

**Evaluation of Mothers' Practice in the Treatment of Children
Diarrhea and Measurement of the Osmolality and PH of Some Oral
Rehydration Solutions and Carbonated Beverages**

تقييم ممارسات الأمهات في حالات الاسهال عند الأطفال وقياس الأسمولية و PH لبعض
محاليل الجفاف والمشروبات الغازية

**Rowa' Al-Ramahi*, Abdelnaser Zaid, Amjad Hussein,
Abeer Yaseen, Khlood Abdallah, Manal Odeh**

رواء الرمحي، عبد الناصر زيد، امجد حسين، عبير ياسين، خلود عبد الله، منال عودة

Department of Pharmacy, Faculty of Medicine and Health Sciences, An-
Najah National University, Nablus, Palestine

*Corresponding author, E mail: rawa_ramahi@najah.edu

Received: (28/1/2015), Accepted: (30/6/2015)

Abstract

The aims of this study were to evaluate the mothers' practice in case of children diarrhea and measure osmolality and PH of some oral rehydration solutions (ORS) and carbonated beverages. The study consisted of two parts; the first part was a face to face questionnaire that was conducted at a group of community pharmacies between July and November 2013. In the second part, Vapor Pressure Osmometer (VAPRO) was used for osmolality determination, while 3520 pH meter was used for the pH determination of some ORS and carbonated beverages. A total of 200 mothers were surveyed in the study. Among them, 85.0% told that they keep breastfeeding during diarrhea. During diarrhea, around half of the mothers (102; 51.0%) told that they give their children potato and (129; 64.5%) told that they avoid sweets, 42.5% told that they use ORS and 47.5% told that they use carbonated beverages. The osmolality of all carbonated beverages tested (except for diet coca cola) and two ORS was higher than the level recommended by the World Health Organization for rehydration solutions (210-268 mOsm/L). A

wide range of variability in PH was found. The values ranged from 3.98 to 8.86. It can be concluded that mothers' practice in case of diarrhea is good in general; however, there is a room for improvement. Continuation of breast feeding and the use of suitable ORS should be encouraged. Use of carbonated beverages should be discouraged.

Keywords: Diarrhea, Children, Oral Rehydration Solutions, Carbonated Beverages.

ملخص

كانت أهداف هذه الدراسة تقييم ممارسات الأمهات في حالات الإسهال عند الأطفال وقياس الأسمولية و PH لبعض محاليل الجفاف والمشروبات الغازية. وتكونت الدراسة من جزأين؛ كان الجزء الأول عبارة عن استبيان وجها لوجه والذي أجري على مجموعة من صيدليات المجتمع بين تموز وتشرين الثاني عام 2013. وفي الجزء الثاني، تم قياس الأسمولية و درجة الحموضة لعدد من محاليل الجفاف والمشروبات الغازية. تم مسح ما مجموعه 200 الأمهات في الدراسة. وقال 85% من بينهن أنها تبقي الرضاعة الطبيعية خلال الإسهال. ما يقرب من نصف الأمهات قلن 51.0% أنهن يعطين أطفالهن البطاطا اثناء الإسهال و64.5% قلن أنهن يتجنبن الحلويات، وقال 42.5% أنهن يستخدمن محاليل الجفاف لأطفالهن بينما ذكر 47.5% أنهن يستخدمن المشروبات الغازية. وكانت الأسمولية لجميع المشروبات الغازية (باستثناء كوكا كولا دايت) واثنين من محاليل الجفاف أعلى من المستوى الموصى به من قبل منظمة الصحة العالمية (210-268 ميلي أسمول/ لتر) و كان هناك تباين في درجة الحموضة وتراوحت القيم بين 3.98-8.86. ويمكن أن نخلص إلى أن ممارسة الأمهات في حالة الإسهال جيدة بصفة عامة؛ ومع ذلك، هناك مجال للتحسين. وينبغي تشجيع استمرار الرضاعة الطبيعية واستخدام محاليل جفاف مناسبة. وينبغي الامتناع عن استخدام المشروبات الغازية.

الكلمات المفتاحية: الإسهال، الأطفال، محاليل الجفاف، المشروبات الغازية.

