

# Nurses' knowledge regarding intravenous fluid therapy at a County hospital in Kenya

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## ABSTRACT

**Background:** Inadequate knowledge of intravenous fluid therapy among health care workers is a leading cause of errors resulting in increased morbidity and mortality in hospitalized patients. Because nurses are the cornerstone of infusion therapy, their knowledge of this subject is critical. This study assessed nurses' knowledge of intravenous fluid therapy and examined relationships between their knowledge and the nurses' demographic and training characteristics.

**Methods:** A cross-sectional survey of 52 staff nurses working in medical and surgical wards was carried out at a County teaching hospital in Kenya. A validated 10-item survey questionnaire was used to measure nurses' knowledge of basic aspects of intravenous fluids, including classification, ionic composition, indications, administration, monitoring, and related complications. The data were entered and analyzed by SPSS version 21.

**Results:** Overall, the mean knowledge score on intravenous fluid therapy among nurses was 57.4% ( $SD = \pm 28.55$ ), depicting moderately adequate knowledge. Adequate knowledge regarding intravenous fluid therapy was present in only 12% of the nurses, whereas 23% had inadequate knowledge. Knowledge deficiencies were highest regarding the ionic composition of intravenous fluids. A positive correlation was observed between nurses' intravenous fluid therapy knowledge and previous further training on intravenous fluids ( $p < 0.001$ ), level of education ( $p < 0.001$ ), and ward ( $p = 0.03$ ).

**Conclusion:** Nurses' knowledge of intravenous fluid therapy is moderately adequate. Continuous education and training of nurses on IV fluid therapy should be conducted regularly to improve their knowledge and consequently, the quality of patient care. Further research involving direct observation of nurses during intravenous fluid therapy is needed for validation of competency.

## 1. Introduction

Intravenous fluid therapy is amongst the commonest routine nursing care procedures and has been practised for more than 180 years globally (Severs, Hoorn, & Rookmaaker, 2015). It involves the administration of intravenous (IV) fluids, to nearly all hospitalized patients, for body fluid and electrolyte maintenance and as diluents for medications (Finfer et al., 2018). The intravenous fluids are liquid substances that are administered into the body's circulatory system via a vein (Frost, 2014) and are classified as crystalloids, colloids, and blood products (Westbrook, Rob, Woods, & Parry, 2011). Crystalloid solutions are composed of water and electrolytes with the ability to cross a semi-permeable membrane into cells and tissues and thus used for fluid replacement; examples include 0.9% Normal saline, Lactated Ringer's, and dextrose

solutions (Lippincott, 2019). On the other hand, colloids contain large molecules that do not cross semipermeable membranes, thereby remaining within the blood vessels as volume expanders due to their high oncotic pressure; examples include albumin and low-molecular-weight dextran (Lippincott, 2019). The choice and dose of IV fluids are determined by the clinical status of a patient, indications, and contraindications (Gross, Samarin, & Kimmons, 2017).

Intravenous fluid therapy is delivered collaboratively by nurses and physicians. Nurses' knowledge of age-specific considerations during the administration of IV fluids is critical in promoting patient safety and preventing complications for positive patient outcomes (Gorski, 2017). The Royal College of Nursing (2016) standards of practice direct that the nurses involved in the administration of IV infusions be trained in infusion therapy, including IV fluids types, clinical judgment,

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assessment, administration, monitoring, and complications. All of these subject areas are covered during basic Nursing education in most countries in addition to the classification, types, indications, and ionic composition of common IV fluids (Felver, 2017; Institute, 2013). Complications of IV fluid therapy have been cited in the literature ranging from infiltration, extravasation, thrombophlebitis, and infections (Dychter et al., 2012) to organ failure resulting from prolonged over-infusion or under-infusion of IV fluids (Njung'e et al., 2017).

