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# Pre-hospital Use of Oral Rehydration Therapy and Zinc and the Risk of Dehydration in Childhood Diarrhoea

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Authors TAO and MTO conceived and designed the study. Author TIRA participated in drawing up the study protocol. Authors TAO and MTO analysed and interpreted the data. All the authors contributed to drafting the manuscript and approval of the final version of the manuscript.*

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## ABSTRACT

**Background:** Diarrhoea is a leading cause of childhood mortality globally. The use of oral rehydration therapy (ORT) with zinc supplementation is recommended in the treatment of childhood diarrhoea.
**Objective:** To determine the pattern of pre-hospital use of ORT and zinc among children with diarrhoea at the secondary levels of health care in Nigeria.
**Methods:** A cross-sectional survey was conducted over a six-month period at two secondary health facilities among children with diarrhoea. A structured questionnaire was administered on consenting caregivers and the level of dehydration was also determined.
**Results:** Out of 109 under-five children, 93 (85.3%) were aged < 24 months; 79 (72.5%) mothers were aware of ORT use but only 56 (51.4%) actually used ORT. Fifty (45.9%) mothers were aware of zinc use but 33 (30.3%) actually administered it. Fifty-nine (54.1%) children had dehydration;

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60.9% of children who had ORT with zinc and 60.5% of those who received neither ORT nor zinc were dehydrated. ORT use was significantly associated with zinc use but had no association with dehydration, rather vomiting was significantly associated with dehydration (p = 0.03).
**Conclusion:** More than half of the children studied presented at the secondary level of care with dehydration despite high maternal awareness and use of ORT. Zinc use was low in this population. Due to vomiting and feed refusal, the impact of ORT and zinc in the prevention of dehydration was obscure.

*Keywords: Children; diarrhoea; oral rehydration therapy; pre-hospital care; secondary health facility; zinc.*

## 1. INTRODUCTION

Diarrhoea is one of the leading causes of under-five mortality globally, contributing close to one out of every five deaths [1]. This global picture is supported by the recent reports from parts of Africa where diarrhoea was reported to cause 7.3% of under-five deaths in a Liberian tertiary facility [2] and 9.3% of under-five deaths [3] in a Ghanaian tertiary health facility. In a previous review of childhood mortalities in a tertiary hospital in Ogun State, Nigeria, diarrhoeal diseases were reported to have contributed 4.8% of deaths among infants and among children aged one to five years [4].

The risk of deaths in diarrhoeal diseases is directly related to the degree of fluid and electrolytes loss as well as caloric deprivation occurring during the illnesses. In the light of this, ORT is globally recommended in the prevention and treatment of dehydration caused by diarrhoeal diseases as a key childhood survival strategy [5]. More recently, zinc supplementation along with low osmolality ORT was recommended for better efficiency and lesser risk of complications [6]. Children who develop diarrhoea tend to have pre-morbid low body levels of zinc and are further predisposed to more zinc losses during diarrhoeal episodes. This aggravated zinc losses contribute to worse intestinal epithelial lining function, increased severity of the illness and higher risks of diarrhoeal complications. The resultant effects include frequent episodes of prolonged diarrhoeal diseases, increased loss of fluid and electrolytes, frequent needs for hospitalization and risk of mortality [6]. Therefore, health care workers at every level of care are trained to prescribe ORT along with daily zinc supplementation for up to 10 days to reduce the duration and severity of diarrhoea and to reduce mortality based on the available body of evidence [7].

