intravenous
Injection, Intravenous	Drip Infusions
Intravenous Infusions	Drip Infusion
Infusion, Intravenous	Infusion, Drip
Intravenous Drip	Infusions, Drip
2) Venipuncture	
Phlebotomies	Venipuncture
Venesection	Venipunctures
Venesections	
3) Vein	
Vein	
4) Peripheral Catheter* NOT Arter* NOT Bronchial	
Peripheral Catheterization	Peripheral Arterial Catheterization
Catheterizations, Peripheral	Arterial Catheterizations, Peripheral
Peripheral Catheterizations	Catheterizations, Peripheral Arterial
Peripheral Venous Catheterization	Peripheral Arterial Catheterizations
Catheterizations, Peripheral Venous	Arterial Catheterization, Peripheral
Peripheral Venous Catheterizations	Catheterization, Bronchial
Venous Catheterizations, Peripheral	Bronchial Catheterization
Catheterization, Peripheral Venous	Bronchial Catheterizations
Venous Catheterization, Peripheral	Catheterizations, Bronchial
Catheterization, Peripheral Arterial	

5) Catheterizations	
Cannulation	Catheters
Cannulations	Cannula
Catheter	Cannulas
6) Catheter-related Infections	
Catheter-related Infection	Infections, Catheter-related
Infection, Catheter-related	
7) Infusion tubing	
8) Vascular assess	
9) Line change	
10) Replacement	
11) #1 OR #2 OR #3	
12) #5 OR #6	
13) #7 OR #8 OR #9 OR #10	
14) #11 OR #12 OR #13	
15) #14 AND #4	
16) Prevention and control	
Preventive therapy	Prevention
Prophylaxis	Control
Preventive measures	
17) Methods	
Study, Methodological	Methodological Studies
Methodological Study	Procedures
Studies, Methodological	Procedure
18) Methods [Subheading]	
Techniques	Methodology
Procedures	
19) Infection Control	
20) Safety Management	
Management, Safety	Surveillance Programs, Hazard
Hazard Surveillance Program	Hazard Management
Hazard Surveillance Programs	Management, Hazard
Program, Hazard Surveillance	Hazard Control
Programs, Hazard Surveillance	Control, Hazard
Surveillance Program, Hazard	Hazard Controls

21) Anti-Inflammatory Agents

Agents, Anti-inflammatory	Agents, Anti-Inflammatory
Anti-inflammatory	Anti-Inflammatories
Anti-inflammatory Agents	Anti Inflammatories
Agents, Anti-Inflammatory	

22) Infection

Infections

23) Contamination, Equipment

Contaminations, Equipment	Equipment Contaminations
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24) Complication

25) #17 OR #18

26) #16 OR #20 OR #21

27) #19 OR #22 OR #23 OR #24

28) #25 OR #26 OR #27

29) #28 AND #15

The retrieved documents based on strategy

#1 OR #2 OR #3	397,595
#5 OR #6	176,656
#7 OR #8 OR #9 OR #10	208,871
#14 AND #4	3,666
#17 OR #18	367,0137
#16 OR #20 OR #21	1,232,410
#19 OR #22 OR #23 OR #24	1,437,203
#25 OR #26 OR #27	5,554,419
#28 AND #15	2,663

Step 3. Decision regarding recommendation grades

Recommendations from the evidence were graded according to SIGN grading system ("SIGN 50: A guidelines developer's handbook," 2008). The grade of recommendation is moved to 'A' from 'D' according to the evidence levels and a number of the supported studies.

Step 4. Draft guidelines

The recommendations and their grades were described in the draft guidelines.

Step 5. Experts' evaluation about the draft

A group for draft guidelines evaluation was composed of experts regarding pediatric PIV therapy. In other words, seven practical experts and seven theoretical experts were selected; nurses who worked in pediatric wards, neonatal wards, pediatric emergency center and practitioners who administer and educate about intravenous therapy. The experts evaluated on adequacy, effectiveness, and application possibility of the recommendations using RAND corporation scale (Sachs GS, Printz DJ, Kahn DA, Carpenter D, & JP., 2005). The evaluation results using Fehring method were converted into a one-point scale; measurement of 1, 2, 3, 4, and/or 5 indicated respective points of 0. 0.25, 0.5, 0.75, and 1 (Fehring, 1987). Recommendations pointed exceeding 0.80 indicate classification of core contents, and pointed of 0.80-0.60 indicate classification as supportive contents and pointed

<0.60 indicate that contents should be modified or removed from the guidelines (EJ, 2003; Johnson & Maas, 1998).

Step 6. Modification of the draft

Depending upon the aforementioned point of step 5, experts opinion analysis and literature review were conducted in order to modify uncertain recommendations.

Step 7. Definitive guidelines

The guidelines were consisted of three categories and 64 recommendations. They are nine recommendations before PIVC, 26 recommendations during PIVC, and 29 recommendations after PIVC.

Step 8. Verification of its validity

To evaluate validity of the definitive guidelines content, Tool of Appraisal of Guidelines for Research and Evaluation (AGREE) was used ("AGREE Korean version," 2001). And, experts consisted of six individuals with extensive theoretical knowledge regarding clinical guidelines: 1) one professor of nursing fundamentals 2) one infection control expert 3) one pediatrician 4) one pediatric orthopedic surgeon 5) two experts, both with Ph.Ds. in Nursing, with more than 15 years of clinical experience.

3. Results

3.1 Methodological Quality Assessment for Assignment of the Evidence Level

Step 2, The result of the methodological quality assessment using the assessment tool of SIGN became evidences level for clinical questions which were derived from the guidelines development scope of step 1.

Four systematic literature reviews, sixteen randomized controlled trials, ten prospective cohort studies, one case-control study, nine cross-sectional studies and two economic evaluation studies were evaluated (Appendix 2-1~2-5).

3.2 Decision of Recommendation Grade

The recommendations were graded by the tool of SIGN. The grade was assigned from 'A' to 'D' according to number of supported studies, evidence level and practical possibility. Step 3, the numbers of A, B, C, and D were six, 22, 13, and 23, respectively.

3.3 Draft Guidelines Evaluation

Draft guidelines derived in step 4 were evaluated in step 5. The adequacy and effectiveness scores of below 0.60 were two; 1) Application of lidocaine cream or 1% lidocaine using needle-free jet injection prior to insertion. 2) When a peripheral catheter is inserted to lower extremities, patients over eight years old are examined about a risk of thrombophlebitis by a physician.

And a low application was four: 3) if PIV therapy was required for more than six days, peripherally inserted central vein or midline should be regarded as alternative methods 4) PIV detection using ultrasound or near-infrared imaging 5) to compensate for the vasoconstrictor effect of lidocaine, glyceryl trinitrate cream that expands blood vessels should be applied for 10 minutes before PIVC 6) clean gloves should be worn in order to protect practitioners (Tables 2~3).

Table 2. Scores of low-graded recommendations in the experts evaluation of the draft

Classified recommendation of low grade	Appropriateness	Applicability	Effectiveness
	M(SD)		
1) Lidocaine application prior to catheterization	0.59(0.19)	0.42(0.26)	0.57(0.19)
2) Physician's prescription for low extremities catheterization in a child >eight years of age	0.58(0.25)	0.50(0.25)	0.59(0.21)
3) Catheters remaining in the peripherally inserted central vein or midline at least six days	0.66(0.30)	0.49(0.27)	0.66(0.30)
4) Detection using ultrasound or near-infrared imaging	0.71(0.19)	0.43(0.26)	0.63(0.21)
5) Glyceryl trinitrate cream application prior to catheterization	0.61(0.22)	0.41(0.27)	0.60(0.26)

6) Wearing clean gloves	0.82(0.21)	0.55(0.28)	0.78(0.25)
7) Compliance with the drying time of Iodine	0.80 (0.29)	0.56 (0.29)	0.76(0.27)
8) Mixture of 70% alcohol and 2% chlorhexidine	0.79 (0.18)	0.57(0.28)	0.77(0.20)

Table 3. Reasons for low-graded recommendations in the experts' evaluation of the draft

Reason	Recommendation of low grade
Lack of resource (budget, installation)	1), 4), 5), 8),
Lack of resource (Experts)	3), 4)
Lack of awareness	1), 2), 3), 5), 6)
Difficulty (time consuming, inconvenient)	1), 6), 7)
Discomfort of children	1)

3.4 Modification of the Draft Guidelines

Step 6, the experts opinions about recommendations need to be deleted were as follows: 1) lidocaine cream or 1% lidocaine using needle-free jet injection causes blood vessels constriction, waiting period is needed after lidocaine application; such a process becomes more complicated if an insertion site should be changed, and then additional medical expenses are incurred 2) PIV detection using the ultrasound or near-infrared imaging was evaluated as an insufficient recommendation from a lack of awareness and evidence.

The experts opinions about recommendations need to be modified were as follows: 1) The prescription that allows low extremities to be inserted with PIV catheters for children \geq eight years of age, the recommendation was so modified that risk factors would be described and any agreement/dissent was recorded. 2) The recommendation for a peripherally inserted central catheter or a midline catheter is limited by situations where there is a lack of professionals to perform the procedure. Therefore, the information was modified as professional staff training and validation of the staffing. 3) The recommendation was modified as the use of clean gloves would not always be required due to the difficulty of detecting a vein, except for cases where an infective disease of patient or hand injury of practitioner is suspected.

3.5 Definitive Guidelines Assessment

Step 7, the definitive guidelines were evaluated by the six experts using AGREE tool. The overall content validity of these guidelines scored 83% and the domain-specific scores were between 70-78% (Table 4).

Table 4. Content validity results of the guidelines

Domain	No. of items	Mean		Standardized domain score (%)
		Min	Max	
Scope and purpose	3	2.8	4.0	74
Stakeholder involvement	4	2.8	3.5	72
Rigor of development	7	3.0	3.9	78
Clarity and presentation	4	2.5	3.5	70
Applicability	3	2.7	4.0	76
Editorial independence	2	3.0	4.0	78
Overall assessment	1	3.0	4.0	83

3.6 Definitive Guidelines

Step 8, these guidelines consist of three categories and 64 recommendations were defined. The three categories consist of recommendation in, before, and after PIVC (Appendix 8-10).

4. Discussion

The success rate of PIVC using the new methods (Doniger et al., 2009) did not higher than the conventional methods (Panbianco et al., 2009; Perry et al., 2011). Therefore, the recommendation was not included in these guidelines. However, PIVC using an improved method should be sought so as to reduce pain, anxiety, and tissue damage. Therefore, further evaluations are needed based on pain relief, cost of lidocaine, and patient satisfaction.

Iodine requires about two minutes for drying after being applied (O'Grady et al., 2002) and the skin is stained with darkened red, so the detection of veins becomes difficult. But 2% chlorhexidine disinfectant mixed with 70% alcohol requires only thirty seconds (Aziz, 2009; O'Grady et al., 2011) and the skin is not stained. Also, that disinfectant is more effective in coagulase-negative staphylococcus and streptococcus infection than other disinfectants (Small et al., 2008).

The recommendation regarding the transparent sterile dressing was included these guidelines, but expert evaluated it as relatively lower probability because additional medical payment was incurred if health care's policy did not permit using of that dressing. However, injection site observation through the transparent sterile dressing should be guaranteed in order to perform PIV catheter replacement depending on the patient's clinical symptoms.

The catheter replacement depending on patient's clinical symptoms shall reduce pain, stress, and tissue damage. So, practitioners could manage other interventions due to reduction in the PIVC time. In addition, medical cost savings can be expected through a reduction of PIV consumables. (Webster et al., 2010).

5. Conclusion

These practical guidelines were based on the clinical questions asked by practitioners who actually performed PIVC management, and the search strategy consisted with the phases of 3 was used to find evidence regarding the clinical questions. For the content validity of guidelines, twice evaluation processes were undergone by many relevant experts.

The number of recommendations grade "A" is six: 1) The formation of PIV injection team 2) Although skin is sterilized, if the skin is touched again by hands, the area is assumed to be contaminated 3) PIV Catheters should be re-placed only in cases of complications 4) The fluid set injected glucose and amino acid independently should not be replaced within 72 or 96 hours unless there is a special condition requiring it. 5) According to an increased number of peripherally injected medications, the complication rate shall be increased. 6) Risk of phlebitis shall be increased when irritating medication is injected. The recommendation graded "B" is twenty-two, "C" thirteen, and "D" twenty-three.

6. What This Paper Adds

Various nursing interventions are performed for peripheral catheterization. Also during the practice, practitioners may have many decisions-making in accordance with various conditions. At that time, these recommendations and its grades could be considered. The higher of a grade, the more accurate interventions should be performed although situations shall be different.

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Appendix 1.