Empirical evidence has continued to show that globally, errors attributable to knowledge inadequacies among health care workers in IV fluid therapy occur often (Lyons et al., 2018), in as high as 20% of the patients (Enquiry, 2011). Specifically, recent studies that have assessed nurses' knowledge of IV fluid therapy have predominantly recorded average knowledge (Devi et al., 2016) to overwhelmingly inadequate knowledge scores in a majority of the nurses (Abwalaba et al., 2018; Lamsal & Shrestha, 2019; Othman & Ahmed, 2019). In South Africa, knowledge inadequacies in IV fluid therapy have also been reported (Luce, Soffair, & Parrish, 2019).

Poor knowledge of IV infusion has the potential of jeopardizing the quality of care provided to patients and consequently lead to poor outcomes. In Kenya, inappropriate IV fluid therapy accounts for about 17% of deaths among hospitalized patients (Abwalaba et al., 2018). These errors have been linked to inadequacies in IV fluid therapy knowledge among health care workers, including nurses (Abwalaba et al., 2018; Frost, 2014; Westbrook et al., 2011). Findings of a study conducted in 13 Kenyan hospitals showed that inadequate knowledge of IV fluid therapy among nurses is a risk factor for mortality and further demonstrated that improved knowledge significantly reduced the mortality of patients (Akech et al., 2018). However, only a few studies have been conducted in the country to examine the nurses' knowledge of IV fluid therapy to identify possible deficiencies.

Continuous assessment of practising nurses' knowledge of IV fluid therapy is critical in ensuring competency (Ahmed, Mohammad, El-Deen, & Sayed, 2013; Lamsal & Shrestha, 2019; Njung'e, 2018), as a reduction in the level of knowledge during nursing practice has been cited (Westbrook et al., 2011). As such, in-service training has been proven to be effective in promoting knowledge, understanding, and rationalization in monitoring patients on IV therapy (Vincent & Mahendiran, 2015). The 2016 Infusion Therapy Standards of the Infusion Nurses Society recommends the regular use of written tests to assess nurses' level of knowledge on various aspects of infusion therapy, with the integration of clinical scenarios to assess their critical thinking skills (Gorski, 2017). Such evaluations can help identify the training needs of staff nurses by assessing their level of knowledge of intravenous fluid therapy, and subsequently tailor the training based on deficiencies noted. This study assessed nurses' knowledge of IV fluid therapy and further examined relationships between this knowledge and the nurses' demographic and training characteristics.

## 2. Materials and methods

A descriptive cross-sectional study was conducted at a 300-bed tertiary teaching hospital in Kiambu County, Kenya. The study was carried out in two medical and two surgical wards. The target population was all the 258 nurses working at the facility, with a study population of 60 nurses working in the four wards. All nurses registered by the nursing council and working in the four wards were eligible to participate. However, student nurses and nurses who did not consent to the study were excluded.

Fischer's formula and Finite population correction for proportions were applied for sample size determination and a sample of 52 nurses was obtained. Calculation of the proportionate sample from the four wards based on the number of nurses in each ward was as follows:

$$\frac{\text{Number of nurses in specific ward}}{\text{Total number of nurses in the four wards (60)}} \times \text{Sample size (52)}$$

$$\text{Surgical ward 1: } (26)/60 * 52 = 23$$

$$\text{Surgical ward 2: } 11/60 * 52 = 9$$

$$\text{Medical ward 1: } 12/60 * 52 = 10$$

$$\text{Medical ward 2: } 11/60 * 52 = 10$$

Subsequently, simple random sampling in which the researcher used randomly marked tickets (Yes/No) was conducted, and nurses who picked the ones marked 'Yes' were selected to participate in the study. Approval to conduct the study was sought from the ethics review committees at both the study site and the National Commission for Science, Technology, and Innovation (Permit number: NACOSTI/P/16/66942/12664). The hospital administrators, departmental heads, and ward managers granted permission to collect data from the nurses at the medical and surgical wards. A validated 10-item survey questionnaire in the English language was developed informed by previous research (Fernandez, 2009). The structured questionnaire included a wide range of questions that measured nurses' awareness of basic aspects of IV fluid therapy including the classification, ionic composition, indications, administration, monitoring, and related complications of IV fluid therapy. It comprised of multiple choice questions in which respondents selected the correct answers such as the ionic composition of Lactated Ringer's solution, and others that required a short factual answer, for example, on the classification of IV fluids. Further, demographic characteristics of the respondents such as age, work experience, the highest level of education, further training on IV therapy, and their wards were also included as these could potentially influence the nurses' knowledge of IV fluid therapy.