Introduction

Diarrhea is a leading cause of mortality in children aged <5 years (Bryce, Boschi-Pinto, Shibuya, & Black, 2005). Because the immediate cause of death in most cases is dehydration, these deaths are almost entirely preventable if dehydration is prevented or treated. Until 1970s, intravenous (IV) infusion of fluids and electrolytes was the treatment of choice for diarrheal dehydration, but this was expensive and impractical to use in low-resource settings. In 1960s and 1970s, physicians working in South Asia developed a simple oral rehydration solution (ORS)

containing glucose and electrolytes that could be used to prevent and treat dehydration due to diarrhea of any etiology and in patients of all ages (Cash, *et al.* 1970).

Oral rehydration solution (ORS) was originally developed in the early 1970s to correct the substantial dehydration that occurs as a result of severe diarrhea, especially acute infectious diarrhea. In its simplest and original form, ORS was an iso-osmolar, glucose-electrolyte solution with added base (e.g., citrate in World Health Organization (WHO-ORS) that was designed to treat dehydration and metabolic acidosis. The original WHO ORS formulation was promoted in 1975 by the WHO and the United Nations Children's Emergency Fund (UNICEF) as a single preparation designed. Its initial formulation containing a concentration of 90 mmol sodium/L and 2% glucose with a total osmolarity of 331 mosm/L represented a middle value for the stool sodium losses between cholera enteritis and other causes of diarrhea. Subsequent researches led to the modification of the original formulation and since 2004, the WHO and UNICEF has jointly endorsed the use of physiologic ORS containing reduced sodium of 50-75 mmol/L and total osmolarity of 210-268 mOsm/L. (World Health Organization(WHO)/ United Nations Children's Emergency Fund (UNICEF) Joint Statement, 2004). This new WHO ORS is superior to the initial formulation as it reduces vomiting, shortens hospitalization stay, and lessens the need for IV fluids (Murphy, Hahn, & Volmink, 2004) that is why ORS should be the first choice to start with in case of mild to moderate dehydration situations.

Treatment with ORS is simple and enables management of uncomplicated cases of diarrhea at home, regardless of etiologic agent. As long as caregivers are instructed properly regarding signs of dehydration or are able to determine when children appear markedly ill or appear not to be responding to treatment, therapy should begin at home. Early intervention can reduce complications as dehydration and malnutrition. Early administration of ORS leads to fewer office, clinic, and emergency department visits and to potentially fewer hospitalizations and deaths (Duggan, *et al.* 1999).

Several studies from other parts of the world tried to investigate mothers' knowledge and practice in case of diarrhea in children, and all of them concluded that mothers' knowledge was not adequate and that there is need to intensify maternal education in this area (Adimora, Ikefuna, & Ilechukwu, 2011; Kudlova, 2010; Mwambete & Joseph, 2010; Shah, *et al.* 2012).

To our knowledge, this is the first study in this field in our country; it is good to have base-line data about the mothers' practice and the products used in the treatment of diarrhea in children to give proper counselling and education for better outcomes. Both the osmolarity and PH of the used fluids (either ORS or carbonated beverages) can influence the effectiveness of the treatment since they affect the body serum concentration of electrolytes and the level of fluids. Incorrect treatment of dehydration especially in case of infant can result in organ damage and even death. That is why it is very important to determine the osmolarity and PH of these products to educate caregivers how to choose the most suitable products.

The aims of this study were to evaluate the mothers' practice in case of children diarrhea and measure osmolality and PH of some ORS and carbonated beverages.

Methodology

The study consisted of two parts; the first part was a prospective cross-sectional study. A face to face questionnaire was used to evaluate practice of mothers in management of diarrhea in children. The data were collected between July and November 2013. The second part was experimental to find the PH and osmolality of several ORS and carbonated drinks. This was done in November. The questionnaire was designed after literature of similar studies (Bilenko, Levy, & Fraser, 1997; Kudlova, 2010; Shah, *et al.* 2012), it was pre-tested and then all mothers who gave their consent were asked to fill the questionnaire. The inclusion criteria were women with at least one child who visited the pharmacies for any reason. This study was approved by Institutional Review Board (IRB) of An-Najah National University. The mothers were

met in three community pharmacies (two in Nablus city and one in Howara). A convenient sample of 200 mothers was collected.

Data collection tool for the first part was a face to face questionnaire, the questionnaire included information about sociodemographic characteristics of the mothers, number of children, methods of treating children with diarrhea, types of food to be avoided and to be given during diarrhea and if they use ORS or carbonated beverages during diarrhea.