- 1~6: before peripheral intravenous catheterization
 - 7~15: during peripheral intravenous catheterization
 - 16~22: after peripheral intravenous catheterization
1. Is it effective for prevention of complications that practitioners understand the general characteristics of the pediatric patient?
 2. Does it reduce the complications of children’s peripheral intravenous therapy to inform about their disease?
 3. Is the personal explanation more helpful for the prevention of complications than general information?
 4. Prior to the catheterization, is it appropriate for the prevention of complications to exchange common information with caregivers?
 5. When repetitive venipunctures are required, does a central catheterization can be substituted for PIV?
 6. Is it necessary in order to prevent complications to use regulated tools for assessing the skin into which a peripheral catheter be inserted?
 7. Does family participation help to reduce anxiety and improve children’s adaptation during peripheral catheterization?
 8. Is the specialized, peripheral intravenous team more effective?
 9. Does it reduce complications to select a smaller gauge catheter?
 10. Could it reduce of complications that only hand hygiene is maintained without wearing disinfected gloves?
 11. Is the 2% chlorhexidine more effective as a skin disinfectant?
 12. Does the most visible vein to be recommended for catheterization?
 13. Is it more efficient for the prevention of complications to insert a catheter into lower extremities than upper?
 14. Could it prevent complications to support the peripheral catheterization site using a splint?
 15. Is it more effective to use a topical anesthetic for children’s pain relief during peripheral catheterization?
 16. Does it prevent complications to replace peripheral intravenous catheter routinely?
 17. Does it prevent complications to replace extension devices routinely, i.e. extension tube and 3-way stopcock, and infusion set?
 18. Does it prevent complications to use assessment tools about phlebitis or infiltration?
 19. Does the use of dressing devices affect to complications?
 20. Is it more secure to inject via an infusion pump than natural dropping?
 21. Is it beneficial to recognize what kind of drug to be administered via peripheral veins?
 22. Does it prevent complications to explain how can monitor its symptoms to children and their caregivers?

Appendix 2-1. Quality appraisal of the systematic review

Study topics for peripheral intravenous catheters were selective replacement (SR-1, SR-4), time to replacement of the infusion set (SR-2), drug injection via peripheral vein, and the duration of catheter placement (SR-3).

No	Focused question	Methodology	Literature search	Quality assess	Combining reasonable	Evidence- based conclusion	Overall assessment
SR-1	1	1	1	1	2	1	++
SR-2	1	1	2	2	2	1	++
SR-3	1	1	2	2	3	1	+
SR-4	1	1	2	1	1	2	++

SR, Systematic review; 1, Well-covered; 2, Adequately addressed; 3, Poorly addressed; 4, Not addressed; 5, Not reported; 6, Not applicable; ++, All or most of the criteria have been fulfilled; +, Some of the criteria have been fulfilled; -, Few or no criteria fulfilled.

Appendix 2-2. Quality appraisal of the randomized controlled trial

Study topics included the comparative study of a 2% chlorhexidine disinfectant mixed with 70% alcohol and existing skin antiseptic (RCT-5), regular exchange of peripheral intravenous catheters and selective exchange (RCT-6, RCT-7, RCT-9, RCT-12, RCT-18), moist and dry heat therapy for vasodilatation (RCT-8), application comparison between existing technology and ultrasound and near-infrared imaging for the detection of peripheral veins (RCT-10, RCT-13), comparison of factors of peripheral intravenous maintenance and complications (RCT-11), comparison of lidocaine and nitrous oxide and ethyl chloride for pain relief upon catheter insertion (RCT-14, RCT-15, RCT-16), PICC and Midline catheter (RCT-17), directional effect of bevel (RCT-19), and effects of a splint for peripheral intravenous catheter support (RCT-20).

No	Focused question	Assign-ment	Conceal-ment	Blind	Similarity	Treated equally	Measure-ment	Analysis	Drop	Multi-site	Overall assessment
RCT-5	1	1	4	4	5	2	2	2	3	5	+
RCT-6	1	1	6	6	2	2	2	2	2	6	++
RCT-7	1	1	3	3	2	2	2	2	1	3	++
RCT-8	1	1	6	6	3	5	2	2	2	6	+
RCT-9	1	1	6	6	4	5	3	3	2	6	-
RCT-10	1	1	6	6	3	3	2	3	1	6	+
RCT-11	1	2	3	3	4	5	2	2	1	6	+
RCT-12	1	1	2	2	3	3	2	2	1	6	+
RCT-13	1	1	6	6	3	3	3	2	1	6	+
RCT-14	1	1	6	6	3	3	3	1	1	6	+
RCT-15	1	1	1	1	3	3	3	3	1	6	+
RCT-16	1	1	1	1	2	5	2	2	2	6	+
RCT-17	1	1	6	6	2	2	2	3	1	6	+
RCT-18	1	2	6	6	4	4	3	2	3	6	-
RCT-19	1	2	6	6	5	4	2	1	2	6	-
RCT-20	1	2	6	6	3	5	2	3	2	6	-

RCT, Randomized controlled trial; 1, Well-covered; 2, Adequately addressed; 3, Poorly addressed; 4, Not addressed; 5, Not reported; 6, Not applicable; ++, All or most of the criteria have been fulfilled; +, Some of the criteria have been fulfilled; -, Few or no criteria fulfilled.

Appendix 2-3. Quality appraisal of cohort studies

Study topics included the comparative study of phlebitis and its factors in peripheral intravenous catheters (CS-21, CS-22, CS-23, CS-25, CS-26, CS-28, CS-30), the success rate of peripheral vein detection using ultrasound (CS-24), the contamination rate associated with the use of a peripheral intravenous catheter (CS-27), and comparison of peripheral intravenous and catheter-related complications occurring in the Emergency Room and in the general hospital environment (CS-29).

No	Focused question	Source population	Participants division	Eligible subjects	Drop out	Blind	Outcome assessment	Con-founder	Analysis	Overall assessment
CS-21	1	1	2	5	5	5	3	3	2	+
CS-22	1	1	5	1	5	5	2	3	2	+
CS-23	1	1	4	1	1	2	1	2	2	++
CS-24	1	1	2	2	5	3	2	3	2	+
CS-25	1	1	2	2	2	2	2	3	2	++
CS-26	1	1	5	1	1	3	3	3	2	+
CS-27	1	1	2	2	2	6	5	4	2	+
CS-28	1	1	5	5	1	5	3	4	2	+
CS-29	1	2	5	2	4	5	3	3	3	-
CS-30	1	1	2	2	1	4	2	3	2	+

CS, Cohort studies; 1, Well-covered; 2, Adequately addressed; 3, Poorly addressed; 4, Not addressed; 5, Not reported; 6, Not applicable; ++, All or most of the criteria have been fulfilled; +, Some of the criteria have been fulfilled; -, Few or no criteria fulfilled.

Appendix 2-4. Quality appraisal of case-control studies and cross-sectional studies

The topics were education and the performance of peripheral intravenous catheterization. Nine, cross-sectional studies (CSSs) were evaluated. CSS topics were regional differences in the management of peripheral intravenous catheters (CSS-33), inconsistent guidelines and the nursing practice regarding peripheral intravenous catheters (CSS-32), recognition of and performance for preventing peripheral intravenous complications (CSS-34), factors influencing peripheral intravenous catheter failure (CSS-35), peripheral intravenous catheter reinsertion factors (CSS-36, CSS-39, CSS-40), pain caused by peripheral intravenous insertion (CSS-37), and selective replacement of peripheral intravenous catheters (CSS-38).

No	Focused question	Comparable populations	Same exclusion criteria	Percentage of each	Drop out	Similarity	Blind	Measurement	Con founder	Overall assessment
CCS-31	1	6	6	6	1	4	6	2	5	+
CSS-32	1	3	3	3	5	2	4	2	3	-
CSS-33	1	4	4	2	3	3	3	2	3	+
CSS-34	1	6	6	6	1	3	6	2	3	+
CSS-35	1	6	6	6	1	3	6	2	2	+
CSS-36	1	6	6	6	1	3	6	2	3	+
CSS-37	1	6	6	6	1	3	6	2	2	+
CSS-38	1	6	6	6	3	3	6	2	2	+
CSS-39	1	6	6	6	1	3	6	2	2	+
CSS-40	1	6	6	6	3	3	6	3	3	+

CCS, Case-control studies; CSS, Cross-sectional studies; 1, Well-covered; 2, Adequately addressed; 3, Poorly addressed; 4, Not addressed; 5, Not reported; 6, Not applicable; ++, All or most of the criteria have been fulfilled; +, Some of the criteria have been fulfilled; -, Few or no criteria fulfilled.

Appendix 2-5. Quality appraisal of the economic evaluation studies

Effectiveness analysis topics considering the cost were chlorhexidine and iodine, and a comparison was made of pain relief medications.

No	Study question	Economic importance	Cost analysis	Information of relevance	Patients participated	Scale of the cost	Statistical measurement	Overall assessment
EE-40	1	3	3	3	6	2	5	+
EE-41	1	3	3	3	6	2	5	+

EE, Economic evaluation; 1, Well-covered; 2, Adequately addressed; 3, Poorly addressed; 4, Not addressed; 5, Not reported; 6, Not applicable; ++, All or most of the criteria have been fulfilled; +, Some of the criteria have been fulfilled; -, Few or no criteria fulfilled.

Appendix 3. Study in which a methodological quality assessment was performed for development of the guidelines for peripheral intravenous administration in pediatric patients.

1) Systematic review

SR-1. Webster, J., Osborne, S., Rickard, C., & Hall, J. (2010). Clinically-indicated replacement versus routine replacement of peripheral venous catheters. *Cochrane Database of Systematic Reviews*, 3, CD007798.

SR-2. Gillies, D., Wallen, M.M., Morrison, A.L., Rankin, K., Nagy, S.A., & O'Riordan E. (2005). Optimal timing for intravenous administration set replacement. *Cochrane Database of Systematic Reviews*, 4, CD003588.

SR-3. Flint, A., McIntosh, D., & Davies, M.W. (2005). Continuous infusion versus intermittent flushing to prevent loss of function of peripheral intravenous catheters used for drug administration in newborn infants. *Cochrane Database of Systematic Reviews*, 4, CD004593.

SR-4. Idvall, E., & Gunningberg, L. (2006). Evidence for elective replacement of peripheral intravenous catheter to prevent thrombophlebitis: a systematic review. *Journal of Advanced Nursing*, 55, 715-722.

2) Randomized controlled trial

- RCT-5. Small, H., Adams, D., Casey, A.L., Crosby, C.T., Lambert, P.A., & Elliott, T. (2008). Efficacy of Adding 2% Chlorhexidine Gluconate to 70% Isopropyl Alcohol for Skin Disinfection Prior to Peripheral Venous Cannulation. *Infection Control Hospital Epidemiology*, 29, 963-965.
- RCT-6. Webster, J., Clarke, S., Paterson, D. et al. (2008). Routine care of peripheral intravenous catheters versus clinically indicated replacement: randomized controlled trial. *BMJ*, 337, 157-160.
- RCT-7. Rickard, C.M., McCann, D., Munnings, J., & McGrail, M.R. (2010). Routine resite of peripheral intravenous devices every 3 days did not reduce complications compared with clinically indicated resite: a randomized controlled trial. *BMC Medicine*, 8, 53.
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- RCT-10. Doniger, S.J., Ishimine, P., Fox, J.C., & Kanegaye, J.T. (2009). Randomized Controlled Trial of Ultrasound-Guided Peripheral Intravenous Catheter Placement Versus Traditional Techniques in Difficult-Access Pediatric Patients. *Pediatric Emergency Care*, 25, 154-159.
- RCT-11. Tripathi, S., Kaushik, V., & Singh, V. (2008). Peripheral IVs: Factors Affecting Complications and Patency: A Randomized Controlled Trial. *Journal of Infusion Nursing*, 31, 182-188.
- RCT-12. Webster, J., Lloyd, S., Hopkins, T., Osborne, S., & Yaxley, M. (2007). Developing a Research base for Intravenous Peripheral cannula re-sites: A randomized controlled trial of hospital in-patients. *International Journal of Nursing Studies*, 44, 664-671.
- RCT-13. Perry, A.M., Caviness, A.C., & Hsu, D.C. (2011). Efficacy of a Near-Infrared Light Device in Pediatric Intravenous Cannulation: A Randomized Controlled Trial. *Pediatric Emergency Care*, 27, 5-10.
- RCT-14. Robinson, P.A., Carr, S., Pearson, S., & Frampton, C. (2007). Lidocaine is a better analgesic than either ethyl chloride or nitrous oxide for peripheral intravenous cannulation. *Emergency Medicine Australasia*, 19, 427-432.
- RCT-15. Andrew, M., Barker, D., & Laing, R. (2002). The use of glyceryl trinitrate ointment with EMLA cream for I.V. cannulation in children undergoing routine surgery. *Anaesth Intensive Care*, 30, 321-325.
- RCT-16. Arendts, G., Stevens, M., & Fry, M. (2008). Topical anesthesia and intravenous cannulation success in pediatric patients: A Randomized double-blind trial. *British Journal of Anesthesia*, 100, 521-524.
- RCT-17. Barría, R.M., Lorca, P., & Muñoz, S. (2007). Randomized Controlled Trial of Vascular Access in Newborns in the Neonatal Intensive Care Unit. *JOGNN*, 36, 450-456.
- RCT-18. Van Donk, P., Rickard, C.M., McGrail, M.R., & Doolan, G. (2009). Routine Replacement versus Clinical Monitoring of Peripheral Intravenous Catheters in a Regional Hospital in the Home Program: A Randomized Controlled Trial. *Infection control and hospital epidemiology*, 30, 915-917.
- RCT-19. Black, K.J., Pusic, M.V., Harmidy, D., & McGillivray, D. (2005). Pediatric Intravenous Insertion in the Emergency Department. *Pediatric Emergency Care*, 21, 707-711.
- RCT-20. Dalal, S.S., Chawla, D., Singh, J., Agarwal, R.K., Deorari, A.K., & Paul, V.K. (2009). Limb splinting for intravenous cannula in neonates: A Randomized controlled trial. *Arch Dis Child Fetal Neonatal Ed*, 94, 394-396.