Pretesting of the questionnaire was performed among nurses working at the gynecology ward at the study site due to similarity in characteristics to the study population and thereafter, appropriate revisions of the tool was done to ensure validity. Notably, some of the questions were rephrased appropriately to ensure clarity and conciseness. Data collection was carried out over one month, in July 2017, to access nurses working in the various shifts. The nurses were informed of the study by the respective unit in-charges during the morning shift report prior to meeting the researchers. Voluntary participation was encouraged and informed consent was obtained from the nurses. The questionnaire was then distributed by the researchers to the study participants during their tea breaks. It took an average of 10 min to for them to complete, after which the questionnaires were handed back to the researchers and confidentiality upheld. Moreover, the questionnaires were serialized and did not include participants' identification details to ensure anonymity.

Data were checked for missing information, coded, entered, and double-checked for complete entries. The Statistical Package for Social Sciences version 21 was used for data entry and analysis. Scoring of the nurses' level of knowledge was such that each correct response was awarded one mark whereas an incorrect response was awarded a score of zero. The least score was zero whereas the maximum possible score was 14. This was due to two questions that required listing of multiple answers: "Mention three ions contained in the Lactated Ringer's solution." and "Which two body systems are mainly monitored in the assessment of body fluid balance?" that earned the respondent 3 points and 2 points respectively. The aggregate scores were graded as follows: a score of 76–100% denoted adequate knowledge on the administration of IV fluids, 50–75% moderately adequate knowledge, and inadequate knowledge was for scores <50% (Fernandez, 2009; Lamsal & Shrestha, 2019).

Data analysis was performed using descriptive and inferential statistics. Univariate statistics, including frequencies, percentages, and means were calculated to summarize respondents' demographics, intravenous fluid therapy training characteristics, and knowledge scores. Pearson Chi-square value was calculated to compare categorical variables and assess for statistically significant differences. Bivariate analysis was done to determine relationships between variables. A p-

value <0.05 was considered significant. The analyzed data was presented on charts, tables, and narrative text.

### 3. Results

#### 3.1. Sample characteristics of the respondents

A response rate of 100% was registered. Female nurses comprised 69.2% (n = 36) of the participants. The majority of respondents (78.8%, n = 41) had attained a Diploma level of nursing training. Only a minority of the nurses (19.2%, n = 10) reported having undergone further training on intravenous fluid therapy during nursing practice. Over half of the participants (57.7%, n = 30) had work experience of more than 20 years in nursing, with only 11.5% (n = 6) having worked for <5 years. [Table 1](#).

#### 3.2. Level of knowledge on IV fluid therapy

In assessing the nurses' knowledge of IV therapy, various basic aspects of IV fluid therapy were tested. Over half of the nurses (57.7%, n = 30) correctly identified normal saline (NaCl 0.9%) as the most physiological IV fluid in relation to plasma. The majority (84%, n = 44) of the nurses were unable to classify IV fluids generally into crystalloids and colloids and give examples. Nearly half (48.9%, n = 25) of the participants did not know the indications of the commonly administered IV fluids, including normal saline 0.9%, Lactated Ringer's solution, and 5% dextrose in water. Only 15.4% (n = 8) of the participants were able to correctly identify at least three ions contained in Lactated Ringer's Solution. However, all respondents correctly mentioned at least two body systems that were mainly monitored in assessing patients' body fluid balance. The highest knowledge deficiencies were related to ionic composition and classification of IV fluids (p = 0.003). Concerning IV fluid monitoring and associated complications, mean knowledge scores on what to monitor during the administration of IV fluids to patients were slightly higher (Mean = 75.55; SD = ±24.43) compared to that on complications related to IV therapy (Mean = 46.65; SD = ±36.50). [Table 2](#).

The overall mean knowledge scores on IV fluid therapy by nurses at the adult medical and surgical wards was 57.4% (SD = ±28.55), which depicted a moderately adequate knowledge level. A higher proportion of the nurses (65%) had moderately adequate knowledge whereas 23% had inadequate knowledge regarding IV fluids ([Fig. 1](#)).

#### 3.3. Correlation of nurses' IV fluid knowledge scores and sample characteristics

Respondents' knowledge scores were further stratified based on demographic and training characteristics. There was a statistically significant difference in average knowledge scores of respondents based on

**Table 1**  
Sample characteristics of the respondents (n = 52).

S. No.	Variables	Categories	n (%)
1.	Sex	Female	36 (69.2)
		Male	16 (30.8)
2.	Age (years)	20–29	7 (13.5)
		30–39	12 (23.1)
		40–49	27 (51.9)
		≥50	6 (11.5)
		1–9	9 (17.3)
3.	Work experience (years)	10–19	13 (25.0)
		≥20	30 (57.7)
		1–9	9 (17.3)
4.	Level of education	Bachelor's degree	9 (17.3)
		Diploma	41 (78.8)
		Certificate	2 (3.8)
5.	Further training on IV therapy	Yes	10 (19.2)
		No	42 (80.8)

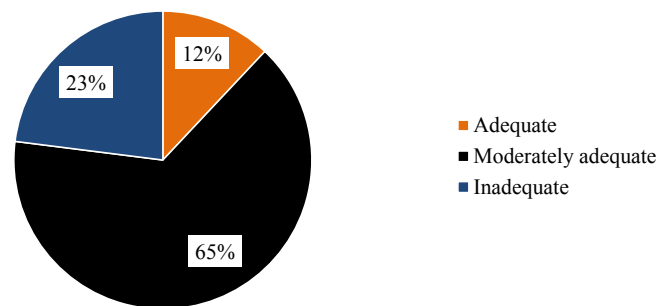
**Table 2**

Frequency of correct responses on nurses' IV fluid therapy knowledge survey questions (n = 52).

S.no no	Variables	n (%)	
1.	Most Physiological IV Fluid in relation to blood plasma	30 (57.7)	
2.	Classification of IV fluids	8 (15.4)	
3.	Indications of commonly administered IV fluids	25 (48.9)	
4.	Ions contained in Lactated Ringer's Solution	8 (15.4)	
5.	What to monitor when administering IV Fluids	(Mean = 75.55; SD= ±24.43)	
		• IV infusion rate	44 (86.4)
		• Input output fluid balance	52 (100.0)
		• Cannula site infiltration	42 (80.8)
		• Daily body weight	18 (35.0)
6.	Complications of IV Fluid Therapy	(Mean = 46.65; SD= ±36.50)	
		• Thrombophlebitis	3 (5.8)
		• Infiltration and extravasation	31 (59.6)
		• Embolism	11 (21.2)
		• Fluid Overload	52 (100.0)
7.	Body systems monitored during IV fluid administration to assess fluid balance	52 (100.0)	

Note: SD Standard deviation.

**Nurses' Knowledge of IV Fluid Therapy**



**Fig. 1.** Nurses' knowledge of intravenous fluid therapy.

ward type (p = 0.03). Nurses in surgical wards had higher average scores (61.0, SD ± 9.79) compared to their counterparts in medical wards (53.9, SD ± 14.70).

The highest knowledge scores (79.7%), were registered among nurses with a Bachelor's degree, specifically, those who had less than five years of post-qualification clinical experience (X<sup>2</sup> = 75.669, p = 0.001). Also, participants with 1–9 years' nursing experience had moderately adequate knowledge at 66.5%. Notably, nurses who had undertaken further training on IV therapy attained significantly higher knowledge scores than the rest (p < 0.001); however, their scores did not correspond to their work experience.

Positive correlations were noted between nurses' IV fluid therapy knowledge and the level of education (p = 0.001) and the nurses' wards (p = 0.03). On the contrary, a negative weak correlation between participant's gender and the IV fluid knowledge scores was recorded, with higher scores registered among female nurses compared to their male counterparts which could be attributed to the higher number of females nurses in the wards (p = 0.07). [Table 3](#).

### 4. Discussion

The findings of this study showed that the average level of knowledge of IV fluid therapy among nurses in the medical and surgical wards was moderately adequate. A higher proportion of the participants (65%) had moderately adequate knowledge of IV fluid therapy compared to those who had adequate knowledge (12%), and inadequate knowledge

**Table 3**  
Correlation of nurses' IV fluid knowledge scores and sample characteristics.

Variables	Mean Knowledge score (%)
Wards	
Medical	53.9, <i>SD</i> ±14.70
Surgical	61.0, <i>SD</i> ±9.79
<i>P</i> = 0.03	
Sex	
Women	58.5
Men	56.3
<i>P</i> = 0.07	
Age (years)	
20–29	61.3
30–39	56.7
40–49	58.9
≥50	52.7
<i>P</i> = 0.13	
Work experience (years)	
1–9	66.5,
10–19	52.4,
≥20	53.3
<i>P</i> = 0.09	
Level of education	
Bachelor's degree	79.7
Diploma	50.6
Certificate	41.9
<i>P</i> = 0.001	
Further training on IV therapy	
Yes	49.7
No	65.1
<i>p</i> < 0.001	

Note: *p* < 0.05; *SD* Standard deviation.

(23%) of IV fluid therapy. These results are consistent with those of a recent study by [Devi et al. \(2016\)](#) in India which found that the majority of the nurses (55%) at the general hospital had moderate knowledge, while 13% of the respondents had inadequate knowledge. In contrast, [Fernandez \(2009\)](#) study in India among nurses obtained higher average IV fluid knowledge scores (75%) compared to the present study (57.4%). In contrast, inadequate level of knowledge on IV therapy among nurses was reported at a teaching hospital in Nepal ([Lamsal & Shrestha, 2019](#)). In an Iraqi study, a majority of the nurses (89.4%) had poor average scores (<50%) on IV fluid therapy knowledge ([Othman & Ahmed, 2019](#)), which was worse compared to the present study's number of nurses with inadequate knowledge (23%). In Kenya, [Abwalaba, Ogotu, and Ng'ang'a \(2018\)](#) reported that knowledge of IV fluid therapy was poor (scores < 60%) in the majority of nurses (88%) in a cross-sectional study carried out in seven hospitals in Kenya. The researchers rated scores <60% as poor, compared to the present study's <50%. As observed in the aforementioned studies, some of the differences in the average nurses' knowledge level may partly be due to disparities in the study methods and rating scales. Nonetheless, the knowledge inadequacies among nurses on routine nursing procedures raise questions on the quality of care delivered to the patients.

Knowledge deficiencies in IV fluid therapy among nurses were significantly high regarding the ionic composition and indications of commonly administered IV fluids (84.6%). This finding is in line with observations of previous research by [Ahmed et al. \(2013\)](#) which reported that only 14.5% of the nurses had good (scores >70%) knowledge on the composition of fluids. Further, the requirement that daily body weight is recorded in patients receiving IV fluids to monitor fluid balance and as a potential indicator of over-infusion was correctly mentioned by a minority of the respondents in this study (35%), which concurs with results of an Australian study in which only 15% of patients on IV fluids had their body weight measurements recorded daily ([Eastwood et al., 2012](#)). However, all participants correctly mentioned fluid overload as one of the complications of IV fluid therapy and input–output fluid balance monitoring as a critical indicator of potential complications. Overall, the study participants demonstrated a higher

knowledge base on IV fluid monitoring (Mean = 75.55; *SD* = ±24.43) compared to that of the complications (Mean = 46.65; *SD* = ±36.50) associated with IV fluid therapy.

Concerning demographic characteristics, respondents in surgical wards had higher average knowledge scores (61.0, *SD* ± 9.79) on IV fluid therapy compared to their colleagues in medical wards (53.9, *SD* ± 14.70). These findings could be attributed to the frequent performance of the procedure due to the high number of preoperative and post-operative patients on IV therapy for fluid maintenance and replacement traditionally practiced in surgical wards, due to the nature of patient's conditions.

The highest level of education of the respondents was significantly related to IV fluid knowledge scores, with Bachelor educated nurses posting higher average scores (79.7%) compared to their diploma (50.6%) and certificate colleagues (41.9%). However, only a small percentage of respondents had Bachelors (17.9%), with the majority having completed a diploma (78.8) in Nursing. This finding aligns with observations of previous research by [Ahmed et al. \(2013\)](#) in Egypt in which most of the nurses (88.6%) had a diploma and by [Abwalaba et al. \(2018\)](#) in Kenya where 50.5% of the participants were diploma holders with only 15.5% accounting for baccalaureate-level trained nurses. Within the Kenyan context, most of the nurse training institutions offer the diploma in nursing, a 3-year course, whereas universities provide the 4-year bachelor of nursing training. The latter has higher cut-off points for enrollment and a longer training period, with a broader theoretical base, followed by a year-long internship. These differences in the curriculum could have accounted for better IV knowledge scores among respondents with a Bachelor's degree.

Previous further training on IV fluid therapy was significantly correlated with knowledge scores (*p* < 0.001). The higher knowledge score among nurses who had undertaken further training on various aspects of IV fluid therapy (19.2%) concurs with findings reported in previous studies in adult wards in Egypt and England that demonstrated significant improvement (*p* < 0.0001) in nurses' knowledge of IV fluid therapy following a designed in-service training protocol ([Ahmed et al., 2013](#)), a 50% reduction in complications associated with IV therapy ([Woody & Davis, 2013](#)), and a 48% increase in fluid balance chart accuracy after a quality improvement project conducted by [Vincent and Mahendiran \(2015\)](#). It is however notable that in the present study, only a small proportion of the nurses (19.2%) had undergone further training on IV fluid therapy consistent with findings of other similar studies. For example, only 16.4% of nurses in a medical ward at an Egyptian hospital ([Ahmed et al., 2013](#)) and 15.3% of nurses at a teaching hospital in Nepal had undertaken further training ([Lamsal & Shrestha, 2019](#)). Respondents in the present study had learned the theoretical and practical aspects of IV fluid administration during their basic nursing training as a requirement of their curriculum. The in-service training was conducted at seminars, conferences, and in-house by visiting infusion nursing experts and other healthcare providers at the hospital. Nurses' knowledge on IV fluid therapy was significantly correlated with their working experience which is consistent with works by [Westbrook et al. \(2011\)](#) that demonstrated a 10.9% reduction in IV therapy-related nursing errors with increase in working experience until the sixth year of practice followed by a decline. This indicates that nurses forget the information they acquire during nursing training over time. This therefore indicates the need for regular in-service training programs at the hospitals on infusion nursing which would serve to update the nurses' knowledge and enhance competency.

Negative correlations were found between nurses' knowledge of IV fluids and age (*p* = 0.13), and gender (*p* = 0.07). Similar findings have been reported by [Fernandez \(2009\)](#) in India on correlation with age (*p* = 0.90). On the contrary, findings by [Lamsal and Shrestha \(2019\)](#) study reported a positive correlation between age and the nurses' level of knowledge (*p* = 0.012). The difference in knowledge score may have been due to differences in sample characteristics, with more female nurses participating in the present study due to their inadvertently

larger numbers in deployment (Abwalaba et al., 2018; Ahmed et al., 2013).

## 5. Conclusion

Nurses' knowledge of intravenous fluid therapy was moderately adequate. Targeted educational intervention strategies on IV fluid therapy through continuous nursing education sessions or workshops should be conducted regularly with a specific focus on the ionic composition of IV fluids, their indications, and monitoring for associated complications, where deficiencies were most notable. There is a need for further studies incorporating observation of nurses' practice of IV fluid therapy for validation of competency.

Clinical significance and relevance: Adequate knowledge regarding IV therapy among nurses is important in ensuring quality healthcare, reducing IV-related morbidity and mortality, and improving patient outcomes.

## CRedit authorship contribution statement

**Winfridah Wangui Njung'e:** Conceptualization, Methodology, Investigation, Writing - original draft. **Elizabeth Kalondu Kamolo:** Visualization, Writing - review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

- Abwalaba, R. A., Ogotu, P., & Ng'ang'a, S. (2018). Nurses' competence on intravenous fluid therapy in under-fives with dehydration in Kakamega County Hospitals Kenya. *IOSR Journal of Nursing and Health Science*, 7(2), 41–48. <https://doi.org/10.9790/1959-0702084148>.
- Ahmed, M. A., Mohammad, Z. A., El-Deen, M. E., & Sayed, S. Y. (2013). Effect of a designed nursing protocol on nurse's knowledge and practice regarding Intravenous Therapy. *Assiut Scientific Nursing Journal*, 1(1), 130–138. <https://doi.org/10.21608/asnj.2013.57392>.
- Akech, S., Ayieko, P., Gathara, D., Agweyu, A., Irimu, G., Stepniewska, K., ... Wafula, J. (2018). Risk factors for mortality and effect of correct fluid prescription in children with diarrhoea and dehydration without severe acute malnutrition admitted to Kenyan hospitals: An observational, association study. *Lancet Child Adolescent Health*, 2(7), 516–524. [https://doi.org/10.1016/S2352-4642\(18\)30130-5](https://doi.org/10.1016/S2352-4642(18)30130-5).
- Devi, A. N., Indria, S., Rajeswari, H., Kalavathi, B., Shabana, S., Deepika, G., & Suchithira, S. (2016). A study to assess the knowledge regarding intravenous fluids and drug administration among staff nurses working in Narayana general hospitals at Nellore. *Indian Journal of Public Health Research and Development*, 7(4), 14–17. <https://doi.org/10.5958/0976-5506.2016.00180.7>.
- Dychter, S. S., Gold, D. A., Carson, D., & Haller, M. (2012). Intravenous therapy: a review of complications and economic. *Journal of Infusion Nursing*, 35(2), 84–91. <https://doi.org/10.1097/NAN.0b013e31824237ce>.
- Eastwood, G. M., Peck, L., Young, H., Prowle, J., Vasudevan, V., Jones, D., & Bellomo, R. (2012). Intravenous fluid administration and monitoring for adult ward patients in a teaching hospital. *Nursing & Health Sciences*, 14(2), 265–271. <https://doi.org/10.1111/j.1442-2018.2012.00689.x>.
- Felver, L. (2017). Fluid, Electrolyte, and Acid-Base balance. In P. A. Potter, P. A. Stockert, A. G. Perry, & A. M. Hall (Eds.), *Fundamentals of Nursing* (9th ed., p. 934). Elsevier.
- Fernandez, V. V. (2009). *A study to assess knowledge about infusion therapy among neuro nurses*. Trivandrum: Sree Chitra Tirunal Institute for Medical Sciences and Technology.
- Finfer, S., Myburgh, J., & Bellomo, R. (2018). Intravenous fluid therapy in critically ill adults. In *Nature Reviews Nephrology* (Vol. 14, Issue 9, pp. 541–557). Nature Publishing Group. <https://doi.org/10.1038/s41581-018-0044-0>.
- Frost, P. (2015). Intravenous fluid therapy in adult inpatients. *BMJ* (Online), 350. <https://doi.org/10.1136/bmj.g7620>.
- Gorski, L. (2017). Infusion Therapy Standards of Practice. *Journal of Infusion Nursing*, 39(1S), 11–18. [www.journalofinfusionnursing.com](http://www.journalofinfusionnursing.com).
- Gross, W., Samarin, M., & Kimmons, L. A. (2017). Choice of Fluids for Resuscitation of the Critically Ill: What Nurses Need to Know. *Critical Care Nursing Quarterly*, 40(4), 309–322. <https://doi.org/10.1097/CNQ.0000000000000170>.