In the second part, Vapor Pressure Osmometer (VAPRO) was used for osmolality determination, while 3520 pH meter was used for the pH determination. ORS products which were tested included Electrosol, Me-lyte, Orset, Aquamix and Hydro stop and carbonated beverages included Fanta, Coca Cola, Coca Cola Diet, Sprite, 7 up, Crystal and Club. Three measurements for every product were found and the means of them were calculated. Then results were compared with WHO standards.

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS version 16.0). Mean \pm standard deviation was computed for continuous data. Frequencies were calculated for categorical variables.

Results

Sociodemographic characteristics of the respondents

A total of 200 mothers were surveyed in the study, 41.5% of the respondents were between 30 to 40 years, the majority of the respondents (69.5%) had 1-3 children. More than half of the mothers lived in a city, half of the respondents were working and 72.5% had a medium monthly income. Regarding education, more than half of the mothers had bachelor degree (Table 1).

Table (1): Sociodemographic characteristics of the respondents.

Variable	Frequency	Percent
Mother Age		
▪ < 20	16	8.0%
▪ 20 - 30	59	29.5%
▪ 30 - 40	83	41.5%
▪ > 40	42	21.0%
Number of Children		
▪ 1 - 3	139	69.5%
▪ 4 - 6	57	28.5%
▪ 7 - 9	2	1.0%
▪ 10 - 12	2	1.0 %
Place of Living		
▪ Camp	13	6.5%
▪ Village	82	41.0%
▪ City	105	52.5%
Income		
▪ Low	17	8.5 %
▪ Medium	145	72.5%
▪ High	38	19.0%
Education		
▪ Primary	3	1.5%
▪ Middle	25	12.5%
▪ Secondary	46	23.0%
▪ Graduate	116	58.0%
▪ Post Graduate	10	5.0%
Working mother		
▪ Yes	99	49.5 %
▪ No	101	50.5 %

Mothers' practices during diarrhea

The results show that 120 (60.0%) of the mothers told that they visit the doctors when their children suffer from diarrhea, 170 (85.0%) of the mothers said that they keep breastfeeding during diarrhea. Regarding the type of treatment that they use for their children during diarrhea, 80 (40.0%) of the mothers used medications, 74 (37.0%) focused on certain types of food and 51 (25.5%) of the mothers considered herbals to treat diarrhea.

Foods used or avoided during diarrhea

Figure 1 shows a list of foods that the mothers documented to use for their children during diarrhea, the most commonly used type of food was potato which was chosen by 102 (51.0%) mothers followed by rice and yogurt in 57 (28.5%) and 43 (21.5%) cases respectively. Figure 2 shows the types of food which were avoided by mothers during diarrhea, there was a strong consensus to avoid sweets by 129 (64.5%) mothers.

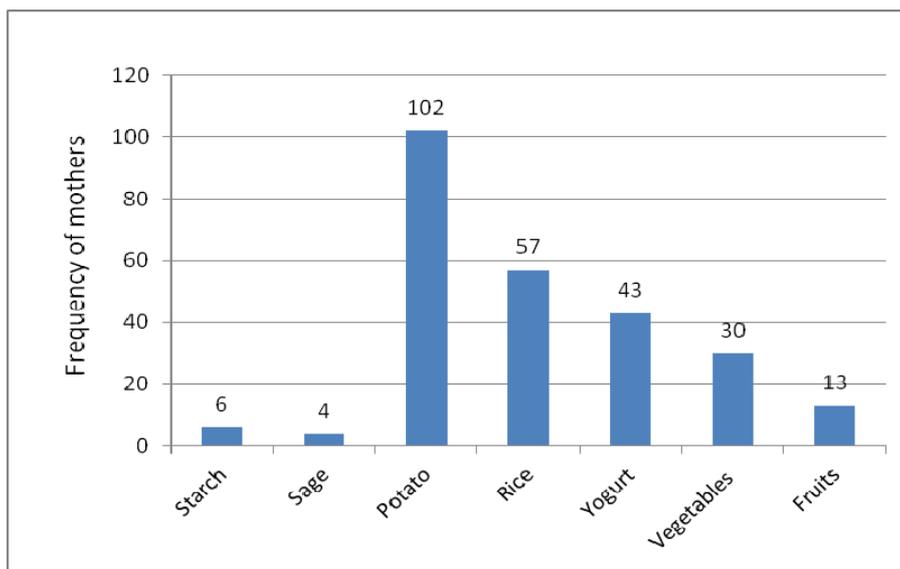


Figure (1): Types of foods used during diarrhea.