Since most of the data on childhood mortalities in Nigeria are obtained from tertiary facilities which are frequently urban in location, it is highly plausible that most of such data may only reflect the epidemiology of childhood diarrhoea in urbanised parts of the country. Indeed, the burden of childhood diarrhoea may be expected to differ between the rural and urban communities due to differences in the prevalence of risk factors for diarrhoea and the quality of care. As at 2015, national figure on access of children with diarrhoea to Oral Rehydration Therapy (ORT) was 34% and there was a differential pattern between the urban and rural parts of the country where access rate to ORT was 45% and 28% respectively [8]. The rural and semi-urban parts of the country may be contributing significantly to diarrhoeal morbidities and mortalities among children. Due to the pattern of distribution of health resources in Nigeria, the health needs of the rural population are mostly met outside the tertiary health facilities. It is imperative to assess the use of ORT and zinc supplements outside the tertiary health facilities where most children with diarrhoeal diseases are likely to seek care first. Therefore, this study was conceived to determine the current pattern of pre-hospital use of ORT and zinc among children presenting with diarrhoeal diseases at the secondary levels of health care and relate this to the degree of dehydration.

## 2. METHODS

This cross-sectional survey was conducted between April and September 2015 at the State Hospital, Ijaye, Abeokuta and State Hospital, Ijebu-Ode. The two facilities were selected for the study out of the five State Hospitals in the state, based on the availability of defined paediatric care services. The State Hospitals are secondary health facilities within Ogun State of Nigeria serving as convergent points of care for all the surrounding local government areas.

Ogun State of Nigeria is divided into three politically-recognised senatorial districts (West, Central and East) and these selected State Hospitals were located within Ogun East and Ogun Central senatorial districts. Ethical approval for the study was obtained from the State Hospital Management Board while parents and caregivers gave informed consent prior to the collection of data. Participants were assured of confidentiality, beneficence and non-maleficence.

Each of the two study locations has a paediatric unit manned by Paediatric Residents and other Senior Medical Officers and provides emergency services, in-patient and out-patient care for sick children. The medical and nursing personnel are trained in the assessment, triage and management of diarrhoea in children. Children with diarrhoeal diseases are received at the out-patient clinic where they are assessed and categorized for appropriate level of care depending on the level of hydration, nutritional status and other co-morbidities. Laboratory investigations, including haematological parameters, are only requested when specifically indicated.

The sample size of 112 was calculated from a prevalence of 8.1% previously obtained from a rural Nigerian community using 95% Confidence Interval and 5% margin of error [9]. Purposive sampling technique was adopted. All consecutive children with diarrhoea whose accompanying parent or caregiver consented were recruited into the study over a six-month period. A self-designed structured questionnaire was administered on the accompanying parent or caregiver while waiting for assessment and triage. The data obtained included age, sex, parental occupation and educational qualification, symptoms, details of pre-hospital care (places and medications) obtained prior to presentation at the study centre. Specifically, notes were taken of awareness and use of oral rehydration solution and zinc supplements or any other form of medication. In addition, each child was physically examined for dehydration using the mental state, eyes, fontanelle (if still patent), buccal mucosa moisture, lacrimation, ability to drink, skin elasticity, urinary output, capillary refill, peripheral pulses and the blood pressure. Based on these criteria, the children were classified into those with no sign of dehydration, mild, moderate or severe dehydration [10].

The data were processed with SPSS 20.0 version statistical software (SPSS Inc., Chicago, IL, USA) using descriptive and inferential statistics [Student's t-test and Odd ratio]. The children were compared for the use of ORT, use of zinc supplements and degree of dehydration based on their socio-demographic profile. Comparison of categorical variables was done using Odds ratio (OR) and 95% Confidence Interval (CI). Statistical significance was established when CI excluded 1.0 or with p-values were <0.05.

## 3. RESULTS

Out of the 117 children surveyed, 109 were aged >28 days to 59 months and further data analysis was limited to the 109 children. The children were aged 2 months to 59 months with the mean of 17.0 ± 12.2 months. Age distribution showed that 60 (55.0%), 33 (30.3%) and 16 (14.7%) were aged < 12 months, 12-24 months and > 24 months respectively. They comprised 70 (64.2%) males and 39 (35.8%) females with a male-to-female ratio of 1.8:1.

