Effectiveness of Packed Rice-Oral Rehydration Solution among Children with Acute Watery Diarrhea

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Objective*: This study aims to compare the effectiveness between the packed rice-oral rehydration solution (R-ORS) and the glucose-based oral rehydration solution (G-ORS) in children with acute watery diarrhea.*
Material and Method*: Randomized control trial was conducted to compare duration of diarrhea, stool frequency, incremental weight gain, intravenous fluid requirement, and duration of admission. Subjects were 70 pediatric patients (9-60 months-old) and were equally divided into two groups (n = 35 for each): treatment group (with R-ORS treatment) and control group (with G-ORS treatment). The data were collected during January 1, 2007 to January 2008. All patients were treated with oral rehydration therapy within first 4 hours of admission. Intravenous rehydration was also scheduled. Both groups were fed with rice gruel or lactose-free formula as tolerated.*
Results*: Using survival analysis, both duration of diarrhea and admission was significantly shortened in the treatment group compared to the control group. (27.5 hrs vs. 40.5 hrs: p = 0.01 and 40.1 hrs vs. 56.0 hrs: p = 0.02 respectively). However, stool frequency, incremental weight gain and intravenous fluid requirement between the two groups remained insignificantly different.*
Conclusion: *R-ORS was more effective in the management of acute watery diarrhea in children. Duration of diarrhea and treatment was shortened when compared to G-ORS.*

Keywords: *Acute watery diarrhea, Rice-based oral rehydration solution (R-ORS), Glucose-based oral rehydration solution (G-ORS).*

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Acute diarrhea is the major cause of mortality and morbidity in infants and children, especially in the developing countries. According to World Health Organization (WHO, 2003), 1.87 million of children under 5 years old died from acute watery diarrhea and 8 out of 10 were those under the age of 2[1]. In Thailand the illness is also considered as an important public health problem. Based on report of The Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health (2002), over a million of people throughout the country suffered from acute watery diarrhea. 85,000 people per 100,000 were children under 5 years old, with 0.015% of mortality rate[2]. The majority cause of death from acute watery diarrhea is dehydration which can be prevented by giving WHO's glucose-based oral rehydration solution[3]. This treatment has been widely used and has proven its result in significantly decreasing the mortality rate[3,4]. The glucose-based oral rehydration solution (G-ORS), however, has some limitations: no effect in decreasing stool volume, frequency and diarrhea[5,6]. The rice-based oral rehydration solution (R-ORS), therefore, has been developed by adding rice powder instead of glucose for treatment in children with acute watery diarrhea for better result[7,8]. In Thailand, Subcharoen A et al also conducted a randomized trial of rice powder salt solution for acute watery diarrhea. Compared to WHO-ORS, G-ORS showed significantly lower stool frequency, rate of stool output, and duration of diarrhea[9]. A meta-analysis of 22 trials suggested that rice-based oral rehydration solution is more effective than glucose-based oral rehydration solution especially in cholera diarrhea. The benefits are controversial in children with non-cholera diarrhea. Hence, the purpose

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of this study is to compare the effectiveness between packed R-ORS and G-ORS in children with acute watery diarrhea.

Material and Method

The study was conducted at Thammasat Chalermprakiat Hospital from January 1, 2007 until January 2008. Protocol was approved by The Ethics Committee of the Faculty of Medicine, Thammasat University. Age of 9 months to 5 years old children with less than 5 days in duration of acute watery diarrhea were enrolled. The parents or guardians were given the information and signed for consent prior to the study. Children were excluded from this study if they had invasive diarrhea (WBC > 5 cell/ HPF or RBC > 5 cell/HPF from stool examination), profound shock, alteration of consciousness or convulsion, severe electrolyte imbalance, severe malnutrition or malabsorption syndrome, renal failure, severe systemic infection, rice allergy and acute abdominal conditions. The R-ORS used in this study was prepared by Thailand Institute of Scientific and Technological Research (TISTR). It composed of 50 grams of rice powder and 6.541 grams of electrolyte salt powder. The final solution contains sodium70 mmol/L, potassium 20 mmol/L, chloride mmol/L and citrate 8 mmol/L. The G-ORS used in this study was produced by The Government Pharmaceutical Organization which contains sodium 60 mmol/L, potassium 20 mmol/L, chloride 80 mmol/L and citrate 10 mmol/L.

70 children were randomized and divided into 2 groups: R-ORS as a treatment group and G-ORS as a control group. WHO clinical assessment guideline for diarrhea was employed to classify the degree of dehydration in all patients[1]. Initial intravenous fluid replacement was started in patients with moderate to severe dehydration or severe vomiting. Oral rehydration therapy was started within 4 hours and all children were fed with rice gruel and lactose-free formula. Breastfeeding was continued in some patients as soon as dehydration was solved. History and physical examination data of initial assessment were recorded. All intake and output were measured every 24 hours until the end of the study or 120 hours after admission. Frequency and stool characteristics as well as incremental of weight gain were recorded during the entire course of illness. Outcomes of treatment between the 2 groups were compared in terms of duration of diarrhea, duration of treatment, stool frequency, intravenous fluid requirement and incremental weight gain.

Statistical analysis

A descriptive statistics was used to present the information of demographic profiles and clinical characteristics of the patients in each group by illustrating the frequency and percentage in categorical variables and by illustrating the average mathematics and the standard deviation in continuous variables. T-test and Chi-square test were used to compare the outcome of treatment in both groups.

Results

Each group (n = 35) received either R-ORS (treatment group) or G-ORS (control group). All of them were diagnosed with acute watery diarrhea. Table 1 shows the comparison of demographic profiles and laboratory investigations in both groups. Most of them were moderate dehydration but none had severe dehydration. Up to 60% of the patients were infected by rotavirus. Abnormality of serum sodium was not found; however, both groups had mild metabolic acidosis. In general, demographic features showed no difference between the 2 groups. As shown in Table 2, the treatment group (with R-ORS) had significantly shorter duration of treatment than those in control group (40.17 ± 3.85 vs. 56.03 ± 5.11 hours respectively: $p = 0.02$). The duration of diarrhea in R-ORS group was significantly shorter than in the G-ORS group (27.53 ± 2.67 hrs vs. 40.46 ± 4.62 hrs respectively: $p = 0.01$). However, stool frequency over the entire course of study showed no differences in both groups, except on the 3rd day of admission. The R-ORS had 0.88 ± 0.21 time while the G-ORS had 1.6 ± 0.27 times ($p = 0.0453$) as shown in Fig. 1. Although intravenous fluid requirement was highest during 48-72 hours, there was no statistically significant difference in total intravenous fluid requirement between two groups (489.98 ± 35.63 cc/kg in R-ORS and 561.91 ± 43.36 cc/kg in G-ORS group: $p = 0.20$). No difference was found in incremental weight gain between the 2 groups as shown in Fig. 2 and Fig. 3, respectively.

Discussion

Based on our study, R-ORS was proven to be more effective than G-ORS in children with acute watery diarrhea in terms of duration of diarrhea and treatment ($p = 0.01$ and 0.02 respectively). Nonetheless, it had no effect in reducing frequency of stool output (6.06 ± 0.89 in R-ORS and 7.0 ± 1.08 in G-ORS: $p = 0.50$). These study results also corresponded to two recent studies by Sabcharoen et al[9] and Wall CR et al[11], which have concluded that R-ORS is more effective in decreasing

Table 1. Demographic profiles

	R-ORS (n = 35)	G-ORS (n = 35)
Boy	15 (57%)	20 (71%)
Age (months) (mean ± SD)	22.37 ± 10.82	24.29 ± 12.32
Weight (kg) (mean ± SD)	10.67 ± 2.67	11.50 ± 2.96
Weight for height (%) (mean ± SD)*	99.57 ± 2.39	95.11 ± 4.36
Duration of fever (days) (mean ± SD)	2.09 ± 2.25	1.64 ± 1.41
Duration of vomiting (days) (mean ± SD)	1.8 ± 1.43	1.63 ± 1.09
Frequency of vomiting in 24 hours before admission (times) (mean ± SD)	5.2 ± 3.79	5.8 ± 4.56
Duration of diarrhea before admission (days) (mean ± SD)	1.94 ± 1.33	1.66 ± 1.08
Stool frequency in 24 hours before admission(times) (mean ± SD)	5.23 ± 2.86	6.11 ± 2.91
Degree of dehydration before treatment		
mild	6 (17.14%)	6 (17.14%)
moderate	29 (82.86%)	29 (82.86%)
Investigations		
Blood chemistry		
sodium (mmol/L) (mean ± SD)	138.74 ± 3.77	137.53 ± 3.59
potassium (mmol/L) (mean ± SD)	4.16 ± 0.52	4.07 ± 0.51
chloride (mmol/L) (mean ± SD)	103.71 ± 4.16	102.68 ± 3.67
bicarbonate (mmol/L) (mean ± SD)	14.36 ± 3.17	14.92 ± 3.83
Stool positive for Rota antigen	16 (51.61%)	19 (61.29%)