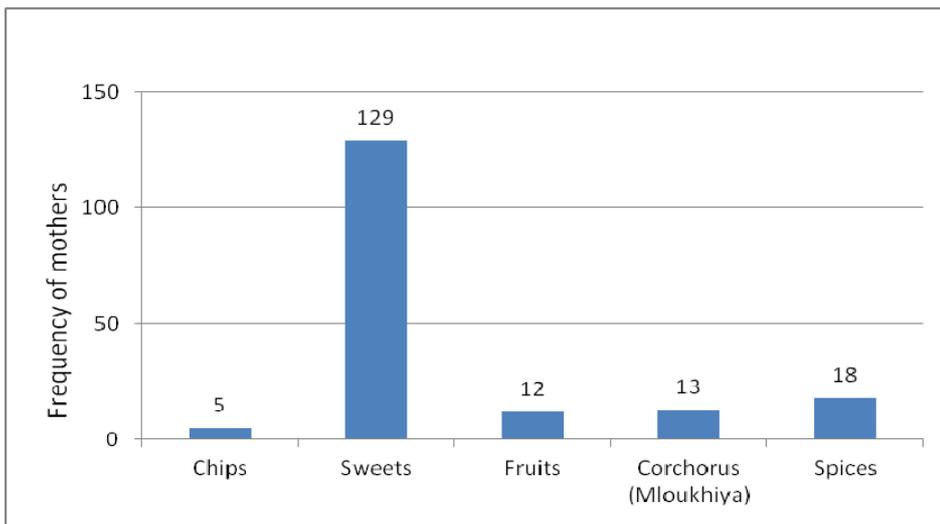


Figure (2): Types of foods avoided during diarrhea.

The mothers were asked if they use ORS and carbonated beverages for their children during diarrhea, 85 (42.5%) only used ORS while 95 (47.5%) used carbonated beverages as a practice that may play a role in the treatment of diarrhea.

Measurement of the osmolality and PH of some ORS and carbonated beverages used in the treatment of diarrhea

Table 2 shows the osmolality of some ORS and some carbonated beverages found in our market. It can be noticed that a wide range of variability is present. The results of PH measurement are shown in Table 3, a wide range of variability can be seen here also. The values ranged from 3.98 ± 0.01 to 8.86 ± 0.13 .

Table (2): Osmolality measurements of some oral rehydration solutions and carbonated beverages (mmole/kg).

Sample	Osmolality 1	Osmolality 2	Osmolality 3	Mean \pm SD
Carbonated beverages				
Club	569	572	566	569 \pm 3.0
Coca cola diet	87	98	99	94 \pm 6.7
Cristal	528	519	532	526 \pm 6.7
Fanta	508	500	511	506 \pm 5.7
Sprite	447	451	455	451 \pm 4.0
Coca cola	418	429	433	427 \pm 7.8
7 up	413	428	421	421 \pm 7.5
ORS				
Me lyte	365	356	346	356 \pm 9.5
Hydrostop	413	419	425	419 \pm 6.0
Aquamix	267	246	244	252 \pm 12.7
Electrosubs	220	217	229	222 \pm 6.2
Orset	229	220	212	220 \pm 8.5

Table (3): PH measurements of some oral rehydration solutions and carbonated beverages.

Sample	PH 1	PH 2	PH 3	Mean \pm SD
Water	7.70	7.50	7.20	7.47 \pm 0.25
Club	4.27	4.24	4.23	4.25 \pm 0.02
Coca cola diet	4.30	4.25	4.26	4.27 \pm 0.26
Cristal	4.02	4.00	3.99	4.00 \pm 0.02
Fanta	4.16	4.16	4.17	4.16 \pm 0.01
Sprite	4.20	4.19	4.20	4.20 \pm 0.01
Coca cola	3.98	3.97	3.98	3.98 \pm 0.01
7 up	4.67	4.66	4.66	4.66 \pm 0.01
Me lyte	4.84	4.89	4.90	4.88 \pm 0.03
Hydrostop	6.35	6.34	6.35	6.35 \pm 0.01
Aquamix	5.73	5.74	5.74	5.74 \pm 0.01
Electrosub	8.75	9.00	8.84	8.86 \pm 0.13
Orset	5.02	5.02	5.02	5.02 \pm 0.00

Discussion

Mothers were asked if they usually visit a physician if their children develop diarrhea. 120 (60%) women answered with yes. It is accepted to treat uncomplicated cases of diarrhea at home using ORS. As long as caregivers are instructed properly regarding signs of dehydration or are able to determine when children appear markedly ill or appear not to be responding to treatment (Duggan, *et al.* 1999).

