

Nurses' Competence on Intravenous Fluid Therapy in Under-Fives with Dehydration in Kakamega County Hospitals Kenya

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Abstract: Worldwide, there are two billion cases of diarrheal disease that kill approximately 1.5 million children due to dehydration every year, which is treated by fluid and electrolytes replacement. Inappropriate use of intravenous fluids therapy occurs in up to 20% of children receiving fluid therapy leading to brain overload, pulmonary edema, heart failure, embolism and renal failure. In Kenya, 17% of under-fives develop complications due to inappropriate intravenous fluid therapy. Anecdotal and empirical reports indicate that many children on intravenous fluid therapy in Kakamega county hospitals develop complications due to inappropriate fluid therapy. The overall objective of this study was to evaluate nurses' competence on intravenous fluid therapy in under-fives with dehydration in Kakamega County Hospitals. Specifically, to assess the knowledge of nurses on intravenous fluid therapy and to examine the practice of nurses' on intravenous fluid therapy. The study was conducted in Kakamega County General Hospital and six sub county hospitals that were randomly selected. Simple random sampling method was used to select participants from each facility to get a sample size of 200 nurses. A descriptive cross-sectional study design was adopted. Quantitative data was collected using observational checklists and structured questionnaire. It was then coded, entered in excel sheet, cleaned and analyzed using Social Package for Social Sciences version 23. Chi-square, logistic regression, mean and percentages were employed. The results of the study showed that 88% of nurses had "low Knowledge level", 12% had "Moderate knowledge level" while none had "High Knowledge level" on intravenous fluid therapy. 65.5 % of the respondents had "Fair practice" 22% had "poor practice", while 12.5% had "good practice". Chi square test showed that there was a statistically significant association between the practice of the nurses and the level of education attained ($p < 0.05$). Logistic regression showed that education level was a predictor of practice OR 2.965; 95% CI. Knowledge was statistically significant predictor of practice as indicated with a $p < 0.05$. In conclusion, nurses, had low level of knowledge and fair practice. Therefore, more trainings and refresher courses were recommended to enhance nurses' competence on intravenous fluid therapy in under-fives with dehydration.

Key words: Intravenous fluid therapy, nurses' competence, under-fives, Dehydration

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I. Introduction

Globally, children get intravenous fluid therapy every day to help maintain hydration since 1950 (Caldwell, 2014). Inappropriate use of intravenous fluids may occur in up to 20% of children receiving fluid therapy leading to brain overload and other serious complications (Hoste *et al.*, 2014). In Kenya, 17% of the children die due to inappropriate intravenous fluid therapy (KDHS, 2014). Inappropriate fluid therapy can increase morbidity and prolong hospital stay (Kavutha, 2010). Worldwide, 1.5 million children die due to dehydration caused by 2 billion cases of diarrheal diseases (WHO, 2009). In Kenya, a report released in April 2015 showed that, the under-fives mortality rate was 52 per 1000 live births, which was far above 39 per 1000 live births targeted under the Millennium Development Goals (KDHS, 2014). In mild cases, oral rehydration salts are given. A study conducted between October 2013 and February 2016 in 14 hospitals in Kenya revealed that, hypovolemic shock secondary to dehydration/diarrhea was 94% (582/622). The overall mortality for all children was 5% (2115/42937) and 7.9% (798/10096) in children with dehydration/diarrhea (Mbevi *et al.*, 2016).

Dehydration results from excessive loss of body fluids and electrolyte (D' Cruz, 2011). Rapid fluid therapy resuscitation is recommended for children with severe septic shock (WHO, 2013). Side effects may occur during rehydration with intravenous fluid therapy leading to brain swelling and death (Caldwell, 2014). Nurses need to have knowledge on intravenous fluid therapy for therapeutic outcome (Vijayan, 2011). They

need to understand the movement of fluid in both the intracellular and extracellular compartments (Davies, 2010). Poor insertion technique may cause blood stream infections, phlebitis, infiltration, fluid overload, hypothermia, electrolyte imbalance and embolism. Rapid fluid therapy is lifesaving for children diagnosed with hypovolemic shock or poor blood circulation (Irimuet *al.*, 2012). Fluid and electrolyte balance is generally essential to body tissues.

