

Assessment of the efficacy and efficiency of Rapid Rehydration in
children with dehydration due to gastroenteritis in the Rehydration Unit
of Red Cross War Memorial Children's Hospital

by

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Thesis submitted in fulfilment of the requirements for the degree:

MMed in Paediatrics

Faculty of Health Sciences

University of Cape Town

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Date of submission:	March 2017
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Abstract

Background: Dehydration due to acute gastroenteritis (AGE) remains a leading cause of child death worldwide. The primary treatment is enteral rehydration. Children who fail a trial of oral fluids require rehydration in hospital, preferably via nasogastric tube. Traditionally, children have been rehydrated over 24 hours; 'Standard Rehydration' (SR). Most treatment guidelines now recommend 'Rapid Rehydration' (RR) over 4-6 hours. There are limited data comparing RR to SR, especially from low-resource settings.

Objectives: To assess the efficacy and efficiency of RR in children with AGE in the Rehydration Unit of Red Cross War Memorial Children's Hospital, Cape Town.

Methods: A retrospective cohort study was performed. The intervention cohort contained 67 children who received RR in March 2007. The control cohort contained 76 children who received SR in March 2006. The outcome measures were weight and hydration status at 4 hours and time to maximum weight to measure efficacy; and length of hospital stay (LOS) to measure efficiency.

Results: Children in the intervention cohort experienced greater weight gain ($p<0.01$) and lower dehydration scores ($p=0.01$) at 4 hours. There was no difference in time to maximum weight. The LOS for the two groups were not statistically different.

Conclusion: RR is an effective method of rehydrating children with AGE. In contrast to two studies in well-developed settings, reduction in LOS following RR could not be demonstrated. There is no reason not to adopt RR as the predominant rehydration method in settings such as ours. More research is required to evaluate the efficiency of RR.

Abbreviations

AGE	Acute Gastroenteritis
ED	Emergency Department
ESPGHAN	European Society for Pediatric Gastroenterology, Hepatology, and Nutrition
ESPID	European Society for Pediatric Infectious Diseases
IVT	Intravenous Therapy
LOS	Length of Hospital Stay
MeSH	Medical Subject Headings
NG	Nasogastric
NGT	Nasogastric Therapy
NICE	National Institute for Health and Care Excellence
NLM	National Library of Medicine
ORT	Oral Rehydration Therapy
PSSU	Paediatric Short Stay Unit
RCCH	Red Cross War Memorial Children's Hospital
RCT	Randomised Controlled Trial
RR	Rapid Rehydration
RU	Rehydration Unit
SR	Standard Rehydration

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Acknowledgements

Professor Anthony Westwood

for expertise, guidance and considerable patience

Patients and staff of Red Cross War Memorial Children's Hospital

for inspiration and motivation

Justin Cupido

for assistance with data collection

Henri Carrara

for assistance with statistical analysis

Charlotte, Josiah and Daniel

for encouragement and love in abundance

Chapter 1: Introduction and Literature Review

Introduction

Acute gastroenteritis (AGE) and ensuing dehydration has been one of the leading causes of death in children worldwide for centuries and remains so today. Diarrhoeal diseases still rank in the top 3 causes of childhood mortality globally, accounting for approximately 15% of post-neonatal deaths in children under the age of 5 years.^[1] Data from South Africa show that this country is no exception, with intestinal infectious diseases the commonest cause of death in this age group.^[2]

The primary treatment for AGE in children is the provision of appropriate rehydration.^[3-8] Without early and appropriate fluid therapy, many children with acute diarrhoea will develop severe dehydration with associated complications such as hypovolaemic shock.^[6,8,9] A major revolution in the treatment of diarrhoea came with the introduction of oral rehydration therapy (ORT), hailed as the most important medical discovery of the 20th century.^[10] This simple therapy has saved millions of lives worldwide since it was popularised in the 1960s and 70s in response to cholera pandemics in the Asian subcontinent.^[11]

Several thorough and well-conducted systematic reviews of current evidence have compared ORT with intravenous therapy (IVT) for the treatment of diarrhoea-induced dehydration in children.^[12-14] They show that ORT is at least as effective as IVT and is probably safer. There is also evidence to suggest that it results in lower costs to the healthcare system^[15,16] and a shorter hospital stay.^[14] These systematic reviews therefore conclude that ORT should be the first course of treatment in children with dehydration due to AGE, provided signs of shock or severe dehydration are not present. They also suggest that further research comparing ORT with IVT in this context is unwarranted and may be unethical. In situations where ORT is not tolerated, enteral rehydration via a nasogastric (NG) tube is probably more beneficial than using IVT^[15] and most treatment guidelines now advocate this practise in the absence of clinical shock.^[3-7] Other aspects of rehydrating children in the context of AGE that have received substantial research attention in recent years concern the attitudes of communities and medical staff towards the use of ORT and the optimal composition of oral rehydration solutions.^[3,4,7]

One aspect of rehydration therapy for children with AGE for which there is a relative paucity of research data concerns the optimum rate at which fluid therapy should be provided. Traditionally, children have been rehydrated over a 24 hour period but over the last two decades there has been a trend towards rehydrating children more rapidly – over 4 to 6 hours – often referred to as ‘Rapid Rehydration’ (RR). Most treatment guidelines now recommend RR ^[3-6,8] and there is evidence to suggest that, once higher risk patients (those under 3 months of age or with overt malnutrition, cardiorespiratory disease or suspected hypernatraemia) are excluded, it is safe in a South African context. ^[17] However, there remains considerable variation in the practise patterns of different clinicians worldwide ^[18,19] and the opinion of the authors of the latest European Society for Pediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) / European Society for Pediatric Infectious Diseases (ESPID) guidelines ^[7] is that there is insufficient evidence to recommend RR rather than standard rehydration (SR) over 24 hours. A recent systematic review of AGE therapies in developed countries also stated that there were limited data to support RR over SR and that the quality of evidence available was low or very low. ^[20] It remains unclear whether RR is indeed more effective and efficient than SR and therefore unclear whether or not it should be adopted as a widespread treatment strategy.

This literature review will examine the research data produced in the last 20 years that assesses the efficacy and efficiency of RR. The term ‘efficacy’, in this context, will refer to the rate of clinical rehydration – i.e. RR will be deemed more effective than SR if it rehydrates patients faster. The term ‘efficiency’, in this context, will refer to the rate at which patients are processed by a healthcare institution – i.e. RR will be deemed to be more efficient than SR if it enables a shorter length of hospital stay.

Objectives

The objective of this literature review is to describe and evaluate the published scientific evidence that assesses the efficacy and efficiency of RR in the treatment of children with dehydration due to AGE.

Literature search strategy

The literature search strategy consisted of two parts:

- 1) PubMed database search
- 2) Review of evidence cited in international treatment guidelines.

These strategies are described below:

1) PubMed database search

A search was conducted of the PubMed database on the United States National Library of Medicine (NLM) website. The search used the following MeSH terms (Medical Subject Headings – the NLM controlled vocabulary thesaurus used for indexing articles on PubMed), which are defined by the MeSH database as follows:

- a. “Child” – a person 6 to 12 years of age.
- b. “Child, Preschool” – a child between the ages of 2 and 5 years.
- c. “Infant” – a child between 1 and 23 months of age.
- d. “Gastroenteritis” – inflammation of any segment of the gastrointestinal tract.
- e. “Diarrhea” – an increased liquidity or decreased consistency of faeces.
- f. “Fluid Therapy” – therapy whose basic objective is to restore the volume and composition of the body fluids to normal with respect to water-electrolyte balance.
- g. “Dehydration” – the condition that results from excessive loss of water from a living organism.

- h. “Rehydration solutions” – fluids restored to the body in order to maintain normal water-electrolyte balance.

Below is the precise Boolean phrase that was searched for:

*(“Child”[Mesh] OR "Child, Preschool"[Mesh] OR "Infant"[Mesh])
AND
("Diarrhea"[Mesh] OR "Gastroenteritis"[Mesh])
AND
("Fluid Therapy"[Mesh] OR "Dehydration"[Mesh] OR "Rehydration
Solutions"[Mesh])*

The search was further refined by adding the following filters:

- a) Publication date: 1st Jan 1996 to 31st Dec 2015
- b) Text availability: Abstract available
- c) Publication language: English

Using the above Boolean phrase and filters, the search yielded 659 articles. (An attempt to filter out less relevant search results using the ‘Clinical Queries’ PubMed tool led to the loss of important studies and was therefore abandoned). The abstracts of these 659 articles were read and the following criteria were used to either include or exclude them from this literature review:

Inclusion criteria

- Clinical trial
 - o i.e. review articles and guidelines on the management of gastroenteritis were not included
- Subjects diagnosed with dehydration due to AGE
 - o i.e. trials focusing on persistent diarrhoea or other causes of dehydration were not included
- One of the primary interventions under assessment is the rate at which rehydration therapy is given

- i.e. trials exclusively assessing drug treatments, attitudes towards rehydration, consistency of rehydration fluids etc were not included

Exclusion criteria

- Trials with fewer than 40 subjects

2) Review of international gastroenteritis guidelines

Evidence-based treatment guidelines for the clinical management of AGE in children are published regularly by international health organisations. These are generally supported by extensive literature reviews and are often accompanied by detailed documentation of the evidence behind each recommendation. Four of the most respected and referenced guidelines are those published by the National Institute for Health and Care Excellence (NICE) in the UK ^[3]; ESPGHAN / ESPID ^[7]; the Centers for Disease Control and Prevention in the USA ^[4]; and the World Health Organisation ^[6]. In South Africa, the Standard Treatment Guidelines for Paediatrics ^[8], produced by the South African Department of Health are also widely consulted. The evidence base for these South African recommendations is not in the public domain. These five guidelines were reviewed, along with any accompanying publications describing the supporting evidence for the recommendations in each guideline.

Using this literature search strategy, 8 studies were identified. ^[15,21-27] All of these were identified by the PubMed database search. No relevant additional studies were found during the review of treatment guidelines. Both the supporting evidence for the NICE guideline and the ESPGHAN/ESPID guideline state that there is a lack of high-quality evidence regarding the optimal time period over which rehydration should be given. ^[7,28] Each of the 8 studies identified were studied in detail and are described below.

Summary of Current Literature

The eight studies identified in the literature search are each evaluated below in terms of the evidence they provide for the efficacy and efficiency of RR in the treatment of AGE-induced dehydration in children. One of the studies is discounted as it is of insufficient quality.^[27] Of the remaining seven studies, two are especially pertinent because they compare RR to SR.^[24,25] These two studies are evaluated in detail. The other five studies are less able to meet the objective of this literature review. They provide valuable data because they are all clinical trials in which patients received RR, but the main focus of each study was to not to assess its efficacy and efficiency. Additionally, most of the subjects in these trials received IVT rather than ORT, making them less relevant as there is now sufficient evidence to suggest ORT should be the standard of care.^[12-14] These five studies will be described and evaluated below in two separate groups. The first group consists of two recent trials from North America, which compare IVT given as RR with IVT given as ‘ultrarapid’ rehydration.^[22,23] The second group contains the remaining three trials; one of which is primarily assessing different compositions of ORT^[21], one compares IVT to nasogastric therapy (NGT)^[15] and the other assesses RR as a means to arrest vomiting.^[26]

Study discounted due to poor quality:

The effect of a rapid rehydration guideline on Emergency Department management of gastroenteritis in children – Waddell et al, 2014

This study was a retrospective comparison of children who had presented to an Australian Emergency Department (ED) with AGE before and after the introduction of a new RR guideline. The guideline aimed to facilitate enteral rehydration within 4 hours of arrival at the ED and thus reduce the length of ED stay and the number of hospital admissions. The study therefore had the potential to be very pertinent to this literature review. However, there are significant flaws in the study that discredit its results and make it difficult to draw meaningful conclusions.

The most obvious deficit in this study is the amount of data that were missing when the medical records of the 235 patients in the trial were reviewed. There was no documented measurement of clinical dehydration in 80% of patients, oral fluid regimes were formally prescribed in less than 5% of patients and more than half of all patients had no record of receiving any oral fluids. The researchers also state that adherence to the new guideline was poor.

The second major concern with this study is that the length of ED stay and rate of hospital admission was complicated by the opening of a Paediatric Short Stay Unit (PSSU) following the implementation of the new guideline but before all of the patients from the post-guideline group had presented. This is likely to have confounded the results for the post-guideline group because the PSSU became an appropriate destination for moderately dehydrated children on discharge from the ED, whereas previously there had been no alternative to full hospital admission. Interpretation of the results is further complicated by the fact that the two groups were from different seasons, with different incidences of childhood AGE, which may have affected the illness severity in each group of patients. The study's authors acknowledge all of these concerns.

Due to these significant concerns in the quality of the data, this study is not considered for further analysis in this literature review.

Studies that compare RR to SR:

Randomized Clinical Trial of Rapid Versus 24-Hour Rehydration for Children With Acute Gastroenteritis – Powell et al, 2011

The study that most directly addresses the efficacy and efficiency of RR is the randomised controlled trial by Powell et al comparing RR over 4 hours with SR over 24 hours.^[25] This trial, published in 2011, was conducted in two metropolitan paediatric teaching hospitals in Australia and included 254 children with moderate dehydration due to AGE. Moderate dehydration was defined as a score of 3 to 6 out of 10 according to the scoring system described by Gorelick et al.^[29] These patients

were randomised to receive either RR in the ED followed by discharge, or SR in the hospital ward. It is important to note that even in the SR group, patients received their calculated fluid deficit (usually 5% of body weight) over just 6 hours with their calculated 24-hour maintenance fluid requirements given over the subsequent 18 hours. In the RR group, 100ml/kg fluid (i.e. 10% of body weight) was given over 4 hours to all patients. Importantly, patients were rehydrated via the NG route, in keeping with current guidelines.^[3-7] The hydration status and weight of each patient was assessed at baseline, at either 4 hours (RR group) or 6 hours (SR group), at 24 hours (in their own home or via telephone in the case of the RR group) and again at 7 days after presentation.

Results showed that at 4 to 6 hours, weight gain was significantly greater in the RR group and dehydration scores trended towards being lower in this group. At 24 hours dehydration scores were similar but, although both groups had lost weight, the SR group had significantly less weight loss. At 7 days the dehydration scores and weight gain of the groups were similar.

Primary treatment failure was defined as a fall in weight of at least 2% from the admission weight at any point during the rehydration process. There was no significant difference between the two groups for this treatment outcome at any stage of the study; both groups had a primary treatment failure rate of approximately 10%.

Secondary outcome measures were grouped together and termed 'secondary treatment failure'. These included an inability to tolerate the insertion of an NG tube, commencement of IVT and frequent or persistent vomiting. None of these outcomes occurred commonly and there were no significant differences between the two groups.

A more common cause of secondary treatment failure was ongoing dehydration. Just under a quarter of patients in the RR group were not discharged after 4 hours and a further 7% of patients were readmitted at 24 hours, mostly due to ongoing dehydration. In the SR group, 27% of patients were considered to still be moderately dehydrated at 6 hours and a further 9% were deemed to require ongoing NG fluids at 24 hours. Overall, the secondary failure rate was significantly higher for the SR group, although this is influenced by these patients in whom medical staff decided to

continue NG rehydration beyond 24 hours. Ultimately, all patients recovered from their AGE and there were no adverse events.

The methodology of the study is well described. Randomisation was computer-generated and supervised by a non-clinical member of the research team. Group allocation remained concealed until after written parental consent had been obtained. The primary outcome measure of the study was an assessment of weight and the article stresses that children were weighed on the same set of scales, which were calibrated daily. The research team were not directly involved in clinical care, reducing performance bias. However, the study was not without potential bias. Clinical decisions were not protocol-based but were left up to the treating clinician, who was not blinded. This could have led to bias where a clinician favoured one rehydration method over another. Another limitation is that the study had smaller numbers than anticipated and did not come close to reaching the targeted sample size as dictated by the pre-trial power calculation. This resulted in an inability to demonstrate non-inferiority of RR when compared to SR. The reason for the smaller recruitment numbers was largely due to the exclusion of 85% of the children screened for the trial as they were assessed as mildly rather than moderately dehydrated and were therefore treated with ORT at home. Another factor was that recruitment only took place in office hours when the research team were present.

Despite these limitations, this study yields important information for assessing the efficacy and efficiency of RR. In terms of efficacy; children who received RR did gain weight faster and there was a trend towards lower dehydration scores at 4-6 hours. This difference was lost at 24 hours and one week after presentation. Therefore, this study suggests that RR is at least as effective as SR as a method of rehydrating children and possibly achieves rehydration more rapidly. Another important fact to note is that all children in the study made a full recovery and there were no serious adverse events. This adds further weight to data described in the introduction to this literature review suggesting that RR via the NG route is a safe treatment in children with AGE.

Assessing efficiency is more difficult owing to the insufficient sample size. However, the study showed that 70% of the RR group were successfully treated in 4 hours in the ED and did not require any further hospital care. It can be surmised that

these patients used fewer resources and were exposed to less risk than their hospitalised counterparts in the SR group. Whether these benefits would be transferrable to a developing world setting is less clear because this study took place in an environment that afforded close follow-up monitoring of discharged patients and 7% of the RR group required readmission after 24 hours.

Clinical pathway using rapid rehydration for children with gastroenteritis – Phin et al, 2003

The other study that evaluates the efficiency of RR as well as its efficacy in treating children with dehydration due to AGE was published in 2003 by a team from the ED of a tertiary children's hospital in Sydney, Australia.^[24] This trial aimed to assess the effectiveness of a new clinical pathway that advocated RR. An intervention group of children managed according to this new pathway was compared to a historical control group from 2 years previously, none of whom received RR. Although staff were encouraged to switch between giving RR as IVT and NGT on alternate weeks, the authors mention that clinicians tended to use whichever method they preferred and more than 75% of patients received their RR intravenously. In the historical control group, NGT was seldom used. When RR was required, according to the new pathway, it was given as a volume of 40ml/kg over 2 hours.

In total, there were 145 children in the intervention group and 170 children in the historical control group. These children were then further subdivided into 'mildly dehydrated' or 'moderately dehydrated'. The degree of dehydration was assessed by the treating doctor using a standard assessment scale, which is published in the journal article. There were significantly more moderately dehydrated patients in the intervention group, but the numbers were still relatively small; 52 in the intervention group and 27 in the control group. In both the intervention and historical control groups, children were first given an oral fluid challenge. In the control group, if this challenge was failed the patients were admitted for SR, given as IVT over 24 hours. In the intervention group, if the fluid challenge was not tolerated and the patients were moderately dehydrated, they were given RR. If they were only mildly dehydrated, the treating clinician decided whether to proceed with RR or to continue

to try ORT. In total, 106 of the 145 patients in the intervention group received RR. Following this, they were given a further oral fluid challenge over one hour. If this second fluid challenge was tolerated and they satisfied discharge criteria they were discharged home.

The results of this trial were very different for the mildly and moderately dehydrated subgroups of patients. For moderately dehydrated children, there was a significant (42%) reduction in admission rates in those in the intervention group. There was also a significant, 12-fold, increase in the proportion who had been discharged 8 hours after their initial presentation to the ED. Despite this reduction in admission rates and increase in the proportion of children discharged from ED within 8 hours, there was no change in the rate of re-presentation within 48 hours of discharge from the ED. In contrast, for mildly dehydrated children, there were no statistical differences in admission rates, 8-hour discharge rates or re-presentation rates between the two groups. Thus, RR seemed to hold no advantage to children who were mildly dehydrated. The study did not subdivide the intervention group by whether they received IVT or NGT.

This study has several obvious limitations. The most striking is that the sample size of moderately dehydrated children – the subgroup that showed significant benefits from intervention – was small, particularly in the control group. Also, in this historical control group, the oral fluid challenge did not follow a standardised formula. The volume of oral fluid consumed was estimated from a parental report and whether or not the challenge was passed or failed was decided by the opinion of the treating doctor; thereby introducing potential bias. Another concern is that clinical assessment alone was used for assessing and reassessing dehydration rather than weight gain, which is widely considered to be the gold standard. Finally, the majority of patients who received RR did so as IVT rather than NGT, which contradicts most international guidelines (as outlined above).

It is not as easy to draw direct conclusions about the efficacy and efficiency of RR from this trial as one could from the trial by Powell et al, described earlier. This is partly due to the limitations described above, but also because this trial is primarily assessing the new treatment pathway as a whole, rather than directly comparing RR to SR. More than a quarter of the intervention group did not receive RR. It is not

clear whether those children who were successfully discharged from the ED within 8 hours were those who received RR or not. This is especially so in the large subgroup of children who were classified as mildly dehydrated on admission. Most of these mildly dehydrated children, in both the control and intervention groups, did not require admission and it is not clear how many of them received RR. However, in the subgroup of moderately dehydrated children, 94% of the intervention group received RR whereas none of the control group did. Another key difference between the two trials discussed in this section is that the trial by Powell et al excluded all children who were classified as mildly dehydrated, whereas this trial included them. The authors here postulate that RR may be inappropriate for mildly dehydrated children, who might fail a fluid challenge simply because they are not very thirsty.

There is still useful information to be gleaned from this trial. That a significantly greater proportion (44% vs 3%) of children from the intervention group went on to be discharged within 8 hours suggests that RR was an efficient method of treatment. It is also worth noting that there were no complications from RR, adding further weight to the assertion that it is safe. Both of these trials suggest that RR is an effective, efficient and safe way to rehydrate children with moderate dehydration due to AGE. Again, the caveat must be added that this study was performed in a developed country and the results may not be transferrable to a less developed setting. Five per cent of the patients who were discharged required readmission, a rate that may not be acceptable and safe in a developing-world setting.

Studies comparing RR to ‘ultrarapid’ rehydration:

Two studies^[22,23] in recent years have compared intravenous RR with so-called ‘ultrarapid rehydration’, which is also given as IVT but at an even faster rate. These studies were both carried out in urban teaching hospitals in North America and the subjects were children with moderate dehydration due to AGE. In both studies, effort was made to give ORT initially and only if this was not tolerated were patients included in the trial and commenced on IVT. It appears that providing NGT was not considered in either study. Both studies were well-designed randomised controlled trials (RCTs) with well-described methodology.

The two studies were similar. Both studies involved children with dehydration due to AGE who had failed an oral fluid challenge. The study conducted in Los Angeles^[23] included 92 patients and compared giving 50ml/kg IVT over just one hour with giving the same volume of fluid over 3 hours. They were then discharged if they passed a second oral fluid challenge and were clinically rehydrated. The other study^[22], based in Toronto, had 226 patients who were randomised to receive either 20ml/kg or 60ml/kg IVT over one hour, followed by fluid at a maintenance rate. The primary outcome measure was rehydration, defined by a validated clinical hydration score, two hours after the start of treatment.

In both studies, there were no significant differences between the two groups for the speed of rehydration, time to hospital discharge or readmission rate. There were no complications in any of the subjects, but both studies were underpowered to detect rare but serious complications.

Interestingly, the two sets of authors came to different conclusions. The authors of the study based in Los Angeles concluded that ultrarapid IVT may be a method to process patients more quickly through the ED.^[23] In contrast, the authors of the Toronto study concluded that there was no obvious benefit to giving IVT so rapidly and therefore such practise should be followed with caution.^[22] They voiced concern that giving rapid IVT can lead to dysnatraemia, which may not be detected as the majority of clinicians do not routinely check serum electrolytes in AGE.^[18]

Further studies that provide data for the efficacy of RR:

The three trials discussed in this section all include dehydrated children who received RR, but none of the trials had a control group that received rehydration at a different rate. Therefore, these trials do not provide data with which to assess the efficiency of RR. However, each trial does give information regarding with efficacy of RR, which is evaluated below.

The first study^[21] was conducted in Bangladesh in the early part of this century. 175 severely malnourished children with confirmed cholera infection were included. It

was primarily a randomised controlled trial comparing different ORT solutions, but all children who had severe dehydration on presentation were first given RR intravenously. The mean volume of fluid administered to the 149 children who received RR was 103ml/kg over 6 hours.

The second trial^[15] included 96 patients and was a comparison between IVT and NGT as a means of delivering RR. It was conducted in a large urban pediatric teaching hospital in Los Angeles and published in 2002. Patients were included in the trial if they had failed an oral fluid challenge. They received RR as 50ml/kg fluid volume over 3 hours.

The third study^[26] was conducted in a paediatric ED in Minnesota and published in 1996. It had a convenience sample of just 58 children who all had acute vomiting, mild to moderate dehydration and metabolic acidosis. Children up to the age of 13 were included and the majority (74%) had few or no loose stools in the preceding 24 hours. The study therefore probably included children in whom the cause of vomiting was not gastroenteritis. The children received 20 to 30ml IVT over 1-2 hours, followed by an oral fluid challenge. The main focus of the study was then to assess whether or not their vomiting settled after RR. None of the children received NGT.

In all three of these trials, the hydration status of each child was assessed and deemed to have improved after the period of RR. In the study from Bangladesh^[21], all of the severely dehydrated children who had received RR were then felt to be sufficiently rehydrated to proceed with the next phase of the trial; the comparison of different ORT solutions. In the study from Los Angeles^[15], all children could be discharged from the ED after RR and fewer than 20% had ongoing symptoms at 24 hours and required re-evaluation. In the study from Minnesota^[26], all patients had improved hydration after RR. Although in each case the hydration status was assessed by clinical examination rather than weight gain (the gold standard), this improvement in hydration after RR in all patients across the three trials does suggest efficacy.

It is also important to note that there were no complications following RR in any of the subjects in these trials. The sample sizes are too small to identify rare but serious complications of RR – this was not the aim of the trials – but the data do add further

evidence in support of the assertion that RR is safe. This is especially relevant in the trial conducted in Bangladesh^[21], because the subject population for this study was very different from all other studies described in this literature review in that all children had severe malnutrition. It would be normal practise to exercise caution in giving rapid IVT to severely malnourished children due to the risk of heart failure and electrolyte imbalance.^[30] However, no side effects were reported with any of these patients, even in this high-risk population.

Conclusion

The objective of this literature review was to describe and evaluate the published scientific evidence that assesses the efficacy and efficiency of RR in the treatment of children with dehydration due to AGE.

All of the studies described above provide some evidence to suggest that RR is an effective method of rehydration. The only one of the studies that does not directly assess the efficacy of RR is the study by Phin et al^[24], as it assessed a treatment pathway rather than RR specifically. However, even in this study, the data suggest that RR rehydrated children effectively. Each of the other six studies showed improved hydration after RR; as measured either by weight gain, clinical assessment, or both. In the one trial that directly compared its efficacy with SR, RR was shown to rehydrate children significantly more quickly.^[25]

There is less available evidence to evaluate the efficiency of RR as a means of reducing patients' hospital stay as this is only addressed in two of the studies. The study by Powell et al showed that RR enabled the discharge of more than 70% of patients within 4 hours of presentation to the ED, without any need for further intervention.^[25] Thus, RR was clearly more efficient for these patients when compared to SR. A further 7% of patients were discharged but required readmission after 24 hours, in some cases after a telephone consultation. It is unclear whether this rate of readmission would be safe in a less well developed healthcare system in which close follow-up of discharged patients is not feasible. The study by Phin provides indirect evidence in support of the efficiency of RR in that the moderately

dehydrated patients who were managed according to the new pathway, which included RR, were significantly more likely to be discharged. Again, the study was conducted in a well-resourced setting and the readmission rate was 5%, which may be unacceptably high in a less developed system.

This literature review shows that there is an ongoing research need for assessing the efficacy and, especially, the efficiency of RR compared to SR as there is little evidence currently available. At least one major international society has concluded that there is insufficient evidence to recommend RR over SR in its treatment guideline.^[7] There is a particular need to assess the use of RR in a less developed settings, in which both the potential benefits and potential risks of a shorter hospital stay would be keenly felt in overburdened healthcare systems.

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Chapter 2 – Publication-ready manuscript

Assessment of the efficacy and efficiency of Rapid Rehydration in children with dehydration due to gastroenteritis in the Rehydration Unit of Red Cross War Memorial Children's Hospital in Cape Town, South Africa

Abstract

Background: Dehydration due to acute gastroenteritis (AGE) remains a leading cause of child death worldwide. The primary treatment is enteral rehydration. Children who fail a trial of oral fluids require rehydration in hospital, preferably via nasogastric tube. Traditionally, children have been rehydrated over 24 hours; 'Standard Rehydration' (SR). Most treatment guidelines now recommend 'Rapid Rehydration' (RR) over 4-6 hours. There are limited data comparing RR to SR, especially from low-resource settings.

Objectives: To assess the efficacy and efficiency of RR in children with AGE in the Rehydration Unit of Red Cross War Memorial Children's Hospital, Cape Town.

Methods: A retrospective cohort study was performed. The intervention cohort contained 67 children who received RR in March 2007. The control cohort contained 76 children who received SR in March 2006. The outcome measures were weight and hydration status at 4 hours and time to maximum weight to measure efficacy; and length of hospital stay (LOS) to measure efficiency.

Results: Children in the intervention cohort experienced greater weight gain ($p<0.01$) and lower dehydration scores ($p=0.01$) at 4 hours. There was no difference in time to maximum weight. The LOS for the two groups were not statistically different.

Conclusion: RR is an effective method of rehydrating children with AGE. In contrast to two studies in well-developed settings, reduction in LOS following RR could not be demonstrated. There is no reason not to adopt RR as the predominant rehydration method in settings such as ours. More research is required to evaluate the efficiency of RR.

Introduction

Acute gastroenteritis (AGE) and ensuing dehydration has been one of the leading causes of death in children worldwide for centuries and remains so today. Diarrhoeal diseases still rank in the top three causes of childhood mortality globally, accounting for approximately 15% of post-neonatal deaths in children under the age of 5 years.^[1] Data from South Africa show that this country is no exception, with intestinal infections the leading cause of death in this age group.^[2]

The primary treatment for AGE in children is the provision of appropriate rehydration.^[3-6] A major revolution in the treatment of diarrhoea came with the introduction of oral rehydration therapy (ORT), hailed as the most important medical discovery of the 20th century.^[7] Several high-quality systematic reviews of current evidence have shown that ORT is at least as effective as intravenous therapy (IVT) and is probably safer.^[8,9] In situations where oral rehydration is not tolerated, evidence suggests that enteral rehydration via a nasogastric (NG) tube is probably more beneficial than IVT^[10]. In the absence of clinical shock, most international treatment guidelines now advocate NG rehydration rather than IVT if ORT is not tolerated^[3-5].

One aspect of rehydration therapy for children with AGE for which there is a relative paucity of research data concerns the optimum rate at which fluid therapy should be provided. Traditionally, children have been rehydrated over a 24-hour period, so-called 'Standard Rehydration' (SR). However, over the last two decades there has been a trend towards rehydrating children more rapidly – over 4 to 6 hours – often referred to as 'Rapid Rehydration' (RR). Most treatment guidelines now recommend RR.^[3,5,6] There is evidence to suggest that, once higher risk patients (those under 3 months of age or with overt malnutrition, cardiorespiratory disease or suspected hypernatraemia) are excluded, it is safe in a South African context.^[11] However, there remains considerable variation in the practise patterns of different clinicians worldwide^[12] and recent reviews have reiterated that there are limited data to support RR over SR^[4,13].

Two studies^[14,15], both performed in Australian teaching hospitals, have attempted to evaluate the use of RR as a means of treating children with dehydration due to AGE. One was a randomised clinical trial that directly compared RR with SR.^[14] RR succeeded in rehydrating children significantly faster and allowed the majority of children to be discharged from the emergency department (ED) after 4 hours. The study was underpowered to demonstrate non-inferiority of RR compared to SR. The other study indirectly compared RR with SR in that it assessed the effectiveness of a new clinical pathway that advocated RR.^[15] This trial also suggested that, for children with moderate dehydration, RR allowed a greater number to be discharged

directly from the ED rather than being formally admitted. However, both of these trials contained relatively small numbers and were conducted in well-developed healthcare systems that afforded close follow-up of discharged patients. It therefore remains unclear whether RR is indeed more effective and efficient than SR and whether it should be adopted as a widespread treatment strategy in countries such as South Africa.

In the Red Cross War Memorial Children's Hospital (RCCH), before 2007 calculated rehydration fluid volumes were given over 24 hours. In the light of changing international practise and as a response to strained resources under the burden of a heavy patient load, a new protocol was initiated in February 2007. This new protocol advocated RR with fluid volumes of up to 30ml/kg/hour over 4 hours and emphasised NG rehydration. The protocol excluded from RR those at an increased risk for complications – children under 3 months of age, those with severe malnutrition or with signs of neurological or cardiorespiratory disease, or those with suspected hypernatraemia. Following the implementation of this new protocol, a review of a sample of patients who received RR revealed no complications. This review suggested that the protocol was safe. ^[11]

The aim of this study was to assess the efficacy and efficiency of RR in children with AGE at RCCH. In this study, the term 'efficacy' refers to the rate of clinical rehydration (i.e. does RR rehydrate patients any faster?) and the term 'efficiency' refers to the rate at which patients are processed within the hospital (i.e. does RR shorten the hospital stay?).

Methods

Design: Retrospective cohort study.

Setting: The Rehydration Unit (RU) of RCCH. This 20-bed unit admits more than 2 000 children annually, largely during the summer months. It is staffed by interns and senior house officers, under the supervision of a paediatric registrar. Children are admitted to the RU if they have failed a trial of ORT, either in the emergency

department or at a community health centre. Children with shock are stabilised in the emergency department prior to admission. This study assessed children admitted to the RU during the month of March, the busiest month of the year for the RU, where resources are most stretched and the pressure for beds most intense.

Participants: Two cohorts were created. The intervention cohort contained children admitted to the RU during March 2007 who received RR. All patients admitted during this month who met the criteria described below were included. The control cohort contained children admitted to the RU during March 2006 who would have been eligible for RR had the new protocol been in operation. Patients were recruited sequentially, according to their date of admission, until there were approximately the same number of children as in the intervention cohort.

Patients were included if they were between the ages of 3 months and 5 years and were admitted with dehydration due to AGE. In the case of the intervention cohort, they were included if they were appropriately prescribed RR and received at least 75% of their prescribed fluid within 4 hours. The prescribed volume of fluid in 4 hours was 15-20ml/kg/hour for patients who were 5% dehydrated (“some dehydration” according to Integrated Management of Childhood Illnesses (IMCI) guidelines) and 30ml/kg/hour for those 10% dehydrated. Patients rehydrated via the nasogastric route received standard Oral Rehydration Solution. Patients rehydrated intravenously received ½ Darrow’s solution with 5% dextrose.

Patients were excluded if there was a contraindication to RR – i.e. pre-existing cardiorespiratory or neurological disease, severe malnutrition or suspected hypernatraemia. They were also excluded if they were transferred out of the RU at any point during their hospital stay as it was difficult to follow up such patients.

Measurements recorded: Medical records were reviewed by a single data capturer. For each patient the age, gender and route of rehydration (NG, intravenous or oral) were recorded. The patient’s weight was recorded on admission and 4 hours after rehydration had been commenced. Their maximum weight and the time taken to reach that weight were also recorded. The attending doctor’s clinical assessment of each patient’s hydration status on admission and at 4 hours was also captured. There

was no formal clinical hydration assessment scale in operation in the hospital at the time so the clinician's opinion of the degree of dehydration, documented as a percentage, was recorded. If more than 4 hours had elapsed before a patient was reassessed or re-weighed, the soonest possible measurement after 4 hours was used. If this measurement was more than 6 hours after the initiation of rehydration fluid, the patient was excluded from the study. The length of each patient's hospital stay (LOS) was gathered from the hospital's computer database. The minimum length of stay recordable was 1 day.

In order to assess the efficacy and efficiency of RR the following two null hypotheses were made:

1) rehydration is at least as fast using RR

- the main outcome measures used to test this hypothesis were:
 - Change in weight at 4 hours
 - Clinical assessment of dehydration at 4 hours
 - Time to maximum weight

2) hospital stay is not prolonged by RR

- the main outcome measure used to test this hypothesis was:
 - LOS

Statistical Analysis: Analysis of data was performed with the aid of Stata statistical software.^[16] Comparisons between the two cohorts of continuous variables (age, weight on admission, weight gain at 4 hours, maximum weight gain, time to maximum weight, LOS) were made using the Wilcoxon rank-sum test. Comparisons of categorical variables (gender, route of rehydration, clinical assessment of dehydration on admission and at 4 hours) were made using Fisher's exact test. A *p* value of less than 0.05 was deemed statistically significant.

Ethical Approval: The University of Cape Town's Human Research and Ethics Committee granted ethical approval for the study. Permission for accessing patient

folders was granted by the hospital's Senior Medical Superintendent. No medical records were removed from the hospital site.

Results

Intervention cohort: In March 2007, 499 children were admitted to the RU. Of these, 75 were aged under 3 months and 3 were aged over 60 months. The records of a further 49 patients could not be found. The medical records of the remaining 372 children were reviewed. RR was indicated in 250 of these patients but was only prescribed in 140 children and only 106 of these received 75% of their prescribed fluid within 4 hours. A further 39 patients were excluded as they were transferred to another hospital rather than remaining in the RU, resulting in an intervention cohort of 67 patients.

Control cohort: In March 2006, 443 patients were admitted to the RU. 45 were under 3 months and 14 were over 60 months. The medical records of the remaining 384 patients were reviewed sequentially, in the order they were admitted, until the control cohort contained a similar number to the intervention cohort. The same exclusion criteria were applied. Ultimately, there were 76 patients in the control cohort.

The baseline characteristics of the two cohorts are shown in Table 1. They were statistically the same, except for a predominance of males in the control cohort. There was a trend towards a difference between the two groups for the clinical assessment of dehydration on admission, with a greater proportion of the control cohort assessed as more than 5% dehydrated.

The two groups were not similar in terms of the route that was used to rehydrate children. More children received NG rehydration in the intervention cohort, whereas more children received IVT in the control cohort.

Table 2 shows the results of the main outcome measures. The children who received RR gained significantly more weight, both at 4 hours and in total. There was no difference between groups in the time taken to reach that maximum weight. More

children in the intervention cohort were less than 5% dehydrated at 4 hours. There was no difference in LOS between the two groups.

Table 3. Baseline characteristics of study cohorts. The standard variation of each result is shown in brackets after the result. Where appropriate, percentages are shown in square brackets.

Variable		Intervention Cohort	Control Cohort	<i>p</i> value
Subjects		67	76	
Age (<i>in months</i>)		15.67 (9.65)	13.55 (7.52)	0.28
Male:Female		33:34	52:24	0.03
Admission Weight (<i>in kg</i>)		9.03 (2.41)	8.51 (2.19)	0.22
Admission dehydration	<5%	8/67 [11.9%]	2/76 [2.6%]	0.07
	5%	51/67 [76.1%]	60/76 [78.9%]	
	>5%	8/67 [11.9%]	14/76 [18.4%]	
Route of rehydration	Intravenous	7/67 [10.5%]	22/76 [29.0%]	0.01
	Oral	5/67 [7.5%]	9/76 [11.8%]	
	nasogastric	55/67 [82.1%]	45/76 [59.2%]	

Table 4. Outcome variable results for study cohorts. The standard variation for each result is shown in brackets. Where appropriate, percentages are shown in square brackets.

Variable		Intervention cohort	Control cohort	<i>p</i> value
Assessments of efficacy – weight measurements				
Weight gain by 4 hours <i>(as % of admission weight)</i>		2.71 (3.07)	1.44 (2.48)	<0.01
Maximum weight gain <i>(as % of admission weight)</i>		6.44 (3.58)	5.19 (3.34)	0.04
Time to maximum weight <i>(in hours)</i>		24.42 (21.32)	22.59 (17.36)	0.95
Assessment of efficacy - clinical hydration status				
Dehydration at 4 hours	<5%	36/67 [53.7%]	26/76 [34.2%]	0.01
	5%	28/67 [41.8%]	49/76 [64.5%]	
	>5%	3/67 [4.5%]	1/76 [1.3%]	
Assessment of efficiency				
Length of stay <i>(days)</i>		1.87 (1.27)	1.59 (0.90)	0.26

Discussion

The principal findings of this study are that RR was at least as effective as SR at rehydrating children with dehydration due to AGE and it did not prolong the LOS. Thus, both null hypotheses stated at the outset can be accepted.

Regarding efficacy; our results show that children who received RR experienced a significantly greater weight gain after 4 hours. This also corresponded with a lesser degree of clinical dehydration at this point. Interestingly, although those children who received RR put on significantly more weight in total, the time taken to achieve this was no different from their SR counterparts. A possible explanation for this is that it took a long time for children to reach their maximum weight; approximately 24 hours on average, with a wide standard variation. This suggests that, although initial rehydration was faster with RR, ongoing losses and incomplete absorption of enteral rehydration fluids delay children reaching their peak weight until they have recovered from their illness many hours or even days later. These findings are in keeping with the randomised controlled trial of RR vs SR referred to above.^[14] In that study there was greater weight gain in the RR group at 4-6 hours and a trend towards lower dehydration scores, but these differences were lost by 24 hours.

Regarding efficiency, our results show no significant difference between the two cohorts for the LOS. Thus, RR did not prolong hospital stay, but it did not shorten it either. A weakness of our study, which significantly impairs its ability to accurately assess efficiency, is that LOS was measured in units of one day. Furthermore, RU policy was never to discharge children at night because of caregivers' transport limitations if the child deteriorated. Therefore, LOS for a patient who arrived late in the evening and was discharged early the following morning would be recorded as 2 days even though they had only been in hospital for a few hours. In contrast, a patient who arrived early in the morning and was discharged later that same day would be recorded as a stay of 1 day, even though they may have been in hospital for longer than the first patient. Given that LOS was less than 2 days for both cohorts, small but significant differences could not be identified.

Our study design has other inherent weaknesses. Firstly, it was a retrospective review of medical records and thus the accuracy of the data is dependent on the quality of assessment and recording at the time. Patients were seen by a variety of clinicians with variation in levels of skill and experience. Secondly, the final number of subjects in the study was smaller than we had hoped. Our strict inclusion and exclusion criteria resulted in only 67 of 499 patients admitted to the RU during March 2007 being included in the intervention cohort. We felt it was important to ensure patients in the intervention cohort truly had received RR, but these small numbers introduce significant potential bias to the results. Finally, another potential source of bias is the greater proportion of patients rehydrated via the NG route in the RR group. This was appropriate in that the new treatment protocol advocated greater use of NG rather than intravenous rehydration in line with modern treatment guidelines^[3-5]. However, the discrepancy between the two groups may have influenced all of the main outcome variables. Future studies assessing RR should focus on enteral rather than intravenous rehydration.

Despite these limitations, our study provides valuable information in this under-researched area. The results suggest that in our context, as well as being safe^[11], RR is an effective method of rehydrating children. This implies that there is no reason not to utilise RR as the predominant method of rehydrating children with AGE in settings such as ours, in keeping with international recommendations.^[3,5,6]

However, we could not show that RR reduces LOS, only that it did not prolong it. One might hope that RR would facilitate shorter LOS, reducing the burden on hospital resources during busy periods. The two studies previously referred to^[14,15] both suggest that RR may facilitate a shorter LOS for moderately dehydrated children with AGE, but the numbers involved were small. The other key difference between these studies and ours is that they were both conducted in teaching hospitals in the developed world. Their patients were older and the population more affluent. Both studies afforded close follow-up monitoring of discharged patients and had a readmission rate of 5-10% for patients who were discharged immediately after receiving RR. It is not clear if this readmission rate would be safe or acceptable in less-developed healthcare settings. As ours was a retrospective study, we were unable to follow up patients after discharge. There is a need for larger studies, ideally

randomised controlled trials, to assess the efficiency and economic implications of RR in both well and less resourced environments. In less-developed settings, it is particularly important to assess the safety and feasibility of any potential accelerated discharges of children who have received RR.

Conclusion

This study shows that RR is an effective method of rehydrating children with AGE in our context. Children who received RR had gained more weight and were clinically less dehydrated at 4 hours than those who received SR. Given that RR - with the exclusions described above - is safe, we found no reason not to comply with international recommendations and adopt RR as the predominant treatment strategy for dehydrated children with AGE in settings such as ours. However, our results showed no difference in the LOS of the two groups. More research is required, ideally large prospective studies, to assess the efficiency and economic implications of RR in both wealthy and less well-resourced healthcare systems.

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Appendices

Appendix A: Author Guidelines from South African Journal of Child Health

Please note that the full author guidelines can be found at the following address:

<http://www.sajch.org.za/index.php/sajch/about/submissions#authorGuidelines>

Below is a copy of the relevant section of the guidelines for this study:

General article format/layout:

Submitted manuscripts that are not in the correct format specified in these guidelines will be returned to the author(s) for correction prior to being sent for review, which will delay publication.

General:

- Manuscripts must be written in UK English (this includes spelling).
- The manuscript must be in Microsoft Word or RTF document format. Text must be 1.5 line spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes). Pages and lines should be numbered consecutively.
- Please make your article concise, even if it is below the word limit.
- Qualifications, **full** affiliation (department, school/faculty, institution, city, country) and contact details of ALL authors must be provided in the manuscript and in the online submission process.
- Abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.
- Scientific measurements must be expressed in SI units except: blood pressure (mmHg) and haemoglobin (g/dL).
- Litres is denoted with an uppercase L e.g. 'mL' for millilitres).
- Units should be preceded by a space (except for % and °C), e.g. '40 kg' and '20 cm' but '50%' and '19°C'.
- Please be sure to insert proper symbols e.g. μ not u for micro, α not a for alpha, β not B for beta, etc.
- Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160.
- Quotes should be placed in single quotation marks: i.e. The respondent stated: '...'

- Round brackets (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes. If you wish material to be in a box, simply indicate this in the text. You may use the table format –this is the *only* exception. Please DO NOT use fill, format lines and so on.

Research Articles:

Guideline word limit: 3 000 words (excluding abstract and bibliography)

Research articles describe the background, methods, results and conclusions of an original research study. The article should contain the following sections: introduction, methods, results, discussion and conclusion, and should include a structured abstract (see below). The introduction should be concise – no more than three paragraphs – on the background to the research question, and must include references to other relevant published studies that clearly lay out the rationale for conducting the study. Some common reasons for conducting a study are: to fill a gap in the literature, a logical extension of previous work, or to answer an important clinical question. If other papers related to the same study have been published previously, please make sure to refer to them specifically. Describe the study methods in as much detail as possible so that others would be able to replicate the study should they need to. Where appropriate, sample size calculations should be included to demonstrate that the study is not underpowered. Results should describe the study sample as well as the findings from the study itself, but all interpretation of findings must be kept in the discussion section, which should consider primary outcomes first before any secondary or tertiary findings or post-hoc analyses. The conclusion should briefly summarise the main message of the paper and provide recommendations for further study.

- May include up to 6 illustrations or tables.
- A max of 20 – 25 references

Structured abstract

- This should be no more than 250 words, with the following recommended headings:

Background: why the study is being done and how it relates to other

published work.

Objectives: what the study intends to find out

Methods: must include study design, number of participants, description of the intervention, primary and secondary outcomes, any specific analyses that were done on the data.

Results: first sentence must be brief population and sample description; outline the results according to the methods described. Primary outcomes must be described first, even if they are not the most significant findings of the study.

Conclusion: must be supported by the data, include recommendations for further study/actions.

Please ensure that the structured abstract is complete, accurate and clear and has been approved by all authors. It should be able to be intelligible to the reader without referral to the main body of the article.

Do not include any references in the abstracts.

Appendix B: Copy of ethical approval letter

UNIVERSITY OF CAPE TOWN



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05 February 2013

HREC REF: 077/2013

Dr N Webb
Paediatric Medicine
School of Child & Adolescent Health
Red Cross Hospital

Dear Dr Webb

PROJECT TITLE: ASSESSMENT OF THE EFFICACY AND EFFICIENCY OF RAPID REHYDRATION IN CHILDREN WITH DEHYDRATION DUE TO GASTROENTERITIS IN THE REHYDRATION UNIT OF RED CROSS CHILDREN'S HOSPITAL

Thank you for SUBMITTING YOUR STUDY TO THE Faculty of Health Sciences Human Research Ethics Committee for review.

It is a pleasure to inform you that the HREC has **formally approved** the above mentioned study.

Approval is granted for one year till the 15 February 2014.

Please submit a progress form, using the standardised Annual Report Form, if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the REC. REF in all your correspondence.

Yours sincerely

signature removed

PROFESSOR M BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHICS

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

sAriefdien

Appendix C: Copy of hospital approval letter



Dr TA Blake
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Dr N Webb
Paediatric Registrar
RCWMCH

Dear Dr Webb

APPROVAL OF RESEARCH

PROJECT TITLE: **Assessment of the efficacy and efficiency of Rapid Rehydration in children with dehydration due to gastroenteritis in the rehydration unit of Red Cross Children's Hospital**

Approval is hereby granted to conduct the above-mentioned study at Red Cross War Memorial Children's Hospital.

Permission is granted to access folders in the Medical Records department and the research should be done in the department. Should you wish to remove folders, not more than 5 folders can be removed at a time, signed for and returned before 16h00 on the same day.

Yours sincerely,

signature removed

Dr Thomas Blake
Manager: Medical Services
12 April 2013

cc Ms Norma Esau

PROTOCOLS FOR REHYDRATION WARD

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The Methods of Rehydration (NG RULES - TRUST THE GUT!!)

Children should only have been admitted to the Rehydration Ward when they have failed an adequate test of oral rehydration in this health facility and/or are "10%" or more dehydrated (IMCI: "severe dehydration").

Thus all children require more than oral rehydration when they are admitted – BUT ALL CHILDREN except those with shock, loss of consciousness or paralytic ileus CAN CONTINUE WITH small, frequent cup and spoon ORAL REHYDRATION. Mothers make their own sugar-salt solution.

NASOGASTRIC REHYDRATION is the **default mode** of initial rehydration.

The only exceptions are:

- a. Circulatory shock
- b. Paralytic ileus (abdominal distension, no bowel sounds; severe vomiting)
- c. "10%" dehydration AND watery diarrhoea AND vomiting
- d. Altered level of consciousness, severe hypotonia

Intravenous rehydration is required in these circumstances. Once the child has improved, oral or nasogastric rehydration can be instituted.

[See computer for evidence that the GUT can be trusted to do the job.]

These protocols are designed for use in the Red Cross Children's Hospital Short Stay Wards

PROTOCOLS FOR REHYDRATION WARD

Rehydration in Extravascular Dehydration

A. METHOD - See preceding Page

B. FLUID TO BE USED

Nasogastric ORS in pre-packed 200ml containers

IVI 1/2 DD unless otherwise indicated.

C. INITIAL FLUID VOLUME AND RATE

Rapid rehydration over 4 hours is given to all children EXCEPT those with:

- Age under 3 months
- Lung or cardiac disease e.g. pneumonia
- Suspected or proven hypernatraemia
- Overt malnutrition – see following page.

Includes any
encephalopathy

a) Calculate the rehydration volumes for the first

FOUR (4) hours:

"5%" dehydrated (i.e. IMCI "some dehydration") - 15-20 ml/kg/hour

(give the higher volume to children with a history of profuse diarrhoea)

"10%" dehydrated (i.e. IMCI "severe dehydration") - 30 ml/kg/hour

NG - Set infusion controller to this rate in mls per hour

IVI - Set infusion controller to this rate in mls per hour

b) Continue breast feeding and small volumes of ORS. Formula milks should not be given during the first 4 hours of rehydration, but should be started after that.

D. ONGOING FLUID MANAGEMENT

a) Review 1-2 hourly (e.g. is the child vomiting?). Full re-assessment at 4 hours:

- **Dehydrated to the same degree:** As above, with higher infusion rate
- **Hydration worse:** on NG, change to IV; on IV, increase the rate
- **Hydration better:** reintroduce full feeds (see (b) on p6 for volumes), give liberal ORS (≥ 50 ml per loose stool), reduce infusion to 5 ml/kg/hr

b) Review every 6 hours thereafter till discharge:

- The infusion should be stopped if
 - Weight is maintained, and the child is drinking

These protocols are designed for use in the Red Cross Children's Hospital Short Stay Wards.

Note: There is no such thing as "2,5%" or "7,5%" dehydration!

SLOWER Rehydration in Extravascular Dehydration in certain patients

Which patients require slower rehydration?

- Age under 3 months
- Lung or cardiac disease e.g. pneumonia
- Suspected or proven hypernatraemia
- Overt malnutrition (never IV unless shocked)

Includes any
encephalopathy

METHOD - See Page 4

FLUID TO BE USED

Nasogastric ORS in pre-packed 200ml containers
IVI Give 1/2 DD unless otherwise indicated.

FLUID VOLUME AND RATE

a) Calculate the **rehydration** volume.

"5%" dehydrated (IMCI "some dehydration")	50 ml/kg
"10%" dehydrated (IMCI "severe dehydration")	100 ml/kg
More than "10%" dry (IMCI "severe dehydration")	100 ml/kg

b) Calculate the **maintenance** volume

Less than 1 year	120 ml/kg/day
1-2 years	100 " " "
2-4 years	85 " " "
4 years and older	70 " " "

c) Estimate **ongoing losses** (if history of large output diarrhoea)

A child with severe diarrhoea loses at least 30ml/kg/24hrs

d) **Add** these three volumes together and divide by 24 hours to get mls/hour required

IVI – Set infusion controller to this rate in **mls per hour**

NG - Set infusion controller to this rate in **mls per hour**

e) **Write** the fluid and rate required in the fluid schedule in the notes and on the 'Blue Board'.

NB THIS IS ONLY AN ESTIMATE OF FLUID REQUIREMENTS AND IS JUST THE STARTING POINT. Repeated review (**the drier the child, the more frequent the review**) and adjustment of fluid rates according to clinical assessment are essential.

These protocols are designed for use in the Red Cross Children's Hospital Short Stay Wards