- Lamsal, S., & Shrestha, R. (2019). Nurses' knowledge and practice regarding intravenous therapy in a teaching hospital, Bharatpur. *Journal of Chitwan Medical College*, 9(1), 13–19. <https://doi.org/10.3126/jcmc.v9i1.23777>.
- Lipincott, Nursing Center (2019).
- Luce, C., Soffair, R., & Parrish, A. (2019). Improving intravenous fluid prescribing in the Eastern Cape in South Africa. *BMJ Case Reports*, 8(3), e000406. <https://doi.org/10.1136/bmjor-2018-000406>.
- Lyons, I., Furniss, D., Blandford, A., Chumbley, G., Iacovides, I., Wei, L., Cox, A., et al. (2018). Errors and discrepancies in the administration of intravenous infusions: A mixed methods multi-hospital observational study. *BMJ Quality and Safety*, 27(11), 892–901. <https://doi.org/10.1136/bmjqs-2017-007476>.suppl1.
- National Confidential Enquiry into Patient Outcome and Death. (2011). *Knowing the Risk - A review of the peri-operative care of surgical patients*. [https://www.ncepod.org.uk/2011report2/downloads/POC\\_fullreport.pdf](https://www.ncepod.org.uk/2011report2/downloads/POC_fullreport.pdf).
- National Institute for Health and Care Excellence [NICE]. (2013). *Intravenous fluid therapy in adults in hospital - Clinical guideline [CG174]*. National Institute for Health and Care Excellence. <https://www.nice.org.uk/guidance/cg174/chapter/1-Recommendations#training-and-education-2>.
- Njung'e, W. W. (2018). Health system factors that affect intravenous fluid administration by nurses at a county referral hospital in Kenya | Njung'e | Kenyan Journal of Nursing & Midwifery. *Kenyan Journal Of Nursing & Midwifery*, 3(2), 73–78. <https://www.kjnm.co.ke/index.php/kjnm/article/view/142>.
- Njung'e, W. W., Mbithi, B. W., & Okoya, R. (2017). Completion of Intravenous Fluid administration regimen by Nurses working in adult Medical and Surgical Wards at a County Referral Hospital, Kenya. *Journal of Health, Medicine and Nursing*, 35, 32–35. <https://www.researchgate.net/publication/329814046>.
- Othman, N. R., & Ahmed, A. A. (2019). Nurses knowledge, attitude and practice concerning fluid therapy in children hospital in Erbil city, Kurdistan region Iraq. *Indian Journal of Forensic Medicine and Toxicology*, 13(4), 658–662. <https://doi.org/10.5958/0973-9130.2019.00367.0>.
- Royal College of Nursing. (2016). *Infusion therapy standards: Rapid evidence review*. *Royal College of Nursing*. <https://www.rcn.org.uk/professional-development/principles-of-nursing-practice>.
- Severs, D., Hoorn, E. J., & Rookmaaker, M. B. (2015). *A critical appraisal of intravenous fluids: From the physiological basis to clinical evidence | Nephrology Dialysis Transplantation | Oxford Academic. Nephrology Dialysis Transplantation*, 30(2), 178–187.
- Vincent, M., & Mahendiran, T. (2015). Improvement of fluid balance monitoring through education and rationalisation. *BMJ Quality Improvement Reports*, 4(1), u209885. w4087. <https://doi.org/10.1136/bmjquality.u209885.w4087>.
- Westbrook, J. I., Rob, M. I., Woods, A., & Parry, D. (2011). Errors in the administration of intravenous medications in hospital and the role of correct procedures and nurse experience. *BMJ Quality and Safety*, 20(12), 1027–1034. <https://doi.org/10.1136/bmjqs-2011-000089>.
- Woody, G., & Davis, B. A. (2013). Increasing nurse competence in peripheral intravenous therapy. *Journal of Infusion Nursing*, 36(6), 413–419. <https://doi.org/10.1097/NAN.0000000000000013>.