

Assessment of the knowledge and use of hypertonic saline among doctors working in paediatrics departments of tertiary institutions in the five states of South-East Nigeria

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ABSTRACT

Objectives: This study aimed to evaluate the knowledge and use of hypertonic saline among doctors in the Southeast region of Nigeria.

Methods: It was a cross-sectional study conducted amongst 182 doctors in the paediatric departments of the six tertiary institutions in South Eastern Nigeria. Data to assess knowledge and use of hypertonic saline were collected using self-administered, structured questionnaires.

Results: After aggregating the knowledge questions (definition of hypertonic saline, knowledge of available concentrations and modes of administration) and categorizing knowledge into good or poor, 148 (81.3%) had good knowledge, while 34 (18.7%) had poor knowledge. Respondents who had ever seen an infusion of hypertonic saline were 93 (51.1%), while only 62 (34.1%) had ever used it during their practice. Among those who had used it, only 33 (18.1%) obtained it from their hospital pharmacy. Most respondents (91.2%) would support advocacy for its increased availability and use in Nigeria.

Conclusions: Our study demonstrated good knowledge of hypertonic saline, however, there is low usage due to unavailability. There is a need for collaboration between paediatricians, pharmaceutical companies and other stakeholders to create demand and initiate the production of hypertonic saline.

Keywords: Hypertonic saline, knowledge, doctors, use, developing country

Hypertonic saline is a crystalloid intravenous fluid that consist of sodium chloride (NaCl) dissolved in water with a greater sodium concentration than that found in normal blood serum or physiological saline



e-ISSN: 2149-3189

Received: January 25, 2023; Accepted: April 15, 2023; Published Online: April 18, 2023

How to cite this article: Ndu IK, Edelu BO, Iloh KK, Nduagubam OC, Iheji CC, Ezeudu CE, et al. Assessment of the knowledge and use of hypertonic saline among doctors working in paediatrics departments of tertiary institutions in the five states of South-East Nigeria. Eur Res J 2023;9(6):1286-1292. DOI: 10.18621/eurj.1241649

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(0.9% w/v) [1]. Commonly used preparations include 2%, 3%, 5%, 7%, and 23% NaCl [2].

It works primarily by an osmotic effect, although it has other mechanisms of action.[3] Through its osmotic effect, hypertonic saline draws fluid out of edematous cerebral tissues because it has a higher concentration of sodium and a lower concentration of water than blood. These concentration differences create an osmotic gradient that promotes excess water flow from cerebral tissue to the blood via osmosis[3, 4]. Other physiological effects beneficial to cerebral injury include hemodynamic, immunomodulatory, and neurochemical changes [5].

Hypertonic saline can treat hyponatremia and is an integral component of treatment for patients with life-threatening conditions such as severe hyponatremic encephalopathy, traumatic brain injury, and cerebral edema[1, 6]. Research shows that 3% hypertonic saline decreases intracranial pressure similarly to 20% mannitol, and both fluids have similar effects on systemic hemodynamics [7]. Central venous lines were until recently the main route of administration of 3% saline, to avoid infusion-related adverse events (IRAEs) in peripheral veins; however, studies have lately reported that administration of 3% NaCl is relatively safe through a peripheral vein [6]. Other uses include treatment of syndrome of inappropriate antidiuretic hormone secretion (SIADH) and cerebral salt wasting (CSW) syndrome [8]. Ophthalmic preparations are used to reduce corneal swelling, and nebulized hypertonic saline can also be used to treat bronchiolitis and cystic fibrosis [9-11]. Hypertonic saline has been reported to be more effective than normal saline in alleviating the symptoms of allergic rhinitis in children [12, 13].

Comparatively, hypertonic saline is superior to mannitol in the management of raised intracranial pressure (ICP) with a more sustained effect and can improve cerebral perfusion pressure more than mannitol [14, 15]. Also, rebound cerebral edema, which is a recognized side effect of mannitol is very uncommon with hypertonic saline [16].

However, despite all these beneficial uses of hypertonic saline, it is not commonly available in the Nigerian pharmaceutical market. The Group Chairman/Chief Executive Officer, Juhel Nigeria Limited (an Indigenous conglomerate founded in 1987 as the first pharmaceutical tablet manufacturing company in

old Anambra State Nigeria), stated that though hypertonic saline could be produced in Nigeria, in the absence of demand, the substantial production costs cannot be sustained by manufacturers. (Dr. Ifeanyi Okoye, Ph.D, FPSN, mni, OFR. 2022, personal communication, 11th January, 2022) Thus with significant demand increases, this situation can be reversed easily. This study aimed to evaluate the knowledge and use of hypertonic saline in our region and hopefully stimulate awareness/increase demand so drug manufacturers can commence commercial production.