Overall, 79 (72.5%) mothers were aware of ORT use in the treatment of diarrhoea while only 56 (51.4%) actually used ORT. Out of the 56 mothers who used ORT, 39 (69.6%) knew had to prepare the solution correctly. Similarly, 50 (45.9%) mothers were aware of the use of zinc whereas 33 (30.3%) actually administered zinc to their children.

Twenty-eight (25.7%) children had visited other health facilities including drug vendors prior to presentation. Sixty-five (59.6%) children had also received a variety of drugs such as antibiotics, anti-diarrhoea and multivitamins. The pattern of ORT and zinc use was as follows: ORT with zinc (23; 21.1%), ORT only (33; 30.3%), zinc only (zinc with other medications apart from ORT) (10; 9.2%) and neither ORT nor zinc (43; 39.4%).

Fifty (45.9%) children had no signs of dehydration, another 50 (45.9%) had mild-to-moderate dehydration while only 9 (8.2%) had severe dehydration. Table 1 shows that a higher proportion of children who had ORT without zinc were not dehydrated (without statistical significance) whereas higher proportions of children who received ORT with zinc, zinc only (with other medications apart from ORT) and neither ORT nor zinc were dehydrated but without statistical significance.

**Table 1. Relationship between pattern of ORT/Zinc use and dehydration**

| Therapy | Total | Dehydrated | Not Dehydrated | Statistics |
|---|---|---|---|---|
| ORS with Zinc | 23 | 14 (60.9) | 9 (39.1) | OR = 1.42; CI 0.51-4.02 |
| ORS without Zinc | 33 | 13 (39.4) | 20 (60.6) | OR = 0.42; CI 0.17-1.06 |
| Zinc without ORS | 10 | 6 (60.0) | 4 (40.0) | OR = 1.30; CI 0.30-5.92 |
| No ORS or Zinc | 43 | 26 (60.5) | 17 (39.5) | OR = 1.53; CI 0.65-3.59 |
| Total | 109 | 59 | 50 | |

Table 2 describes the clinical and demographic factors associated with the pattern of ORT use. A significantly higher proportion of children who had ORT also received zinc (p = 0.012) and the mean frequency of bowel motions was significantly smaller among children who received ORT compared to those who did not receive ORT (3.5 ± 2.1 days vs 5.0 ± 2.7 days; t = 3.27, p = 0.02). Higher but insignificant proportions of children who received ORT belonged to mothers with high education and low occupation; these children who received ORT vomited and refused feeds but were not dehydrated compared to those who did not receive ORT. Age and sex of children as well as maternal age had no definite relationship with the pattern of ORT use.

In Table 3, zinc use was significantly associated with ORT use (p = 0.012) but zinc use showed no relationship with the age and sex of children, maternal age, maternal education, maternal occupation, presence of vomiting with feed refusal, the use of other medications or frequency of bowl motion.

Table 4 describes the relationship between clinical and demographic factors and dehydration. A significantly higher proportion of children of mothers with high occupation were dehydrated (p = 0.000). Similarly, a higher proportion of children who had vomiting with feed refusal were dehydrated (p = 0.03). The age and sex of the child, maternal age and education, frequency of bowel motions, ORT use and zinc use had no relationship with the occurrence of dehydration.

## 4. DISCUSSION

The present study revealed that close to three quarters of the caregivers were aware of ORT use in childhood diarrhoea. This was lower than 98% [11] previously recorded in a community-based study at Ibadan, Nigeria and 89.9% [12] reported from a hospital-based study at Port-Harcourt, Nigeria. The differences may be attributed to the settings of the studies since Ibadan and Port-Harcourt are more cosmopolitan than Ijebu-Ode and Abeokuta and the residents are ordinarily expected to have better access to health information. However, despite the ORT awareness rate of 72.5%, pre-hospital ORT use in the present study was 51.4% contrary to 81.3% previously reported from Ilesa, Nigeria [13] about a decade ago, 77% from Port-Harcourt, Nigeria, [12] 61.8% from Ibadan, Nigeria [11] and 66% [14] and 31.9% [15] reported from South Africa and Bangladesh respectively. This observation on ORT use rate in Ogun State, Nigeria justifies stronger advocacies for focused dissemination of health information regarding home management of childhood diarrhoea in this part of the country.