* % of national growth references for children under 20 years of age[17]

Table 2. Clinical outcome over the entire course of study

Outcome variable	R-ORS	G-ORS	p-value
Duration of treatment (Mean ± SE)	40.17 ± 3.85 hrs	56.03 ± 5.11 hrs	0.02
Duration of treatment (Mean ± SE)	27.53 ± 2.67 hrs	40.46 ± 4.62 hrs	0.01
Stool frequency (Mean ± SE)	6.06 ± 0.89 times	7.0 ± 1.08 times	0.50

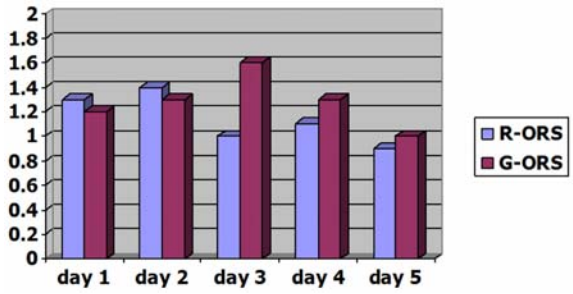

Fig. 1 Daily stool frequency in clinical course (times/day)

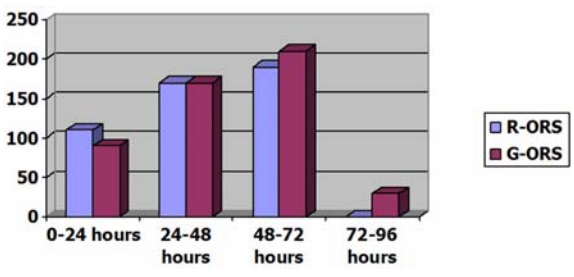

Fig. 2 Intravenous fluid requirement (cc/kg)

stool output, stool frequency, and duration of diarrhea.

Some recent studies have emphasized that R-ORS cannot decrease stool output in non cholera diarrhea[7,12], while in cholera diarrhea, R-ORS is proven to be more effective[10,13]. Although using ceralLyte-90 could reduce stool output during the first 8 hours of

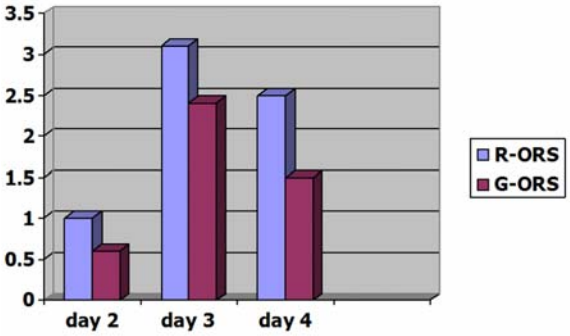

Fig. 3 Incremental weight gain (%)

treatment, there were no differences in reducing total stool output[14]. Since the major cause of diarrhea in young children is Rotavirus, similar to our study (51.61-61.29%), the superior outcome in R-ORS group was not clearly seen. Moreover, R-ORS was reported not to be highly effective in young infants because of their limitation of rice digestibility[15]. Also, lactase deficiency is another factor which may possibly prolong the duration of diarrhea; lactose-free formula was therefore fed to the patients in this study to exclude this problem. However, it is important to note that percentage of incremental weight gain is not only influenced by stool output, but also by other factors such as daily dietary consumption during the illness.

Irene et al[12] have indicated that R-ORS significantly lowers the requirement of intravenous fluid whereas no differences in the total intravenous fluid requirement were found between the two groups in this study. A joint WHO/ICDDR, B Consultative Meeting of ORS formulation, reviewed the clinical trial and concluded that R-ORS is not superior to standard ORS for adults and children with acute non cholera diarrhea, especially when food is given shortly after rehydration[1].

Zavaleta N et al[16] have also investigated the improvement of R-ORS, by adding recombinant human lactoferin and lysozyme. The results show significant decrease in duration of diarrhea and increase in the number of the children who achieved solid stool in 48 hours. The further study should be performed for the better outcome of treatment in acute diarrhea.

Conclusion

Rice-based oral rehydration solution was effective in the management of acute watery diarrhea in children. Duration of diarrhea and treatment was shortened when compared to glucose-based oral rehydration solution.

Acknowledgements

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References

1. World Health Organization. The treatment of diarrhoea: a manual for physicians and other senior health workers. 4th rev. Geneva: WHO; 2005.
2. Center of Epidemiology Information; Bureau of Epidemiology, Ministry of Public Health, Thailand (7/03/05).
3. Rahaman MM, Aziz KM, Patwari Y, Munshi MH. Diarrhoeal mortality in two Bangladeshi villages with and without community-based oral rehydration therapy. Lancet 1979; 2: 809-12.
4. Santosham M, Greenough WB III. Oral rehydration therapy: a global perspective. J Pediatr 1991; 118 (Pt 2): S44-51.
5. Mahalanabis D, Sack RB, Jacobs B, Mondal A, Thomas J. Use of an oral glucose-electrolyte solution in the treatment of paediatric cholera—a controlled study. J Trop Pediatr Environ Child Health 1974; 20: 82-7.
6. Sack DA, Chowdhury AM, Eusof A, Ali MA, Merson MH, Islam S, et al. Oral hydration rotavirus diarrhoea: a double blind comparison of sucrose with glucose electrolyte solution. Lancet 1978; 2: 280-3.
7. Gore SM, Fontaine O, Pierce NF. Impact of rice based oral rehydration solution on stool output and duration of diarrhoea: meta-analysis of 13 clinical trials. BMJ 1992; 304: 287-91.
8. Fayad IM, Hashem M, Duggan C, Refat M, Bakir M, Fontaine O, et al. Comparative efficacy of rice-based and glucose-based oral rehydration salts plus early reintroduction of food. Lancet 1993; 342: 772-5.
9. Sabchareon A, Chongsuphajaisiddhi T, Kittikoon P, Chanthavanich P. Rice-powder salt solution in the treatment of acute diarrhea in young children. Southeast Asian J Trop Med Public Health 1992; 23: 427-32.
10. Gore SM, Fontaine O, Pierce NF. Efficacy of rice-based oral rehydration. Lancet 1996; 348: 193-4.
11. Wall CR, Swanson CE, Cleghorn GJ. A controlled trial comparing the efficacy of rice-based and hy-

potonic glucose oral rehydration solutions in infants and young children with gastroenteritis. J Gastroenterol Hepatol 1997; 12: 24-8.
12. Maulen-Radovan I, Gutierrez-Castrellon P, Hashem M, Neylan M, Baggs G, Zaldo R, et al. Safety and efficacy of a premixed, rice-based oral rehydration solution. J Pediatr Gastroenterol Nutr 2004; 38: 159-63.
13. Dutta D, Bhattacharya MK, Deb AK, Sarkar D, Chatterjee A, Biswas AB, et al. Evaluation of oral hypo-osmolar glucose-based and rice-based oral rehydration solutions in the treatment of cholera in children. Acta Paediatr 2000; 89: 787-90.
14. Zaman K, Yunus M, Rahman A, Chowdhury HR, Sack DA. Efficacy of a packaged rice oral rehydration solution among children with cholera and cholera-like illness. Acta Paediatr 2001; 90: 505-10.
15. De Vizia B, Ciccimarra F, De Cicco N, Auricchio S. Digestibility of starches in infants and children. J Pediatr 1975; 86: 50-5.
16. Zavaleta N, Figueroa D, Rivera J, Sanchez J, Alfaro S, Lonnerdal B. Efficacy of rice-based oral rehydration solution containing recombinant human lactoferrin and lysozyme in Peruvian children with acute diarrhea. J Pediatr Gastroenterol Nutr 2007; 44: 258-64.
17. National growth references for children under 20 years of age. Nonthaburi: Nutrition Division, Department of Health, Ministry of Public Health, Thailand; 1999.