METHODS

Setting

This cross-sectional study was conducted amongst doctors in the paediatric departments of the six tertiary institutions in South Eastern Nigeria namely: Enugu State University Teaching Hospital, Parklane, Enugu; University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu; Nnamdi Azikiwe University Teaching Hospital; Federal Medical Centre Owerri; Federal Medical Centre Umuahia; Alex Ekwueme Federal University Teaching Hospital, Abakiliki.

Data Collection

Self-administered, structured questionnaires were given to consultant paediatricians, paediatric residents and house-officers who consented to participate in the study between 1st – 31st March 2022. The study variables were collected into the relevant sections of the questionnaire. In the first section, predictor variables which included sociodemographic features of participants such as age, sex, years of experience, and rank of staff, were collected. The second section of the questionnaire collected information that assessed respondents' level of (a) knowledge of hypertonic saline (b) of use of hypertonic saline.

The parameters that assessed the knowledge of hypertonic saline included: (i) Whether the respondents had ever heard of hypertonic saline (categorized as yes or no), (ii) source of information about hypertonic saline (information provided by the respondent), (iii) definition of hypertonic saline (categorized as correct and incorrect) based on the definition of hypertonic saline,¹ (iv) concentrations of hypertonic saline known by the respondent (information provided by the re-

spondent), and (v) modes of administration of hypertonic saline known by the respondent (information provided by the respondent).

The parameters that assessed the level of use of hypertonic saline included: (i) Whether the respondents had ever used hypertonic saline (categorized as yes or no), (ii) conditions hypertonic saline was used for (information provided by the respondent), (iii) where hypertonic saline was obtained from (information provided by the respondent), (iv) other indications for its use (information provided by the respondent), (v) contra-indications to the use of hypertonic saline (information provided by the respondent), (vi) complications of the use of hypertonic saline (information provided by the respondent), (vii) combination of fluids to constitute 3% hypertonic saline (information provided by the respondent), (viii) willingness of the

respondent to use HS if available (categorize as yes or no) (ix) anticipated challenges to its production and use (information provided by the respondent).

Ethical Considerations

Ethical approval was obtained from the Ethics and Research Committee of the ESUTH, Enugu (REF NO: ESUTHP/C-MAC/RA/034/VOL.3/171). Informed consent was obtained from the consultant paediatricians, paediatric residents and house-officers.

Statistical Analysis

Data was analyzed with IBM SPSS version 26 (Chicago, IL). Descriptive statistics such as frequency, percent, mean, and standard deviation were used to summarize categorical and continuous variables. Chi-square statistical test was used to test for association between categorical variables at a 5% level of significance.

RESULTS

A total of one hundred and eighty-two doctors from different cadres responded to the self-administered questionnaire. Their ages ranged from 23 to 68 years, with a mean age of 38.8 ± 8.2 years. There were 114 (62.6%) females and 68 (37.4%) males. Table 1 shows the rank and demographics of the respondents.

Knowledge

All of the respondents had heard of hypertonic saline. Their sources of knowledge are shown in Table 2. However, only 89 (48.9%) could define hypertonic saline correctly. Fifteen (8.2%) of the respondents did not attempt the definition, while the rest (42.9%) gave incorrect definitions. In terms of concentration, 3% saline seemed to be the commonest known concentration of hypertonic saline (145 respondents, 79.7%), 24 (13.2%) respondents were aware of 2% saline, 45 respondents (24.7%) knew 5% saline, while 17 (9.3%) and 18 (9.9%) respondents had knowledge of 7% and 23% saline respectively. Respondents who had ever seen an infusion of hypertonic saline were 93 (51.1%), while only 62 (34.1%) had ever used it during their practice. Among those who had used it, only 33 (18.1%) obtained it from their hospital pharmacy, although most (96.2%) considered it essential and were

Table 1. Demographic characteristics of the respondents

	Frequency	Percentage
Age (years)		
20-29	19	10.4
30-39	93	51.1
40-49	51	28.1
50-59	13	7.1
60-69	6	3.3
Sex		
Male	67	36.8
Female	115	63.2
Rank		
House officer	16	8.8
Junior resident	64	35.2
Senior resident	49	26.9
Consultant	53	29.1
Years of practice		
1-5	38	20.9
6-10	56	30.8
11-15	52	28.6
16-20	18	9.9
≥ 21	18	9.9

Table 2. Sources of knowledge about hypertonic saline

Source	Frequency	Percentage
Medical school	113	62.1
Hospital in-service/ Training	78	42.9
Medical journals/ Books	53	29.1
Colleagues	57	31.3
Conferences/ Seminars/ Continuing education programs	51	28.0

ready to use it if available. For the modes of administration, the intravenous route was the most known (87.9%), while the ophthalmic route was the least known (1.6%). Only 14 (7.7%) respondents could list up to five modes of administration of hypertonic saline. After aggregating the knowledge questions (definition of hypertonic saline, knowledge of available concentrations and modes of administration) and categorizing knowledge into good or poor, 148 (81.3%) had good knowledge, while 34 (18.7%) had poor knowledge.

Use of Hypertonic Saline

The uses of hypertonic saline listed by respondents are shown in Table 3. The contraindications to hypertonic saline use listed by respondents include: Hyponatraemia (37.4%), Congestive Cardiac Failure

(8.2%), Acute Kidney Injury (AKI) (8.2%), Hypertension (5.5%), Metabolic acidosis (3.8%) and Addison’s disease (0.5%).

The complications enumerated by the respondents include: Rebound cerebral oedema (12.1%), Seizures (12.1%), Intracranial hypertension (5.5%), Hypernatremia (19.2%), Volume overload and hypertension (11.5%), Thrombophlebitis (6.0%), central pontine myelinolysis (9.9%), AKI (1.1%), Thromboembolism (2.7%).

Twenty (11.1%) of the respondents reported how to reconstitute hypertonic saline in the absence of commercially prepared solutions, using the following combinations: NaCl + NaH₂CO₃ (35%), NaH₂CO₃ + 5% Dextrose water (5%), KCl + NaCl (5%), KCl + 5% Dextrose water (10%), NaH₂CO₃ + 10% Dextrose water (25%), NaCl+10% Dextrose water (15%), and NaCl + 5% Dextrose water (5%).

There was no significant association between rank ($\chi^2 = 1.002, p = 0.317$), years of practice ($\chi^2 = 0.045, p = 0.831$) and knowledge of hypertonic saline. Similarly, there was no significant association between rank ($\chi^2 = 0.168, p = 0.682$), years of practice ($\chi^2 = 0.869, p = 0.351$) and use of hypertonic saline. No significant association was found between knowledge and use of hypertonic saline.

Most respondents (91.2%) would support advocacy for its increased availability and use in Nigeria. The challenges anticipated by respondents towards the production and use of HS in Nigeria are enumerated in Table 4.

Table 3. Respondents knowledge of indications for the use of Hypertonic saline solution

	Frequency	Percentage
Hyponatremia	98	53.8
Raised intracranial pressure	70	38.5
Bronchiolitis	31	17.0
Traumatic brain injury (TBI)	12	6.6
Nasal congestion	10	5.5
Croup	3	1.6
Sputum induction	3	1.6
Cerebral salt wasting (CSW) syndrome	3	1.6
Adrenal crisis	1	0.5
Cystic fibrosis	1	0.5
Syndrome of inappropriate antidiuretic hormone secretion	1	0.5

Table 4. Challenges anticipated by respondents towards the production and use of hypertonic saline in Nigeria

Challenges	Frequency	Percentage
Lack of awareness	54	29.7
Affordability	48	26.4
Fake products	3	1.6
Lack of advocacy by doctors	2	1.1
Lack of hospital guidelines	3	1.6

DISCUSSION

Hypertonic saline is being increasingly used in developed countries to manage various conditions, most notably raised intracranial pressure [17]. However, despite all the beneficial uses of hypertonic saline, it seems to be unavailable in the Nigerian pharmaceutical market. This may explain the number of respon-

dents who could not define hypertonic saline correctly. Hypertonic saline solutions are prepared in concentrations that include 2%, 3%, 5%, 7%, and 23% NaCl; however, the 3% solution is the most widely used [14, 18, 19]. This is in keeping with our study, which reported that 3% saline seemed to be the most commonly known concentration of hypertonic saline. Overall knowledge of hypertonic saline in our study was good, which is probably a reflection of the strength of our medical curriculum and theoretical knowledge of our paediatricians. This is further buttressed by the fact that majority of the participants indicated medical school as the source of their knowledge about hypertonic saline. In a Survey Report about the Emigration of Nigerian Medical Doctors most of doctors (83%) who filled out the survey were based abroad and were licensed in Nigeria, indicating that they had completed their medical education in Nigeria and were deemed competent enough to practice in developed countries [20].

Indications for using hypertonic saline include hyponatremia, traumatic brain injury, cerebral edema,

Table 5. Association between rank, years of experience and knowledge of hypertonic saline

	Knowledge, n (%)		χ^2	p value
	Good	Poor		
Rank				
Resident	105 (83.3)	21 (16.7)	1.002	0.317
Consultant	40 (76.9)	12 (23.1)		
Years of practice				
≤ 10 years	77 (81.9)	17 (18.1)	0.045	0.831
> 10 years	71 (80.7)	17 (19.3)		

Table 6. Association between rank, years of experience and use of hypertonic saline

	Use of hypertonic saline, n (%)		χ^2	p value
	Good	Poor		
Rank				
Resident	42 (33.3)	84 (66.7)	0.168	0.682
Consultant	19 (36.5)	33 (63.5)		
Years of practice				
≤ 10 years	35 (37.2)	59 (62.8)	0.869	0.351
> 10 years	27 (30.7)	61 (69.3)		

Table 7. Association between knowledge and use of hypertonic saline

Use of hypertonic saline, n (%)	Knowledge		χ^2	<i>p</i> value
	Yes	No		
Yes	47 (31.8)	15 (45.5)	2.248	0.134
No	101 (68.2)	18 (54.5)		

CSW syndrome and SIADH [17, 21, 22]. The commonest indications for use in the present study include, hyponatremia, raised ICP, bronchiolitis, and traumatic brain injury (TBI). On the other hand, Brenkert *et al.* [20] in 2013, in the United States of America, reported raised ICP as the commonest indication followed by diabetic ketoacidosis, and hyponatremia. Cystic fibrosis, a rare condition in our environment, was not surprisingly amongst the least mentioned indications in the present study. However, it is a common indication for use in Europe and the United States of America [10, 21].

Specific contraindications to hypertonic saline are largely unknown. However, in patients with congestive heart failure or renal insufficiency, it is advised to use hypertonic saline with caution because of their already increased fluid and sodium loads [17]. Similarly, respondents in the present study reported congestive heart failure or renal insufficiency as common contraindications in addition to hypernatremia. Although one respondent listed Addison's disease as a contraindication, hypertonic saline has been used to treat severe hyponatremia in a patient with primary adrenal insufficiency [22].

Most complications of hypertonic saline are associated with more extended infusion periods, when compared to bolus administration. Possible complications include hyperchloremic metabolic acidosis, hypernatremia, central pontine myelinolysis, and rebound cerebral edema. The most common adverse effects include infection at the IV site, thrombophlebitis, extravasation, and hypervolemia. These are related to intravenous route of administration. Similar complications were reported in our study, including rebound cerebral edema. However, rebound cerebral edema in hypertonic saline occurs less compared to mannitol [11, 16].

Our study revealed a scarcity of hypertonic saline in Nigeria's entire southeast region. Only one out of

the six centres in the region had 3% saline in the hospital pharmacy. However, it is pertinent to note that even this had to be imported from a foreign company because there is no local production. Consequently, doctors attempt to reconstitute 3% hypertonic saline from readily available fluids in their centers. However, only seven respondents used the combination of normal saline and sodium bicarbonate (0.9% NaCl + NaHCO₃) found in the relevant literature [23].

There were no significant associations between knowledge, use, and demographics (cadre and years of experience). The unavailability of hypertonic saline in the south east region of Nigeria may explain this.

Most of the conditions requiring hypertonic saline are common in our environment, and most respondents indicated their readiness to use it if available. Therefore, efforts should be made to mitigate the challenges anticipated by the respondents, such as lack of awareness, affordability, and proliferation of fake products.

CONCLUSION

Our study demonstrated good knowledge of hypertonic saline, however there is low usage due to unavailability of the product. There is need for collaboration between paediatricians, pharmaceutical companies and other stakeholders such as National Agency for Food and Drug Administration and Control (NAFDAC), to create demand and initiate production of hypertonic saline.

Authors' Contribution

Study Conception: IKN, BOE; Study Design: IKN, CCI, KKI; Supervision: OCN, OCI; Funding: ONI, JE, NNO; Materials: CEE, OMI; Data Collection and/or Processing: JE, OCI, NNO; Statistical Analysis and/or Data Interpretation: IKN, BOE, KKI, OCN,

CCI, CEE, JE, OOI, ONI, OMI, LNNO, NNO; Literature Review: OCN, CEE, LNNO; Manuscript Preparation: IKN, KKI, CCI, BOE and Critical Review: IKN, BOE, KKI, OCN, CCI, CEE, JE, OOI, ONI, OMI, LNNO, NNO.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

Financing

The authors disclosed that they did not receive any grant during conduction or writing of this study.

Disclaimer

The views expressed in the submitted article are that of the authors and not an official position of Enugu State University Teaching Hospital.

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