Among mothers, 170 (85%) of the mothers told that they keep breastfeeding during diarrhea, which is good and recommended. In a study by Shah *et al.* (2012) from India, 69% of the mothers continued breastfeeding their children during the episode and in another by Bilenko *et al.* (1997) a quarter of the women reported stopping or decreasing the frequency of breast feeding.

To maintain a good and stable status for children during diarrhea a suitable diet should be considered, as shown in this study mothers were able to minimize the effect of diarrhea by feeding their children certain types of food while avoiding other type to reduce the exacerbation of diarrhea. In other studies also, mothers usually modify foods during diarrhea (Kudlova, 2010). However, the percentage of mothers who said that they focus on certain types of food when one of their children suffers from diarrhea was 37.0% while it reached 75.2% in other studies (Kudlova, 2010).

Fluid therapy is based on an assessment of the degree of dehydration present. If diarrhea is present, but urinary output is normal, the normal diet and breast-feeding may continue at home with fluid intake dictated by thirst. High osmolarity fluids such as undiluted juices should be avoided (1994). A good percentage of mothers, 64.5% said that they avoid sweets during diarrhea. This reflects a good level of understanding; however, it confirms the need to improve counseling by physicians and pharmacists.

During diarrhea, 42.5% told that they use ORS, this practice need to be encouraged more as ORS are highly recommended in cases of mild diarrhea where there is no need to use IV fluids, and 47.5% told that they

use carbonated beverages. This is a very high percentage which means that this practice is very common in our country.

The osmolality of the used fluids (either ORS or carbonated beverages) can influence the effectiveness of the treatment since they affect the body serum concentration of electrolytes and the level of fluids. In its original form, ORS was an iso-osmolar, glucose-electrolyte solution. Subsequent researches led to the modification of the original formulation and since 2004, the WHO and UNICEF has jointly endorsed the use of physiologic ORS containing reduced sodium of 50-75 mmol/L and total osmolality of 210-268 mOsm/L (Optimal 245 mOsm/L) (WHO/UNICEF Joint Statement, 2004). The efficacy of the World Health Organization ORS solution and of commercial ORS formulations has been enhanced by reducing osmolality (Sentongo, 2004).

The osmolality of analyzed ORS and carbonated beverages varied over a relatively wide range. For ORS tested in this study, the osmolality of three of them was within the range recommended by the WHO (210-268 mOsm/L). Two of them had osmolalities > 350 mOsm/L, which is considered high. A reduced osmolality ORS has been associated with less vomiting, less stool output, and a reduced need for unscheduled intravenous infusions when compared with standard ORS among infants and children with diarrhea (Hahn, Kim, & Garner, 2001). In another study to evaluate ORS in the United States some of the flavored ORS had osmolalities higher than recommended (Wesley, 2004).

It can be noticed that the osmolality of all carbonated beverages tested (except for diet coca cola) is higher than this level (all have osmolality > 420 mmole/kg) so, according to their osmolality, carbonated beverages are not suitable as substitutes of ORS. These beverages with elevated osmolalities have high concentration of glucose. There was a significant negative correlation between the solution osmolality and net water absorption (Pillai *et al.* 1994). Solutions of lower osmolality, but that maintain the 1:1 glucose to sodium ratio, perform optimally as oral solutions for diarrhea management, clinical research, documented in multiple controlled trials and summarized in a meta-analysis has supported adoption of a lower osmolality ORS (i.e.,

proportionally reduced concentrations of sodium and glucose). (Hahn *et al.* 2001). None of the carbonated beverages meets these criteria. Solutions which are more concentrated than the blood can induce osmotic diuresis. In this process, fluid is drawn into the intestine from the blood, worsening the diarrhea. So, there is no need to use these higher osmolarity products, since there are solutions with lower osmolarities.

For diet coca cola, osmolality is very low and close to mineral water. However, diet cola is not expected to be the used carbonated product by mothers, the common practice is to use spite or 7 up. The readings of osmolality and PH of the carbonated beverages in our study are close to previous results (Mettler, Rusch, & Colombani, 2006) which confirms the findings.

Regarding the PH, all the products (with the exception of electrosub) had an acidic PH. This is similar to a study from the United States (Wesley, 2004). We were surprised that the solution pH values were this acidic. In addition to rehydration, these solutions are intended to help correct the acidic intestinal conditions occurring during the diarrhea.