ประสิทธิผลของข้าวผงผสมเกลือแร่ในผู้ป่วยเด็กอุจจาระร่วงเฉียบพลัน

ศุกระวรรณ อินทรขาว, ภาสกร ศรีทิพย์สุโข, ขวัญตา เอื้ออุฬาร

วัตถุประสงค์*: เพื่อเปรียบเทียบผลการรักษาระหว่างข้าวผงผสมเกลือแร่กับผงเกลือแร่มาตรฐานในผู้ป่วยเด็กโรคอุจจาระร่วงเฉียบพลันและเข้ารับการรักษาในโรงพยาบาล*

วัสดุและวิธีการ*: เป็นการศึกษาในผู้ป่วยเด็กชายและเด็กหญิงที่มีอายุตั้งแต่ 9 เดือน ถึงอายุ 5 ปี ที่วินิจฉัยเป็นโรคอุจาระร่วงเฉียบพลันซึ่งรับไว้ในโรงพยาบาลในหอผู้ป่วยกุมารเวชกรรม โรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติ ระยะเวลาตั้งแต่ 1 มกราคม พ.ศ. 2550 ถึง 31 มกราคม พ.ศ. 2551 จำนวน 70 ราย โดยการสุ่มตัวอย่างซึ่งกลุ่มแรกได้รับข้าวผงผสมเกลือแร่ เป็นกลุ่มรักษาจำนวน 35 ราย และกลุ่มที่สองได้รับผงเกลือแร่มาตรฐาน (ผลิตโดยองค์การเภสัชกรรม) เป็นกลุ่มควบคุมจำนวน 35 ราย เด็กทุกรายได้รับการรักษาโดยสารน้ำทางหลอดเลือดดำตามดุลพินิจแพทย์ผู้รักษา และเริ่มให้สารละลายน้ำตาลเกลือแร่ทางปากเพื่อรักษาภาวะขาดน้ำภายใน 4 ชั่วโมงแรก โดยผู้ป่วยทุกรายสามารถให้นมหรือข้าวบดในปริมาณเท่าที่รับได้ มีการประเมินผลการรักษาจาก จำนวนครั้งของการถ่ายเหลว จำนวนชั่วโมงของการถ่าย น้ำหนักที่เปลี่ยนแปลงเมื่อเทียบกับน้ำหนักแรกรับ ปริมาณน้ำเกลือที่ได้รับทางหลอดเลือดและระยะเวลาการรักษา*

ผลการศึกษา*: เมื่อวิเคราะห์เปรียบเทียบทั้ง 2 กลุ่ม จากจำนวนชั่วโมงของการถ่ายเหลวในโรงพยาบาลก่อนผู้ป่วยถ่ายอุจจาระปกติ พบว่ากลุ่มรักษาด้วยข้าวผงผสมเหลือแร่มีจำนวนชั่วโมงที่น้อยกว่าเมื่อเปรียบเทียบกับกลุ่มควบคุม คือ 27.5 ชั่วโมง และ 40.5 ชั่วโมง ตามลำดับโดยมีความแตกต่างอย่างมีนัยสำคัญทางสถิติ (p-value = 0.01) นอกจากนั้น ระยะเวลาในการรักษาในโรงพยาบาลของกลุ่มรักษาคิดเป็น 40.1 ชั่วโมง ซึ่งน้อยกว่าอย่างมีนัยสำคัญทางสถิติ เมื่อเปรียบเทียบกับกลุ่มควบคุม 56 ชั่วโมง (p-value = 0.02) อย่างไรก็ตามพบว่าจำนวนครั้งของการถ่ายเหลว น้ำหนักที่เปลี่ยนแปลงและปริมาณสารน้ำทางหลอดเลือดของทั้ง 2 กลุ่มไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติ*

สรุป*: การรักษาโรคอุจจาระร่วงเฉียบพลันโดยข้าวผงผสมเกลือแร่นั้นช่วยลดระยะเวลาการถ่ายเหลว และระยะเวลาการรักษาในโรงพยาบาลเมื่อเทียบกับการรักษาโดยผงเกลือแร่มาตรฐาน*