Electrolytes include sodium, potassium, magnesium, calcium, chloride, phosphate and bicarbonate. Crystalloid, hypertonic and colloid solutions are used. Fluid deficit lead to dehydration which require urgent replacement either orally or intravenously. Dehydration occurs due to excessive fluid loss, inadequate fluid intake or both (Mc Millen & Pitcher, 2010). These can lead to electrolyte imbalances which result in metabolic disorders. However, in children, intravenous fluid replacement therapy is one of the most frequently used therapies due to its effectiveness. Hyponatrenia can occur during fluid therapy due to excessive anti diuretic hormone leading to retention of water. It is recommended that maintenance fluids should be given closer to the basal metabolic rate curve. This can best be done by giving 75 mL/Kg for the first 10 Kg, 40 mL/Kg for the next 10 Kg (10-20Kg), and 20 mL/Kg for weight above 20Kg (Martin, 2016). Rapid fluid resuscitation is recommended in children with hypovolemic shock (WHO, 2014). The normal serum electrolyte levels are Sodium 135-145mEq/L, Chloride 95-105Me/l, Potassium 3.5-4.5mEq/L, Calcium 9-11mg% phosphate 1.7-2.6mEq/L, Magnesium 1.3-2.1mEq/l (Vijayan, 2011). Kakamega County General hospital is the largest and referral hospital in the county with the largest number of sick children being admitted diagnosed with dehydration, while other children with dehydration are treated in the sub county hospitals.

Main Objective

To evaluate nurses' competence on intravenous fluid therapy in under-fives with dehydration in Kakamega County Hospitals.

Specific Objectives

1. To assess the knowledge of nurses on intravenous fluid therapy in under-fives with dehydration.
2. To examine the practice of nurses on intravenous fluid therapy in under-fives with dehydration.

II. Research Variables

Independent Variable: Nurses' competence (Age, sex, education level, trainings, years of experience).

Dependent Variable: Intravenous fluid therapy

III. Methodology

A descriptive cross-sectional study design was conducted in Kakamega County General Hospital and six sub county hospitals. Random sampling was used to select the six sub county hospitals from the twelve sub county hospitals found in the county. Quantitative methods were adopted. The study was conducted for a period of thirteen weeks from 2nd March 2017 to 29th May 2017.

Sampling Procedure

Simple random sampling was used (Random number table) to select the six out of the twelve Sub county hospitals to be included in the study in addition to Kakamega County General Hospital. The sample size was proportionately chosen depending on the number of nurses who work in the pediatric departments in each facility. Participants were selected using simple random sampling method. In KCGH, purposive sampling method was used basing on the sections that manage pediatric patients. Simple random sampling method was used to select individual participants for the study. Cochran (1963) formulae was used with an attrition rate of 10% then the population correction factor formula to get the actual sample. Size of 200 from the known population of 283.

Research Instruments

The questionnaires and observation schedule were used to collect the data.

Data Analysis

Data was collected using structured questionnaires and observation checklist. Raw data was assigned numerical values and coded. It was then entered into a coding table and cleaned. Data analysis was done by descriptive and inferential statistics. Descriptive statistics: Frequency, means, percentages, standard deviation. Inferential statistics: Chi-square test and logistic regression tests were used. Data was analyzed using Statistical Package for Social Science version 23. Thereafter, the numerical numbers representing responses from the questionnaires were transferred to a code sheet so as to obtain quantitative results from the closed ended

questions. Categorical variables were compared using chi-square tests. Logistic regression was also used to predict the association between variables. Quantitative data was summarized, interpreted, and reported.

IV. Results

Demographic Characteristics of Participants

Gender

In this study, majority of the respondents were females represented by 56% while the males' respondents were 44%.

Age

53.0 % of the respondents were aged between 30 and 39 years, 27.0 % were aged between 40 and 49 years, 10.5 % were aged between 20 and 29 years, 9.5% were aged over 50 years. The mean age was 37.9 with a standard deviation of 7.7. The minimum age was 23 years and the highest age was 57 years.

Religion

80% of the respondents were Christians while 20% of the respondents were Muslims.

Marital Status

59.0 % of the respondents were married, 32.0 % were single, 6.0% were separated, 2.5 % were widowed and 0.5 % of the respondents were divorced.

Institution of training

70.5 % of the respondents trained in public institutions while 29.5 % of the respondents trained in private institutions. The results showed that majority of the respondents trained in public institutions as compared to those trained in private institutions.

Year of qualification

36.5 % of the respondents qualified between years 2001 and 2010, 33.5% qualified later than 2011, followed by 21.0 % who qualified between 1991 and 2000. 9.0 % of the respondents qualified between years 1981-1990.

Level of education

From the results, 50.5 % of the respondents were diploma holders, Certificate holders were 34.0 % while 15.5% had a Bachelor degree in nursing.

Distribution by sections (wards)

Majority of the nurses represented by 52% worked in pediatric medical ward, while the fewest worked in the neonatal baby unit 7%. 15.0% work in the paediatric surgical unit, 7.5% in the casualty and 18.5% in the outpatient department.

Pediatric experience

Respondents who had worked in paediatric departments with experience of 1 year to 3 years were the majority represented by 55.5 %, while those with experience of over 10 years in the paediatric department were the least with 7 %. Respondents with experience of 4 years to 6 years accounted for 27.5 % of the total and those with experience of 7 years to 9 years were 15.5%.

Knowledge of nurses' on Intravenous fluid therapy

To assess the knowledge of nurses' on intravenous fluid therapy in under-fives with dehydration, a structured questionnaire was used. The tool was adopted from (Fulcher & Frazier, 2007) and modified to suit the research objectives. The tool was also adopted and modified and used by Perry *et al.*, 2014. Respondents answered seventeen multiple choice questions on intravenous fluid therapy and its efficacy. Each correct response was given one mark and zero for wrong answer with a total of 34 marks due to some questions having had multiple correct answers. The score varied from 0 - 34 points and was classified into 3 levels according to Blooms (1963) knowledge rating levels. The knowledge scores were computed and index scores created. The scores were then standardized by creating T scores, at a mean of 50 and a standard deviation of 10 for purposes of comparison analysis. The results showed that the mean knowledge score of the respondents was 16.3 out of a possible score of 34 points (SD=2.6). 88 % of the respondents had a "low Knowledge level", 12 % of the respondent had "Moderate knowledge level" while no respondent had "High Knowledge level" on intravenous fluid therapy. This is summarized in the Table below:

Table 1.0 Knowledge of respondents on intravenous fluid therapy (Blooms, 1963)

Knowledge Level	Rating	Scores	Frequency	Percentage scored %	Mean 16.3 SD 2.6 Minimum 6.0 Maximum 27.0
Low	<60 %	Less than 20	176	88.0	
Moderate	61-79 %	21-27	24	12.0	
Total			200	100.0	

According to Blooms (1963) high knowledge level is rated at 80-100 % with scores of 28-34, Moderate knowledge level is 61-79 % with 21-27 scores and low knowledge level is below 60 % with scores below 20. For one to be considered competent, a high score of 80 % and above is recommended. From the analysis of the results, only 5.5 % of the respondents answered correctly on what should be done before and after intravenous fluid therapy while 85.5% answered wrongly. 71.5 % of the respondents did not know an example of a colloid while only 28.5 % answered correctly. 45.5 % of the respondents knew the manifestation of hypovolemia while 54.5% did not know. 62.0 % of the respondents knew the consequences of potassium imbalance while 38% did not know. 54.0 % of the respondents knew the normal serum potassium level while 46% did not know. 53.0% of the respondents knew when to flush intravenous line while 47% did not know. However, a few questions were answered well including the indicators for assessing renal failure whereby 91.5% of the respondents got it right. 96% of the respondents answered correctly on the causes of dehydration and how fluids and electrolytes are lost, 96 % of the respondents were able to correctly answer the classification of dehydration according to WHO. On the factors to be observed during intravenous fluid therapy, 16% of the respondents indicated type of fluid, 10.5 % indicated amount of fluid, 2.5% indicated number of drops in a minute, while 71.0 % mentioned workload as a factor to be observed.

Practice of nurses on intravenous fluid therapy

To evaluate the nurses on the practice of intravenous fluid therapy in under-fives with dehydration, an observation checklist was used which was adopted from (NCK Manual, 2013) and modified to suit the research objectives. The tool is a standardized tool that was set and verified by the Nursing Council of Kenya and is used in training of nurses on intravenous fluid therapy. It was then incorporated with integrated management of childhood illness whereby management of dehydration in pediatrics is essential by fluid therapy. Data was collected on skills and practice of intravenous therapy by direct observation. The checklist was ticked as either “met” when the participant performed the skill well according to the checklist or “not met” if the participant did not perform the skill according to the checklist. The checklist had 33 items which were consolidated in a composite variable called “practice score” with “met” getting a score of 1 and “not met” getting a score of 0. The total score for the practice checklist was a cumulative of 44 points. The overall score was classified into three levels of practice according to the Blooms (1963) practice classification and score as shown:

- Poor practice less than 60% (less than 26 points)
- Fair practice 60%-79% (26-35 points)
- Good practice 80%-100% (36-44 points)

The mean practice score of intravenous fluid therapy amongst the respondents was 28.3 out of a possible 44 points (SD=4.8). The maximum practice score was 37 while the minimum score was 0. As presented in table below, majority of the respondents represented by 65.5% had “Fair practice”. 22% of the respondents had “poor practice”, while 12.5% of the respondents had “Good practice”. The study hence indicated that most nurses who participated in the study were rated at fair practice (60%-79%) with a score of 26-35 points according to Blooms (1963) knowledge rating.

Table 2.0: Distribution of Practice levels by nurses towards intravenous fluid therapy (Blooms, 1963).

Practice Level	Rating	Scores	Frequency	Percentage scored %	Mean 28.3 SD 4.8 Minimum 0 Maximum 37.0
Good	80-100 %	36-44	25	12.5	
Fair	60-79 %	26-35	131	65.5	
Poor	<60 %	Less than 26	44	22.0	

Data shown in table below summarizes responses for the practice questions of the questionnaire. 68% of the respondents were able to explain the procedure to the caretaker of the child including its benefits and risks while 32% did not. This is important because it is the clients right to understand all the care they deserve for

supportive therapy. 31.0 % prepared the site for insertion aseptically while 69.0% did not. This is risky because this can introduce pathogens through the vein leading to blood stream infections. 52.5% of the respondents prepared the environment by screening the bed for privacy while 47.5% did not. 66.7% of the respondents took the equipment's to bedside or within reach. Only 17.2% of the respondents elevated the level of the bed to a comfortable height while 82.8% did not. Only 14.6% of the respondents positioned the patient in fowlers or semi fowler's position with extremities intended for cannulations below the level of the patients' heart but 85.4 % did not. 21.2% of the respondents placed the mackintosh under the site for venipuncture and 66.7% washed their hands, dried and put on clean gloves. 29.5% of the respondents took vital observations which included temperature, pulse, respiration and blood pressure while 70.5 % did not. 32.0% of the respondents monitored the fluid for flow and time while 68% did not. 38.5% of the respondents flashed the line with heparinized normal saline after the drip was over while 61.5% did not. The table below shows a summary of how the respondents performed on direct observation by the researcher and research assistants.

Tests of association between different variables

Comparison of practice score between grouping variables was done. Chi square (X^2) test of independence determines whether two variables are independent or related; the test can be used with nominal or ordinal data (Burns & Grove, 2011). In this study association between the study variables were assessed by X^2 test and a two-tailed probability value of $p < 0.05$ were used to test significance.

Chi square test of Association between age and practice of IVF Therapy

There was a statistically insignificant relationship between age and practice of nurses on IVF therapy with a $p > 0.05$.

Chi square test of Association between level of education and practice of IVF Therapy

There was a statistically significant association between the level of education of the respondents and the practice of intravenous fluid therapy in under-fives with dehydration with a $p < 0.05$. Logistic regression was done as a posthoc test to further confirm the chi-square results. The results showed that nurses who were certificate holders were 2.97 times more likely to belong to the poor practice group than the good group practice compared to degree holders with O.R 2.97; 95% CI .Nurses with diploma were 2.72 times more likely to belong to the poor practice group than the group practice group compared to degree holders OR 2.72; 95% CI; $p (0.01)$.

Chi square test of Association between knowledge levels and practice levels of nurses on IVF Therapy

There was a significant association between knowledge levels of the respondents and the practice of IVF therapy $p < 0.05$. On regression model test, knowledge was a significant predictor of practice of nurses on IVF therapy in under-fives with dehydration with a $p < 0.05$.

Association between gender and practice of IVF therapy

Association between gender and level of practice was insignificant with a $p > 0.05$. This implied there was probably no difference in IVF therapy practice of male and female nurses.

Association between Institution of training and practice of IVF

The results of the chi square test of independence showed that there was no significant association between practice of intravenous fluid therapy and the institution where the respondents trained with a $p > 0.05$.

Association between years of paediatric experience and practice of IVF therapy

The chi square test indicated that the association between years of pediatric experience and IVF therapy practice was statistically insignificant with a $p > 0.05$. This implies that paediatric experience had no significant relationship with intravenous fluid therapy practice of the nurses.

Association between years of marital status and practice of IVF therapy

There was no significant relationship between marital status and the practice of nurses on intravenous fluid therapy in under-fives with dehydration with a $p > 0.05$. Association between Religion and practice of IVF

The results of the chi square test of independence showed that there was no significant association between practice of intravenous fluid therapy and the religion of the respondents with a $p > 0.05$. This is shown in the table below:

Table 3.0: Summary of association between different variables with intravenous fluid therapy practice

VARIABLE	X^2	d f	P value
Age	6.793	8	0.56
Experience	5.799	6	0.44
Gender	2.985	2	0.23

Institution	3.573	2	0.17
Level of education	20.484	8	0.01
Knowledge	28.234	2	0.006
Religion	1.488	2	0.46
Marital status	5.644	8	0.69

V. Discussion

Analysis of the results

Knowledge of nurses' on Intravenous fluid therapy in under-fives with dehydration

Nurses' knowledge on IVF therapy was assessed from the responses given on each question in the questionnaire. From the analysis of the results, 88% of the respondents had a 'low level of knowledge', 12% had 'moderate level' and none had 'high level of knowledge' according to the classification of Blooms (1963) cut off points rating on knowledge. The mean knowledge score was 16.3 out of possible score of 34 points). The results indicated that most of the respondents had a score of below 60% after computing all the scores, analyzing the results and rating in the three categories of knowledge score. For one to be considered as competent, a score of 80%-100% is required which is high knowledge level (Blooms, 1963).

Most of the respondents had low level of knowledge on most of the questions in the questionnaire which were used to measure knowledge level. 71.5% of the respondents did not know the types of colloids used in intravenous fluid therapy. 54.0% of the respondents did not know the manifestation of hypovolemia, 46% did not know the normal serum potassium levels, and 38% did not know the consequences of potassium imbalance. Low level of nurses' knowledge may pose a high risk of poor practice on intravenous fluid therapy in under-fives with dehydration. This might lead to ineffective therapy and complications. Inappropriate use of intravenous fluids may occur in up to 20% of children receiving fluid therapy. This might lead to brain overload, renal failure, and heart failure (Hosteet *al.*, 2014). Nosocomial infections associated with intravenous fluid therapy cause blood stream infections in today's medical care. Infiltration and extravasations of intravenous fluid next to a vascular artery may cause vascular flow obstruction and lead to amputation (Thomas, 2011). The results of the study indicated that nurses had low level of knowledge which would contribute to their inappropriate practice of intravenous fluid therapy in under - fives with dehydration.

The results of this study concurs with a study that was carried out in India to assess high volumes of intravenous fluid therapy in cardiac patients which showed increased mortality rate due to fluid overload. This was associated with insufficient knowledge of nurses working in the department (Pradeep *et al.*, 2010), hence recommended studies to be conducted on nurses' knowledge in relation to practice of intravenous fluid therapy.

However, some of the respondents knew causes and classification of dehydration, how fluids and electrolytes are lost and the body systems affected with electrolytes imbalance. Nursing Council of Kenya has set national examinations for nurses to assess the knowledge level before issue of license to practice. It is the duty of the nurse and the hospital management to ensure that the practitioner retains the highest level of knowledge, get updates and other specialized trainings to ensure competent performance. Nurses should have good knowledge on intravenous fluid therapy, assessment of dehydration, the management in under-fives and be aware of any complications that might occur.

The results of this study which showed that nurses had low level of knowledge differs with a similar study which was conducted in India on nurses' knowledge on intravenous fluid and electrolyte therapy. The results showed that, 50% of the nurses had knowledge above average (Vijayan, 2011), while in Kakamega County, only 12% had moderate knowledge, with no one having high knowledge level. This could be attributed to failure of the nurses to get refresher courses and trainings, and work overload with a ratio of 1:30 (one nurse managing 30 sick under-fives) instead of the normal international standard of 1:4-8 (one nurse managing 4 to 8 patients (WHO ,2015). Global trade union federation for public service international also supports a ratio of one nurse managing four to eight patients for better healthcare. The respondents seem to have challenges of updating themselves with current information on intravenous fluid therapy hence more studies need to be carried to confirm the reasons which could be contributing to the above.

Practice of nurses on intravenous fluid therapy in children with dehydration

An observation checklist was used to rate the respondents as they performed the procedures by direct observation. From the rating 12.5% of the respondents had "good level of practice", 65.5% "Fair practice level" and 22.0% low level of practice" according to (Blooms 1963) practice rating. The mean practice score was 28.3 with a SD of 4.8 with a maximum score of 37 and minimum score of 0. 83.0% of the respondents did not elevate the bed to comfortable height. 85.5% did not place the patient in fowlers' position with extremities below heart level. This is an important procedure which should be done always to enhance venous access and ensure successful cannulation. 34% of the respondents did not apply tourniquet which helps in occlusion of venous flow leading to vein distension, visibility hence promoting access to vein. 68% of the respondents were not able to monitor the fluids being administered to detect any change of status and drop factor. This is dangerous because it can lead to complications such as fluid overload or heart failure in case it runs very fast

(Caldwell, 2014). In some cases, the line may tissue leading to infiltration and extravasation of the fluid into tissue. 64.5% of the respondents were not able to calculate number of drops per minute and regulate the flow rate and use aseptic technique in insertion of the cannula.

The results of this study which showed that many nurses had been rated at moderate practice level on IVF therapy, concurs with a prospective study that was carried out by Han *et al.*, (2010) in Australia, to assess the factors predictive of Intravenous fluid administrative errors in Australian surgical care wards. All the samples received continuous infusion of IV fluids. The result showed that the most common error observed was wrong administration rate by nurses. The researcher concluded that administration errors involving continuous infusions occur frequently, and could be reduced by use of intravenous infusion control devices and regular checking of administration rates by nurses. Nurses' level of practice needs to be high to avoid complications that might occur in relation to inappropriate intravenous fluid therapy (Davies, 2010).

The findings of this study concur with a similar study that was conducted in India on nurses practice on intravenous fluid therapy which portrayed most nurses had an average score of practice (Vijayan, 2011). The chi square test indicated that there was a significant association between the level of practice of the nurses' on IVF and the education level attained with $p < 0.05$. This implies that there was an actual difference in practice of IVF among nurses of different levels of education. Logistic regression was done as a posthoc test to further confirm the chi-square results. The results showed that nurses who were certificate holders were 2.97 times more likely to belong to the poor practice group than the good group practice compared to degree holders O.R 2.97; 95% CI. Nurses with diploma were 2.72 times more likely to belong to the poor practice group than the good practice group compared to degree holders OR 2.72; 95% CI.

The chi square test showed that there was a significant association between knowledge and practice of IVF therapy with a $p < 0.05$. Logistic regression model indicated that the level of knowledge was a predictor of practice with a $p < 0.05$. Hence, the highest knowledge level that one had predicted the practice of nurses on IVF therapy in under-fives with dehydration. This could be attributed to the advanced knowledge, practice and technology attained during trainings at higher learning levels. However, some procedures were well performed like informing the caretaker about the procedure, including risks and benefits, preparation of the equipment's, environment and privacy. Hand washing was done and drying of hands, putting on gloves in the right manner and identifying the intended vein for cannula insertion.

VI. Conclusion and Recommendations

In conclusion, nurses had low level of knowledge on intravenous fluid therapy in under-fives with dehydration. The practice of nurses on intravenous fluid therapy was rated as "fair practice" according to the classification by Blooms (1963) and as per the standards set by the Nursing Council of Kenya. Education level had a statistically significant association with nurses' practice on intravenous fluid therapy in under-fives with dehydration. The researcher therefore recommends refresher courses and on job trainings for nurses working in paediatric departments on intravenous fluid therapy to improve knowledge. There should be Supportive supervision and mentorship programs to improve nurses' practice on intravenous fluid therapy. Finally, further researches to be conducted on the relationship between level of education of nurses' and intravenous fluid therapy practice to add the literature and knowledge generation in this field of study.

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