In summary, children receiving semisolid or solid foods should continue to receive their usual diet during episodes of diarrhea. Foods high in simple sugars should be avoided because the osmotic load might worsen diarrhea; therefore, substantial amounts of carbonated soft drinks, juice, gelatin desserts, and other highly sugared liquids should be avoided (King, Glass, Bresee, Duggan, 2003).

The first limitation of this study was in the limited number of mothers who visited the community pharmacies included in addition to the possibility of recall bias. Another limitation was that data collection included community pharmacies in three areas only so it might not be representative to the practice in the whole west bank. However, these results can give a baseline data that can be useful in designing and implementing suitable education and performing other related studies.

Conclusion

Mothers' practice in case of diarrhea is good; however, there is a room for improvement. Continuation of breast feeding and the use of suitable ORS should be encouraged. The osmolarity of carbonated beverages is higher than that recommended by the WHO for hydration solutions. Use of carbonated beverages and sweets should be discouraged.

References

- Adimora, G.N., Ikefuna, A.N., & Ilechukwu, G. (2005). Home management of childhood diarrhoea: need to intensify campaign. *Nigerian Journal of Clinical Practice*, 14(2), 237-241.
- Bilenko, N., Levy, A., & Fraser, D. (1997). Reporting maternal behavior during diarrhea in Bedouin children. *Harefuah*, 132(10), 699-702.
- Bryce, J., Boschi-Pinto, C., Shibuya, K., & Black, R. E. (2005). WHO estimates of the causes of death in children? *The Lancet*, 365, 1147–1152.
- Cash, R. A., Nalin, D. R., Rochat, R., Reller, L. B., Haque, Z. A., & Rahman, A. S. (1970). A clinical trial of oral therapy in a rural cholera-treatment center. *The American Journal of Tropical Medicine and Hygiene*, 19, 653–656.
- Duggan, C., Lasche, J., McCarty, M., Mitchell, K., Dershewitz, R., Lerman, S. J., Higham, M., Radzevich, A., & Kleinman, R. E. (1999). Oral rehydration solution for acute diarrhea prevents subsequent unscheduled follow-up visits. *Pediatrics*, 104, e29.
- Hahn, S., Kim, Y., & Garner, P. (2001). Reduced osmolarity oral rehydration solution for treating dehydration due to diarrhoea in children: systematic review. *British Medical Journal*, 323, 81-85.
- King, C.K., Glass, R., Bresee, J., & Duggan, C. (2003). Managing acute gastroenteritis among children. Retrieved from: <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5216a1.htm>.

- Kudlova, E. (2010). Home management of acute diarrhoea in Czech children. *Journal of Pediatric Gastroenterology and Nutrition*, 50(5), 510-515.
- Mettler, S., Rusch, C., & Colombani, P. C. (2006). Osmolality and pH of sport and other drinks available in Switzerland. *Schweizerische Zeitschrift für Sportmedizin und Sporttraumatologie*, 54 (3), 92–95.
- Murphy, C., Hahn, S., & Volmink, J. (2004). Reduced osmolarity oral rehydration solution for treating cholera. *The Cochrane Database of Systematic Reviews*, 4, CD003754.
- Mwambete, K. D., & Joseph, R. (2010). Knowledge and perception of mothers and caregivers on childhood diarrhoea and its management in Temeke municipality, Tanzania. *Tanzania Journal of Health Research*, 12(1), 47-54.
- G. V., M. J., D., & B. K. (1994). Studies of water movement across the gut using oral rehydration solutions in a rat perfusion model. *Alimentary Pharmacology*, 8(5), 555-558.
- Sentongo, T. A. (2004). The use of oral rehydration solutions in children and adults. *Current Gastroenterology Reports*, 6(4), 307-313.
- Shah, M. S., Ahmad, A., Khalique, N., Afzal, S., Ansari, M.A., & Khan, Z. (2012). Home-based management of acute diarrhoeal disease in an urban slum of Aligarh, India. *Journal of Infection in Developing Countries*, 6(2), 137-142.
- Wesley, J. F. (2004). Evaluation of infant rehydration solutions. Product evaluation, 1-8.
- World Health Organization (WHO)/ United Nations Children's Emergency Fund (UNICEF) Joint Statement. (2004). Clinical Management of Diarrhoea. Retrived from:
http://whqlibdoc.who.int/hq/2004/WHO_FCH_CAH_04.7.pdf.
(Accessed 12/4/2014).