3) Cohort studies

- CS-21. Singh, R., Bhandary, S., & Pun, K.D. (2008). Peripheral intravenous catheter related phlebitis and its contributing factors among adult population at KU Teaching Hospital. *Kathmandu University Medical Journal*, 6, 443-447.
- CS-22. Abbas, S.Z., de Vries, T.K., Shaw, S., & Abbas, S.Q. (2007). Use and complications of peripheral vascular catheters: a prospective study. *British Journal of Nursing*, 16, 648-652.
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- CS-27. Subha, Rao S.D., Joseph, M.P., Lavi, R., & Macaden, R. (2005). Infections Related to Vascular Catheters in a Pediatric Intensive Care Unit. *Indian Pediatrics*, *42*, 667-672.
- CS-28. Nassaji-Zavareh, M., & Ghorbani, R. (2007). Peripheral intravenous catheter- related phlebitis and related risk factors. *Singapore Medicine Journal*, *48*, 733-736.
- CS-29. Zarate, L., Mandleco, B., Wilshaw, R., & Ravert, P. (2008). Peripheral Intravenous Catheters Started in Prehospital and Emergency Department Settings. *Journal of Trauma Nursing*, *15*, 47-52.
- CS-30. Lim, M.R. (2008). Incidence of Phlebitis According to Intravenous Therapy in Inpatients. Msc thesis, Keimyung University, Daegu, Korea.

4) Cross-sectional studies, Case-control studies

- CCS-31. Ozyazicioğlu, N., & Arikan, D. (2008). The effect of nurse training on the improvement of intravenous applications. *Nurse Education Today*, *28*, 179-185.
- CSS-32. Johansson, M.E., Pilhammar, E., Khalaf, A., Willman, A. (2008). Registered Nurses' Adherence to Clinical Guidelines Regarding Peripheral Venous Catheters: A Structured Observational Study. *Worldviews on Evidence-Based Nursing*, *5*, 148-159.
- CSS-33. Walker, S.R., Farraj, R., Papavassiliou, V., & Arvanitis, D. (2006). A Descriptive Survey of the Different Management Practices for Peripheral IV Catheters Among Greek, Jordanian, and Australian Teaching Hospitals. *Journal of Infusion Nursing*, *29*, 101-108.
- CSS-34. Jacobson, A.F., & Winslow, E.H. (2005). Variables influencing intravenous catheter insertion difficulty and failure: An analysis of 339 intravenous catheter insertions. *Heart Lung*, *34*, 345-359.
- CSS-35. Kim, H.J. (2006). Factors related to the restart of PIV in Hospitalized Children. Msc thesis, Yonsei University, Seoul, Korea.
- CSS-36. Jung, J.H. (2009). A Study of Peripheral Intravenous Cannulation & Intravenous Injection Pain in Hospitalized Children. Msc thesis, Eulji University, Sungnam, Korea.
- CSS-37. Yoon, H.S., Park M.A., Park E.J. et al. (2010). Study on Prolonging Peripheral Intravenous Catheter Indwell Time Based on Phlebitis Rate. *Journal of Korean Clinical Nursing Research*, *16*, 145-153.
- CSS-38. Sung, S.H., & Kim, H.S. (2007). Risk Factors of Intravenous Infiltration in Children. *Journal of Korean Clinical Nursing Research*, *13*, 61-72.
- CSS-39. Lee, K.S. (2005). Factors related to the duration of PIV in hospitalized children. Msc thesis, Yonsei University, Seoul, Korea.

5) Economic evaluation study

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6) Non-analysis studies, Expert's opinion

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51. Gorski, L.A. (2009). Standard 14: Documentation. *Journal of Infusion Nursing*, 32, 19-20.
52. Gorski, L.A. (2009). Standard 37: Site selection. *Journal of Infusion Nursing*, 32, 125-126.
53. Gorski, L.A. (2007). Standard 44: Dressings. *Journal of Infusion Nursing*, 30, 87-88.
54. Gorski, L.A. (2007). Standard 53: Phlebitis. *Journal of Infusion Nursing*, 30, 265-266.
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Appendix 4. Recommendations for user before peripheral intravenous catheterization

Recommendations	Levels of evidence (study)	Recommendation -grade	Appropriateness	Applicability M(SD)	Effectiveness
1. Evaluate the demographic characteristics of a child.					
1-1. The period of peripheral intravenous catheterization is shorter as the age of a child decreases.	1+(1) 2+(2)	B	0.64 (0.26)	0.61 (0.24)	0.61 (0.21)
1-2. There is no difference in phlebitis between genders.	2+(2)	C	0.81 (0.23)	0.84 (0.19)	0.80 (0.23)
2. Verify the disease information.					
2-1. The diagnosis and expected period of treatment should be verified.	3(2)	D	0.79 (0.13)	0.73 (0.21)	0.74 (0.20)
2-2. The clinician's previous catheterization experience should be assessed. In a case where its placement is difficult, an expert should be chosen to select a method that is suitable for a child.	3(2)	D	0.79 (0.15)	0.79 (0.17)	0.79 (0.18)
<u>Recommendation details</u>					
- Have you had an intravenous injection in the past?			0.79 (0.11)	0.80 (0.12)	0.79 (0.11)
- If so, what difficulties did you have when having the intravenous injection?					
- How many times did the nurse attempt the injection?					
- Where did you have the injection?					
- Did you have to be re-injected due to a problem occurring after the injection?					
2-3. Identify risk factors that exist in children.	3(1)	D	0.92 (0.07)	0.90 (0.10)	0.92 (0.07)
<u>Recommendation details</u>					
- Close data collection regarding the child and his/her physical examination should be performed in order to prevent complications, i.e. anaphylactic shock, allergy. (Such as the condition of a vein, chronic disease, obesity, several attempts at intravenous injection, decline decrease of blood circulation, availability of communication regarding self-expression, and the patient's medication history).			0.86 (0.13)	0.83 (0.20)	0.85 (0.16)
3. Explain to the child and the caregivers who participate in the course of intravenous therapy how to take precautions.					
3-1. For children younger than three years, it is effective to explain the course of intravenous therapy by using a real model as an example as they are unable to understand an example if an explanation is made through a dummy or other representative object. The explanation should be provided in simple and clear words.	3(1)	D	0.79 (0.18)	0.69 (0.27)	0.80 (0.19)

Recommendations	Levels of evidence (study)	Recommendation -grade	Appropriateness	Applicability M(SD)	Effectiveness
<u>Recommendation details</u>					
- Photos or illustration can help the subject remember the contents of the information provided.					
- It is possible to effectively prepare them by allowing them to observe the catheterization of other children.			0.80 (0.16)	0.68 (0.29)	0.80 (0.18)
- In the case of a child between three and seven years of age, the preparatory course which is organized according to stories read by their parents is effective. For children older than seven years of age, it is more effective to help them prepare by providing general information. However, it can be more effective to provide the least amount of information in case a patient receives repeated intravenous injections. In children between six and 11 years of age, an emotional explanation should be avoided and the detailed procedure should be explained, e.g. the arm will be sterilized; it will be cold.. The course and sensations should be explained in a stable tone of voice according to the order of the procedure.					
3-2. The child’s information, such as character and behavior, is collected from their caregivers while clinicians provide ways to help the caregivers.	3(2)	D	0.85 (0.12)	0.79 (0.14)	0.85 (0.11)
<u>Recommendation details</u>					
- In cases of expected difficulty regarding the intravenous injection, communication with the child, the nurses, and doctors is required. Only by understanding the purpose of the intravenous injection can the overall course be supported.			0.91 (0.09)	0.82 (0.20)	0.88 (0.11)
4. Check the application period of the peripheral intravenous injection therapy in order to reduce repeated venipuncture.					
4-1. When peripheral intravenous injection therapy is needed for more than six days, professional experts should be educated and secured to apply the peripherally inserted central catheter (PICC) or midline catheter.	1+(1) 3(1)	B	0.66 (0.30)	0.49 (0.27)	0.66 (0.30)
5. Use the equipment or tools to evaluate the area of catheter placement.					
5-1. The hydrothermal therapy performed around the area of the peripheral intravenous injection helps the area selection for catheter placement by inducing vasodilatation.	1+(1) 3(1)	B	0.77 (0.14)	0.76 (0.16)	0.79 (0.14)

Appendix 5. Recommendations during peripheral intravenous catheterization

Recommendations	Levels of evidence (study)	Recommendation -grade	Appropriateness	Applicability M(SD)	Effectiveness
1. Aim to reduce anxiety among children and to promote their adaptation during their peripheral intravenous therapy.					
1-1. Although the presence of caregivers is not always helpful, family-oriented care has positive effects. Considering such facts, the presence of caregivers can help child to remain comfortable during the course of catheterization.	3(1)	D	0.72 (0.18)	0.74 (0.23)	0.65 (0.21)
2. Search for the most effective management method of inserting a peripheral intravenous catheter.					
2-1. The peripheral intravenous injection team composed of professional medical experts helps to reduce the occurrence of potential complications and costs by preventing the formation of catheter-related infection and decreasing the risk of infection.	1+(2) 2++(4) 4(1)	A	0.86 (0.19)	0.77 (0.28)	0.86 (0.19)
3. Select the catheter considering the catheter gauge.					
3-1. A catheter with the smallest gauge that allows appropriate treatment should be selected.	2++(1) 2+(1) 3(8)	C	0.87 (0.15)	0.85 (0.15)	.87 (0.15)
<u>Recommendation details</u>					
- A small gauge catheter helps to prevent damage in the intravascular membrane while encouraging blood flow through the catheter. If the flow of blood is decreased due to an oversized catheter, residual medicine can remain and can cause delayed contact of the catheter to the wall of a blood vessel. Eventually, it causes chemical phlebitis.			0.89 (0.10)	0.87 (0.10)	0.88 (0.11)
- A small-gauge catheter is sufficient to supply the solution. For example, a catheter with 22 gauges can supply 2.5L of solution per hour. Thus, there is no difficulty with 3L of hydration per day.					
4. Maintain hand hygiene when managing intravenous injection.					
4-1. Hand hygiene can be guaranteed by using alcohol gel or anti-bacterial soap.	1+(1)	B	0.96 (0.05)	0.96 (0.05)	0.95 (0.05)
4-2. Gloves are not essential in order to ensure hand hygiene and when using the 'no-touch' technique (No touch after sterilization). However, it is necessary to wear clean gloves so as to protect the medical service provider if the child has an infectious disease or is there is a wound on the clinician's hand.	1+(1) 3(2)	B	0.82 (0.21)	0.55 (0.28)	0.78 (0.25)
4-3. Before and after contacting a child as well as before wearing clean gloves, the correct hand hygiene should be performed.	3(2)	D	0.89 (0.19)	0.90 (0.09)	0.91 (0.09)
5. Prepare the skin with disinfectant that is effective for preventing complications and is easy to use.					
5-1. 2% Chlorhexidine (CHG) is more effective than other types of disinfectant; however, 70% alcohol or iodine can also be used for skin preparation.	1+(1)	B	0.80 (0.16) 0.84 (0.14)	0.68 (0.29) 0.86 (0.13)	0.80 (0.18) 0.84 (0.12)

Recommendations	Levels of evidence (study)	Recom mendat ion -grade	Appr opriat eness	Applica bility M(SD)	Effecti veness
5-2. In case of disinfection using iodine, the disinfectant performance is revealed after the medicine dries. Therefore, a timer capable of measuring the point in time that passes two minutes after applying the disinfectant, after which the catheter should be placed after it is dry.	1+(1)	B	0.80 (0.29)	0.56 (0.29)	0.76 (0.27)
5-3. A 70% alcohol + 2% CHG solution are easy to use as it dries 30 seconds after being applied. It is also effective against coagulase-negative staphylococcus (a representative catheter-related blood stream bacterial infection) and Staphylococcus aureus. Thus, it is recommended to be used for the sterilization of catheterization.	1+(1) 2+(1) 3(2)	B	0.79 (0.18)	0.57 (0.28)	0.77 (0.20)
5-4. The catheterization area is assumed to be contaminated if it is touched again with the hands after sterilization.	1+(2) 3(1)	A	0.93 (0.11)	0.83 (0.25)	0.89 (0.22)
6. Select an area for catheterization that can lower the possibility of complications and allows easy maintenance.					
6-1. The area selected for catheterization should be discussed with the child and the caregivers.	3(1)	D	0.85 (0.13)	0.75 (0.17)	0.80 (0.14)
6-2. There is an increased chance of the occurrence of phlebitis if an intravenous catheter is used in the same area more than once.	2+(1) 3(2)	C	0.79 (0.19)	0.77 (0.20)	0.80 (0.17)
6-3. When selecting an area for catheterization, it should start from the distal area of the upper-limb while selecting the area by moving to the proximal area rather than the area of the previous catheterization, in cases of re- catheterization. If the area is further distal than that of the previous catheterization, medicine may leak into the area where the previous catheter was removed.	3(3)	D	0.82 (0.16)	0.76 (0.16)	0.83 (0.15)
6-4. A catheter can be dislocated at the bending areas even by normal movement and when its maintenance period is short.	1+(1) 2+(1) 3(8)	B	0.89 (0.12)	0.85 (0.16)	0.85 (0.16)
6-5. Anticubital fossa should be avoided.	2+(1) 3(6)	C	0.82 (0.15)	0.76 (0.13)	0.82 (0.15)
<u>Recommendation details</u> - If infiltration occurs in this area, it may not be detected at an early stage. Once the surrounding tissue is compressed due to the accumulated solution, the artery and nerves also become compressed and may thus cause nerve damage and tissue necrosis.			0.86 (0.14)	0.81 (0.16)	0.85 (0.14)
6-6. Thrombophlebitis increases as the insertion site going up from a hand to an arm.	2++(1) 2+(1) 3(1)	B	0.70 (0.19)	0.67 (0.18)	0.69 (0.18)
6-7. When taking a close look around the venous valve, there are small eminences. When a catheter is placed in this area, back flow of blood is invisible and the catheter may penetrate the blood vessel. Therefore, such an area should be avoided in order to prevent possible complications.		D	0.82 (0.13)	0.71 (0.21)	0.78 (0.15)
<u>Recommendation details</u> <Physical examination>			0.90 (0.08)	0.89 (0.10)	0.90 (0.09)

Recommendations	Levels of evidence (study)	Recom mendat ion -grade	Appr opriat eness	Applica bility M(SD)	Effecti veness
- Any injuries to the hands or arms should be examined, e.g. bruise, wound, scar, fracture, etc. - Membrane and skin elasticity should be examined.					
7. It is possible to consider the maintenance of the intravenous injection on the lower limb for the children younger than seven years of age.					
7-1. For the vein, the front and back of the upper limb, including basilic vein, cephalic vein, and metacarpal vein should first be checked.	3(1)	D	0.87 (0.12)	0.88 (0.18)	0.90 (0.10)
7-2. The lower limb of an adult is not recommended for an area of catheterization owing to the potential risk of thrombosis and embolism. However, the head, neck, and lower limb can be included in children.	3(2)	D	0.79 (0.22)	0.72 (0.24)	0.75 (0.22)
7-3. As the placement of a catheter into an upper limb suppresses the cluster formation more so than catheter placement in the lower limb, it is effective in order to prevent complications.	2+(1)	C	0.78 (0.16)	0.75 (0.18)	0.76 (0.18)
7-4. In cases of catheterization of a lower limb in children older than eight years of age, the potential dangers of thrombophlebitis which can be generated by unknown causes such as non-movement, the number of blood coagulation factors, dehydration, and circulation disorder, should be explained. Agreement is required and such agreed intention should be documented.	3(1)	D	0.58 (0.25)	0.50 (0.25)	0.59 (0.21)
7-5. There is no significant difference in the period of blood vessel maintenance in the upper and lower body in children.	1+(1) 2+(1)	B	0.72 (0.20)	0.73 (0.21)	0.72 (0.21)
8. A catheter shall be firmly fixed for maintenance after its placement.					
8-1. If catheter fixation is well-maintained following the catheterization, dislocation of the catheter can be prevented.	2+(1) 3 (5)	C	0.88 (0.11)	0.88 (0.11)	0.88 (0.11)
<u>Recommendation details</u>					
- A well-fixed catheter and the intravenous injection maintenance device can reduce solution leak up to 57% and infiltration up to 100%.			0.86 (0.10)	0.85 (0.08)	0.86 (0.10)
8-2. A transparent, aseptic dressing shall be applied for frequent monitoring of the catheterized area.	2+(1) 3(7)	C	0.85 (0.16)	0.61 (0.30)	0.82 (0.19)
8-3. The clean and dry condition of the dressing shall be maintained until the next dressing is placed 72 hours later and a loosened, wet or contaminated dressing should be replaced.	3(3)	D	0.91 (0.11)	0.89 (0.12)	0.92 (0.09)
8-4. Splints should be used to limit the excessive movement of the catheterized area and to prevent complications.	1+(1) 2+(1) 3(8)	B	0.91 (0.09)	0.89 (0.11)	0.91 (0.11)

Appendix 6. Recommendations after peripheral intravenous catheter

Recommendations	Levels of evidence (study)	Recom mendation -grade	Appr opriat eness	Applica bility M(SD)	Effecti veness
1. Do not exchange peripheral intravenous catheters in children on a regular basis.					
1-1. In a pediatric patient, the tendency toward phlebitis generation is not proportional to the maintenance period of the peripheral intravenous injection. Therefore, it should be maintained if there are no complications.	1+(1) 2+(1) 3(1)	B	0.77 (0.24)	0.72 (0.25)	0.75 (0.24)
<u>Recommendation details</u>					
- There was no statistical significance, although, the number of clusters increased over time. However, the comparison made regarding the correlation between the number of clusters and septicemia showed no significant results.			0.71 (0.18)	0.69 (0.21)	0.71 (0.18)
1-2. The cause of the early catheter removal is related to phlebitis. However, 98.8% of this was not caused by micro-organism infection.	2++(1)	C	0.75 (0.19)	0.74 (0.20)	0.74 (0.20)
1-3. The catheter should be removed within 48 hours if an aseptic technique was not used during any emergency situation.	2++(2)	C	0.72 (0.24)	0.61 (0.25)	0.75 (0.23)
1-4. Proper management and insertion of a catheter is more important than its replacement period.	2+(1)	C	0.89 (0.10)	0.86 (0.13)	0.87 (0.12)
1-5. Even adults can experience a small number of catheterizations during the same period of peripheral intravenous injection therapy if a catheter is re-placed only in cases of complications.	1++(3) 1+(1) 2++(1) 4(1)	A	0.78 (0.20)	0.76 (0.20)	0.75 (0.21)
<u>Recommendation details</u>					
- Deciding the period of replacement of a catheter by evaluating complications helps to reduce pain while increasing patient satisfaction. It can also reduce nurses' workload as well as the consumables and post-mortem disposal.			0.85 (0.23)	0.83 (0.22)	0.85 (0.23)
1-6. The occurrence of complications should be prevented by having 96 hours as the replacement period for a peripheral intravenous injection catheter in adults.	1+(1) 3(2)	B	0.72 (0.21)	0.75 (0.21)	0.75 (0.20)
1-7. The occurrence of phlebitis in an adult's peripheral intravenous injection increases as the maintenance period of a catheter increases.	2++(2) 2+(1)	B	0.76 (0.21)	0.72 (0.23)	0.73 (0.23)
2. Follow the periodic equipment replacement such as the fluid set and extension devices (Extension tube, 3-way).					
2-1. The fluid set that independently injects glucose and amino acid should not be replaced unless there is a special condition requiring it within 72 to 96 hours after its initial placement, and a case that does not exceed seven days for prevention of complications is cost-effective.	1++(3) 2++(1) 3(4)	A	0.82 (0.19)	0.80 (0.19)	0.79 (0.20)
2-2. In cases of fat-soluble fluid or blood derivatives, including a case that gets a mixture from separate lines, the fluid set and extension device should be replaced within 24 hours.	1+(1) 3(3)	B	0.84 (0.13)	0.79 (0.16)	0.82 (0.14)
2-3. The exchanged date and time should be marked on the fluid set, including the extension tube.	3(1)	D	0.90 (0.09)	0.88 (0.15)	0.90 (0.10)

Recommendations	Levels of evidence (study)	Recom mendat ion -grade	Appr opriat eness	Applica bility M(SD)	Effecti veness
2-4. As the use of a three-way stop-cock can be a source of infection, it should be used after sterilization with 70% alcohol or iodine and its cleanness should be maintained after its use.	1++(1)	B	0.89 (0.15)	0.86 (0.17)	0.89 (0.15)
2-5. The unused three-way stop-cock should be sealed.	1+(1)	B	0.97 (0.05)	0.97 (0.05)	0.97 (0.05)
2-6. The three-way stop-cock should be replaced every 72 hours.	1++(1) 3(2)	B	0.68 (0.31)	0.66 (0.27)	0.64 (0.31)
2-7. When the fluid set is replaced according to the guidelines, the extension device should be replaced as well.	3(1)	D	0.93 (0.07)	0.91 (0.08)	0.93 (0.06)
3. Evaluate phlebitis or infiltration objectively.					
3-1. The baseline statement should be established using a standardized assessment instrument such as the Visual Infusion Phlebitis (VIP) Score or the INS Standards.	3(3)	D	0.83 (0.21)	0.78 (0.24)	0.81 (0.21)
3-2. The site where complications occurred, such as phlebitis, should be evaluated for 48 hours following the removal of a catheter.	3(1)	D	0.89 (0.12)	0.80 (0.22)	0.87 (0.13)
<u>Recommendation details</u>					
- The risk of having mechanical phlebitis increases when the maintenance period of a catheter is extended, a catheter failed to be fixed stably or a dressing is not replaced.			0.86 (0.10)	0.82 (0.16)	0.86 (0.11)
- As chemical phlebitis is caused by medicine, the speed of the medicine's injection should be reduced and properly diluted medicine should be injected.					
- To access edema, the patient's arms should be lifted and if the roundness around the catheter placement area is large and spreads to the sides when lit by a flashlight, it indicates stagnated solution under the skin.					
3-3. Even in cases of medication injected using an infusion pump, there should be frequent monitoring.	2+(1) 3(1)	C	0.88 (0.13)	0.86 (0.14)	0.88 (0.13)
<u>Recommendation details</u>					
- As a certain amount of medicine is introduced through an infusion pump on a regular basis, a medication should be given periodically regardless of internal damage, even in cases of complication generation. As more medicine can be accumulated through the pressure introduced by an infusion pump, thus organ damage can thus be accelerated.			0.89 (0.14)	0.89 (0.14)	0.89 (0.14)
4. Identify the risk characteristics of medications in order to prevent complications.					
4-1. As the number of medications is increased in cases of intravenous injection in pediatric patients, the number of days of peripheral intravenous injection maintenance decrease.	1+(2) 2+(2) 3(1)	A	0.80 (0.21)	0.76 (0.24)	0.78 (0.24)
4-2. Infection occurs as the interval of injection becomes shorter.	1+(1) 2+(1)	B	0.64 (0.25)	0.61 (0.22)	0.64 (0.24)

Recommendations	Levels of evidence (study)	Recom mendat ion -grade	Appr opriat eness	Applica bility M(SD)	Effecti veness
4-3. There are more cases of phlebitis even using isotonic solution if irritating medicine, such as KCL, is mixed with the isotonic solution.	2+(1)	C	0.86 (0.13)	0.86 (0.10)	0.86 (0.13)
	1+(2)	A	0.87 (0.08)	0.88 (0.07)	0.88 (0.07)
4-4. Phlebitis increase when irritating medicine is used.	2+(1)				
	3(2)				
<u>Recommendation details</u>					
- As the osmotic pressure and pH of the highly concentrated solution (more than 500 mOsm/L of osmotic pressure) and a solution with a high pH (more than pH 9, less than 5) cause mechanical and chemical damage to the intima-media of blood vessels, the risk of phlebitis increases.			0.90 (0.09)	0.89 (0.08)	0.89 (0.08)
4-5. Parenteral nutrition of the particles with high osmotic pressure cannot be introduced peripherally even for a short period of time due to the risk of serious phlebitis and thrombosis.	3(1)	D	0.75 (0.23)	0.68 (0.23)	0.75 (0.23)
4-6. Bolus injection causes anaphylactic reactions as well as the risk of speed shock, infiltration, and phlebitis.	3(1)	D	0.79 (0.19)	0.71 (0.17)	0.75 (0.16)
4-7. Injection should be done with the solution diluted as much as possible within the limit of drug instructions.	3(2)	D	0.86 (0.13)	0.81 (0.15)	0.84 (0.15)
4-8. The back flow of blood before injection should be verified.	3(2)	D	0.91 (0.09)	0.89 (0.14)	0.89 (0.13)
4-9. When using multi-dose drugs, the vial's cap should be disinfected with 70% alcohol before use while taking care not to contaminate it by touching it.	1++(1)	B	0.93 (0.08)	0.91 (0.08)	0.91 (0.08)
4-10. According to the recommendation of the drug manufacturer, multi-dose drugs should be refrigerated after being opened.	2++(1)	C	0.90 (0.13)	0.88 (0.13)	0.88 (0.13)
4-11. With blood products, injection should not exceed more than four hours and when injecting an independent or mixed fat-soluble solution, the injection should end within 24 hours.	1+(1)	B	0.90 (0.12)	0.88 (0.14)	0.90 (0.13)
5. Explain how to monitor complications to the child or caregivers who maintain the peripheral intravenous injection.					
5-1. The information needed to monitor the catheterized area should be provided to the caregivers and children who are able to communicate, so that they can immediately inform the medical experts if there is any problem related to the peripheral intravenous injection.	3(5)	D	0.86 (0.10)	0.82 (0.08)	0.86 (0.10)