While 45.9% were aware of zinc use in diarrhoea, only 30.3% actually administered zinc to children with diarrhoea. These rates were better than 36.9% and 25.5% respectively reported from Port-Harcourt, Nigeria about three years prior to the present study [12] but poorer than zinc use rate of 67% [16] reported from Kenya. The Nigerian literature on zinc use in childhood diarrhoea is sparse apparently because it is a new therapeutic recommendation. This low awareness rate for zinc use may reflect the low prescription by health workers. In a study of health care staff in Benin City, Nigeria, 35% prescribed zinc for childhood diarrhoea but only 10% did so consistently for every case of diarrhoea. The health facilities are supposed to be the leading sources of health information but this role may fail in situations where the health workers do not practice the recommended therapies. The health care staff are more likely to counsel clients on their own practices. Therefore, training of health workers and health education of caregivers on childhood diarrhoea may not be complete without emphasis on zinc use.

**Table 2. Relationship between pre-hospital ORS use and clinico-demographic parameters**

| Parameters | | ORS used (n =56) | ORS not used (n = 53) | Statistics |
|---|---|---|---|---|
| Age of children | ≤12 mo | 30 (53.6) | 30 (56.6) | OR = 0.88; CI 0.39-2.02 |
| | >12 mo | 26 (46.4) | 23 (43.4) | |
| Sex | Male | 35 (62.5) | 35 (66.0) | OR = 0.86; CI 0.36-2.02 |
| | Female | 21 (37.5) | 18 (34.0) | |
| Maternal age | <30 | 29 (51.8) | 31 (58.5) | OR = 0.76; CI 0.33-1.74 |
| | ≥30 | 27 (48.2) | 22 (41.5) | |
| Maternal education | High* | 30 (53.6) | 23 (43.4) | OR = 1.51; CI 0.66-3.44 |
| | Low** | 26 (46.4) | 30 (56.6) | |
| Maternal occupation | High+ | 20 (35.7) | 28 (52.8) | OR = 0.50; CI 0.21-1.12 |
| | Low++ | 36 (64.3) | 25 (47.2) | |
| Mean number of bowel motions in the last 24 hrs | | 3.5 ± 2.1 | 5.0 ± 2.7 | T =3.27; p = 0.002 |
| Vomiting with feed refusal | Yes | 17 (30.4) | 11 (20.8) | OR = 1.66; CI 0.64-4.38 |
| | No | 39 (69.6) | 42 (79.2) | |
| Use of other OCT*** | Yes | 29 (51.8) | 36 (67.9) | OR = 0.51; CI 0.22-1.19 |
| | No | 27 (48.2) | 17 (32.1) | |
| Zinc use | Yes | 23 (41.1) | 10 (18.9) | OR = 3.00; CI 1.16-7.87; p = 0.012 |
| | No | 33(58.9) | 43 (81.1) | |
| Dehydration | Yes | 27 (48.2) | 32 (60.4) | OR = 0.61; CI 0.27-1.40 |
| | No | 29 (51.8) | 21 (39.6) | |

** University and Post-secondary, **Secondary, Primary, None ***Over the counter drugs*
*+Senior Civil Servant, Business Tycoon, Junior Civil Servant, ++Artisans, Petty traders, unemployed*

**Table 3. Relationship between pre-hospital zinc use and clinico-demographic parameters**

| Parameters | | Zinc used (n =33) | Zinc not used (n = 76) | Statistics |
|---|---|---|---|---|
| Age of children | <12 mo | 21 (63.6) | 39 (51.3) | OR = 1.66; CI 0.66-4.19 |
| | >12 mo | 12 (36.4) | 37 (48.7) | |
| Sex | Male | 20 (60.6) | 50 (65.8) | OR = 0.80; CI 0.32-2.02 |
| | