

Pediatric rehydration for moderate dehydration: Comparison of UK and KSA emergency physicians

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Abstract

We performed a meta-analysis of the selected studies comparing Nasogastric Rehydration Therapy (NGT) versus Intravenous Rehydration Therapy (IVT) in children presenting to ED with moderate dehydration due to gastroenteritis. We also conducted a survey of the United Kingdom (UK) and the Kingdom of Saudi Arabia (KSA) Emergency Department (ED) physicians to compare their practice of nasogastric rehydration. The meta-analysis revealed more fluid intake in the first 24hrs, lesser diarrhoea and shorter length of hospital stay in the NGT group. The comparative survey of the physicians showed a decreased use of NGT amongst the KSA physicians. Lesser training in the NGT use seems to be the most common reason for its lesser use.

Introduction

A 3-year-old child is brought to the Emergency Department (ED) with diarrhea and vomiting. An emergency physician estimates him to be suffering from moderate dehydration requiring rehydration. Aware that he may not take oral fluids, and is likely to vomit anyway, you wonder whether nasogastric rehydration or IV fluids is an option for management?

Gastroenteritis is a very common pediatric illness and is the major cause of morbidity and mortality around the world [1,2]. It is a common reason for children presenting to ED with dehydration. It usually presents with acute onset of diarrhea, which may be accompanied by nausea, vomiting, and abdominal pain [2]. The mechanisms potentially responsible for viral diarrhea include lysis of enterocytes, interference with the brush border function that leads to malabsorption of electrolytes, stimulation of cyclic adenosine monophosphate (cAMP) and carbohydrate malabsorption. The proposed pathophysiology of bacterial gastroenteritis involves the elaboration of toxin by enterotoxigenic pathogens and the invasion with inflammation of mucosa by invasive pathogens [3,4].

Acute diarrhea refers to the passage of loose or watery stools, usually at least three times per 24 hours and lasting less than 14 days [4]. Worldwide, 12% of deaths among children less than five years of age are due to diarrhea [5]. Diarrhea accounts for 12 to 15 per 1000 admissions of children under the age of 5 years in England [6]. Dehydration accounts for 50% of the deaths in children and most involve children less than one year of age worldwide [5,6].

The severity of dehydration can be classified as mild (3% to 5%), moderate (6% to 9%) and severe (10% or greater) [7]. Widespread use of oral rehydration salt solutions began in the 1970s as an effective and inexpensive method of treating mild to moderate dehydration. The basis for its use lies in the knowledge that glucose enhances sodium and water absorption in the bowel, even during diarrhea [8,9]. It can be administered orally and *via* the nasogastric route. Despite the success of oral rehydration therapy (ORT), its proven efficacy [9] and recommendations for use by various organizations [10], studies show

that ORT continues to be underused globally [11], and specifically by physicians in developed countries [8-11].

Predilection towards IVT is very commonly observed amongst Emergency Physicians (EPs). The use of NGT in children for dehydration secondary to gastroenteritis and even for diseases like cholera has been effectively practiced for a long time in developing countries [12,13]. Recently conducted studies have shown the use of NGT to be efficacious, cost effective and less time consuming as compared to IVT in developed countries like Australia and USA [14-16]. We therefore decided to review the current literature and conduct a brief survey of EPs in the United Kingdom (UK) and Kingdom of Saudi Arabia (KSA) to study their practice patterns in children with moderate dehydration.

Methods

A clinical scenario was created which included a 3 years old child with moderate dehydration with vomiting and diarrhea due to gastroenteritis. This scenario was presented as a clinical problem to the practicing EPs in the UK & KSA and we also conducted a search of current literature.

Survey

A short questionnaire (Appendix A) posing the above clinical scenario was sent electronically to EPs in the UK and the KSA. This survey was designed to inquire into the physician preferences for rehydration of pediatric patients with moderate dehydration. The clinical scenario was of a child with viral gastroenteritis requiring rehydration. The responses were recorded in excel format. The

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statistical analysis of this survey was done by using the software package SAS version 9.4 (SAS Institute Inc., Cary, NC, USA). Descriptive statistics for the continuous variables are reported as mean ± standard deviation and categorical variables are summarized as frequencies and percentages. The categorical variables are compared by Chi-square test and the continuous variables are compared by Student's independent t-test. The level of statistical significance is set at $p < 0.05$.

Search strategy

A three-part question was used for literature search; in [children with moderate dehydration] are [nasogastric fluids better than intravenous fluids] at [producing satisfactory rehydration].

PubMed, Google Scholar and Cochrane were searched. Following key words were used; (nasogastric [All Fields] AND versus [All Fields] AND intravenous [All Fields] AND ("fluid therapy"[MeSH Terms] OR ("fluid"[All Fields] AND "therapy"[All Fields]) OR "fluid therapy"[All Fields] OR "rehydration"[All Fields]) AND ("child"[MeSH Terms] OR "child"[All Fields] OR "children"[All Fields]) AND moderate [All Fields] AND ("dehydration"[MeSH Terms] OR "dehydration"[All Fields])) AND ("1966/01/01"[PubDate]: "2018/12/31"[PubDate]).

Randomized controlled trials (RCT) which used NGT as a form of treatment alone or together with ORT comparing with IVT were used for meta-analysis. Children from 2 months to 18 yrs. of age were included in these studies. We compared the RCTs for the amount of fluid intake in the first 24 hours, the Hospital length of stay and duration of diarrhea.

Literature search

A total of 1956 articles were found with some relevance however, only 20 studies were relevant to our three-part question. Out of these 20 studies, 18 were Randomized Control Trials (RCTs) comparing ORT with IVT. Two were meta-analyses [22,23] also comparing ORT with IVT (one meta-analysis included all 18 RCTs and second included 16) without subgroup comparative analysis of NGT with IVT. We included 5 RCTs for our analysis which used NGT alone or together with ORT as a form of therapy [17-21]. One RCT in Finnish was translated in English before being included in the analysis [17] (Table 1).

Results

Survey results

Out of 160 UK EPs who received the questionnaire only 89 (56%) while 95 (61%) of 155 KSA EPs completed the survey. 86 (96.63%) of

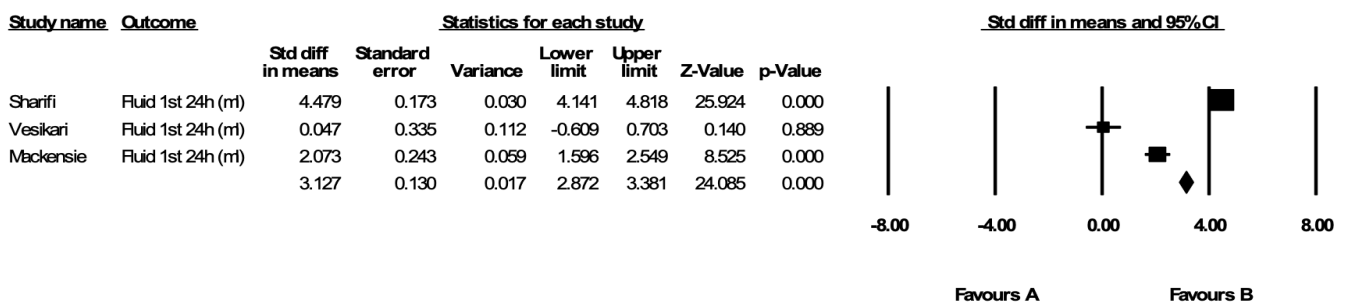
the UK physicians wanted to start ORT as the first step for pediatric rehydration compared to only 3 (3.15%) of the KSA EPs. NGT was the choice of 80/86 (93%) UK practitioners after failure of ORT while none of the KSA practitioners opted for NGT. All of the UK practitioners wanted to start NGT if the IV line was not established compared to only 63 (66.31%) in the KSA group. The main reason for not using NGT was parental concern in the UK EPs while lack of experience was the biggest concern in the KSA group. Other reasons included lack of training, time consumption and fear of nasogastric tube misplacement. The practice of confirming the NG tube placement varied amongst the UK respondents (pH monitoring (5%), X-ray (34%) and clinical evaluation (61%)). However, the majority resorted to the use of a premixed commercial oral rehydration solution (Dioralyte™) as the most common solution for the NGT.

Meta-analysis of RCTs comparing NGT with IVT:

Fluid intake in the 1st 24 hours: The following graphic is associated with the meta-analysis on the outcome of fluid intake during the first 24 hours (Graph 1). From among the five studies, three included fluid intake during the first 24 hours as an outcome and could be used in this meta-analysis. In the graphic below, a positive value indicates that the fluid intake during the first 24 hours for the NGT method is more than that for the IVT method. One can see below that overall there is not a significant smaller ($p < 0.05$) amount of fluid intake during the first 24 hours for the NGT method than for the IVT method.

The length of hospital stay: The following graph is associated with the meta-analysis on the outcome of length of hospital stay (Graph 2). From among the five studies, two included the length of hospital stay as an outcome and could be used in this meta-analysis. In the graphic below, a negative value indicates that the length of hospital stay for the NGT method is less than that for the IVT method. One can see below that overall there is a significant smaller ($p < 0.05$) length of hospital stay for the NGT method than for the IVT method.

Days of diarrhea: The graph below illustrates the meta-analysis on the outcome, diarrhea (Graph 3). From among the five studies, three included days of diarrhea as an outcome and could be used in this meta-analysis. In the graphic below, a negative value indicates that the number of days of diarrhea for the NGT method is less than that for the IVT method. One can see below that overall there is a significant smaller ($p < 0.05$) number of days of diarrhea for the NGT method than for the IVT method.



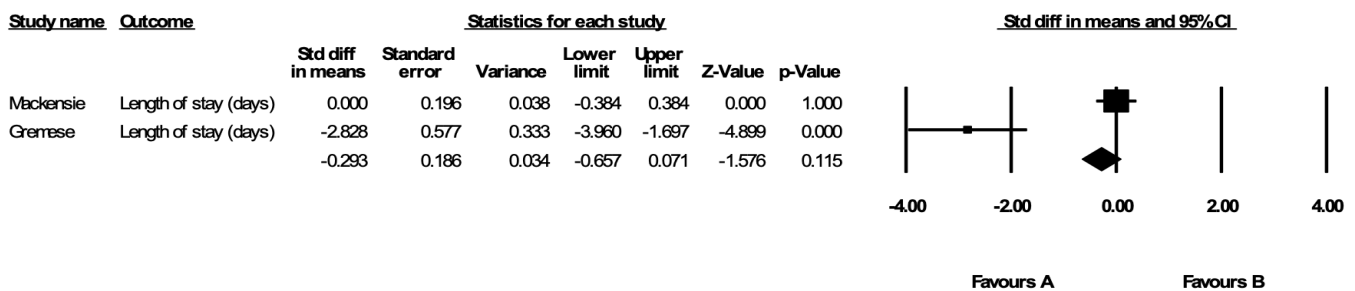
Meta Analysis

Graph 1. The following graphic is associated with the meta-analysis on the outcome of fluid intake during the first 24 hours

Table 1. RCTs included for analysis

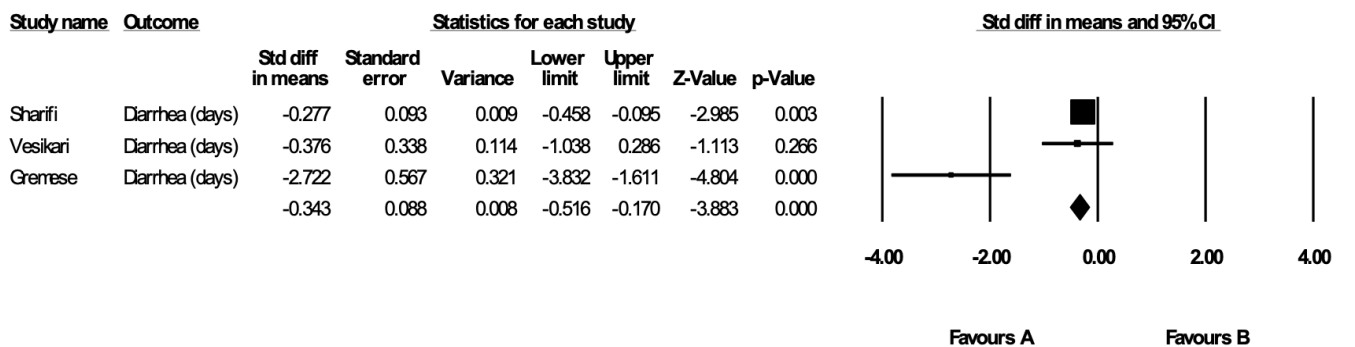
Authors name, Date , Country	Patient Population	Study Type	Outcomes	Key Results*	Comments
Sharifi et al. 1985 Iran	470 children aged 1 to 18 yrs were randomly allocated to NGT & IVT groups. 151 children were moderately dehydrated in NGT group 236 given NGT 234 given IVT All children in NGT group were given fluid at 40mls/ kg/ hr for 2 hrs. IVT group was given 20-30 mls/ kg /hr or bolus within 1 hr All children were breast fed or given formula milk within 24 hrs.	RCT	Failure (worse/ unchanged within 2 hrs)	One in NGT group	Randomization process not clear. No mention about the blinding process Malnourished (36%) & shocked (21%) children included in NGT group Death occurred in malnourished children. *mean (SD)
			Weight gain at discharge (after 24 hrs)	NGT 8.9% IVT 7.2% p<0.001	
			Total fluid intake at 24 hrs	NGT 846mls IVT 680mls p<0.001	
			Complications phlebitis Abdominal distension Seizures	NGT 0 IVT 5 4 0 2 6	
			Duration of diarrhea (days)	NGT 4.8 IVT 5.5 p<.001	
			Death (3-8 days post therapy)	NGT 2 IVT 5	
Vesikari et al.. 1987 Finland	37 children <5yrs moderately dehydrated children randomly allocated to treatment groups 22 given ORT 15 given IVT Both groups had 2/3rd fluid deficit replaced within 6hrs followed by maintenance	RCT	Weight gain by 12 hrs (grams)	ORT 285 IVT 103	Small number of children. Blinding process not clear. Fluid deficit was inconsistently corrected Only 13 children were given NGT (selection criteria not mentioned) *mean (SD)
			Total fluid intake (mls) 0- 6 hrs 6-12 hrs	ORT 823 (399) IVT 671 (272) 316 (98) 486 (201)	
			Duration of diarrhea (days)	ORT 4.1 (1.5) IVT 4.8 (2.3)	
			Number of patients with uncomplicated restart of feeds at 12 hrs	ORT 17 IVT 6	
			Failures (children in ORT group needing IV fluids)	2 children in ORT group without NGT (one had consumed insufficient fluids by 6 hrs and other had continuous vomiting)	
Mackenzie et al. 1991 Australia	111 children aged 3 to 36 months with diarrhea <7 days & moderate dehydration randomized to treatment groups 52 given ORT 52 given IVT Oral therapy was replaced over 6 hrs and IV over 24hrs	RCT	Failures (children in oral group needing IV fluids)	Two failures in ORT group Both had intractable vomiting (NG fluids were not tried in these children)	ORT & NGT group analyzed together. Inconsistency in replacing fluids in both groups. IVT group also given oral fluids during first 24 hrs 7 children in IVT group developed redness at the drip site. *median (IQR)
			Fluid intake (mls/kg) 0-6hrs 0-24hrs	ORT 63 (41-81) IVT 47 (39-57) 94 (79-142) 122 (90-147) P<0.05	
			No. of vomits (0-24) No. of stools (0-24)	1 (0-2) ORT 0 (0-0) IVT 5 (1-10) ORT 4 (1-6) IVT	
			Weight at 24 hrs (kg)	11.2 (9.5-12.5) ORT 11.3 (9.8-12.3) IVT	
			Length of hospital stay (days)	2.0 (2.0-4.0) ORT 2.0 (2.0-3.0) IVT	
Gremese et al. 1995 USA	24 children aged 2 to 24 months of age with unsuccessful oral rehydration (secondary to vomiting and refusal of fluids) were randomized to NGT and IVT groups 12 given NGT 12 given IVT All children were 5-10% dehydrated with acute gastroenteritis <5 days Fluid deficit replaced over 6 hrs	RCT	Failures (children requiring IVT due to persistent vomiting)	One in NGT group (secondary to persistent vomiting)	Small number of patients. Study assessors were blinded. Oral rehydration was tried on all these children before enrolment in study *mean (SEM)
			Duration of rehydration (hrs)	NGT 5.8 (0.5) IVT 7.1 (1.2)	
			Duration of diarrhea (h) Duration of vomiting (h) (After admission)	NGT 23.3 (7.0) IVT 43.9 (8.2) 5.8 (0.5) 7.1 (1.2)	
			Daily cost of hospitalization (\$/day)	NGT 870 (114) IVT 1,064 (133)	
			Duration in hospital (days)	NGT 2.8 (0.4) IVT 1.8 (0.3)	
			Complications	No complications seen in either group	

Nager et al. 2002 USA	96 children aged 3 to 36 months with diarrhea <7 days and vomiting were randomly allocated to rapid NGT and rapid IVT 46 given NGT 44 given IVT Both the groups were given fluids at a rate of 50mls/kg over 3 hrs followed by oral fluids	RCT	Failures (Children who vomited 3 times after start of NGT)	None	Oral fluid challenge was given to all children prior to enrolment.
			Safety and efficacy Mean per case failure rate	NGT 4.3% IVT 61.4% P<0.0001	Assessors blinded
			Weight gain Grams Percentage body weight	NGT 220 IVT 350 2.21 3.58	3 children with persistent emesis excluded (2 IVT & 1 NGT group)
			Cost per patient (\$)	NGT 525.90 IVT 642.64	Telephone follow up after 24 hrs
			Complications	No significant difference	8 NGT & 7 IVT group children returned after 24hrs (none needed admission)



Meta Analysis

Graph 2. The following graph is associated with the meta-analysis on the outcome of length of hospital stay



Meta Analysis

Graph 3. The graph above illustrates the number of days of diarrhea between the NGT and the IVT group

Discussion

Our meta-analysis, indicates that nasogastric rehydration is an effective alternative to IVT in moderately dehydrated children. There was no significant difference in the amount of fluid intake in the first 24hrs, more weight gain and lesser length of hospital stay in the NGT group. However, our case based survey shows that the EPs in the KSA prefer IVT as their first line treatment for rehydrating a child with moderate dehydration in the ED, while the UK EPs preferred to try ORT/NGT before starting the IVT.

Nasogastric rehydration is safe to use in children of all ages [16,23,24]. Rehydration through an NGT can be particularly useful in children with moderate dehydration, where rapid correction of hydration might prevent hospitalization [16,18,19,21]. Rapid NGT rehydration is well tolerated, leads to much quicker replenishment of fluid deficit and maintenance of weight gain in the first 6 hrs [16-18,21]. NGT rehydration helps the child restart his feeds quicker, which greatly improves the outcome of dehydration [23,25]. It is associated with fewer complications as there is less rapid shift of electrolytes and

more rapid correction of acidosis [24,26]. Continuous slow nasogastric rehydration can be used in the presence of vomiting, as correction of acidosis and dehydration lessens the frequency of vomiting [25,26]. The use of single oral dose ondansetron in children with gastroenteritis has also reduced the incidence of vomiting and frequency of IV fluid rehydration [27,28]. Gremese and Nager *et al.* found NGT as a cost-effective therapy in the ED compared to IVT (\$525.90 vs. \$642.64/patient). The two previous systematic reviews [21,22] did not find any difference in the amount of weight gained between treatment groups but they only compared ORT with IVT groups without analyzing the NGT group separately. Our meta-analysis showed weight gain in the NGT group was significant.

NGT risks may include aspiration due to misplacement, pain, epistaxis but the benefits probably outweigh these risks [27-29]. Nasogastric tube can be easily inserted and its gastric placement can be confirmed with a pH test of aspirated fluid (< 5.5) [27,30-32]. NGT should not be used in cases of paralytic ileus, in severe hypovolemia or shock. In such cases IVT is the modality of choice [23-28]. IVT has its own risks including; requiring multiple attempts to place the cannula, extravasation of infused fluids into the soft tissues, phlebitis, or cellulitis at the puncture site and a failure rate requiring intraosseous route [23-25].

Despite the European Society of Gastroenterology, Hepatology & Nutrition (ESPGHAN) guidelines for rehydration in gastroenteritis with emphasis on ORT and NGT prior to IVT, the clinical practice guidelines (CPGs) in various European countries vary significantly [33-37]. The use of NGT is less common in EPs without pediatric emergency specialty experience [32]. A lot of variation in the use of NGT also exists among various pediatric emergency departments across Europe [36]. Majority of the European pediatric practitioners start ORT as the first line therapy with significant difference in the second line therapy [36,37]. Parental preference of IVT as a second line therapy does influence EPs behavior in the choice of therapy [34].

In our survey, the lack of provider experience with NGT was the main deterrent. The fear of wrong placement, discomfort to the child, parental concerns and increased time consumption with NGT were other reasons preventing its use. ED resources should include appropriately trained nursing staff and supplies to facilitate NGT. Evidence based practice, protocol driven management, and scenario based simulation training of EPs will increase awareness and confidence in its use.

Limitations

None of the trials was double blinded due to the nature of the intervention. There was no allocation concealment. The methods confirming the placement of NG tube have not been mentioned.

Conclusions

NGT has equivalent efficacy compared to IVT in children with moderate dehydration secondary to gastroenteritis. It is a safe and effective way of rehydration for children in the ED as it may decrease patient's length of stay. NGT is still under-utilized in the KSA; training and awareness of the EPs may increase its utilization as a treatment option.

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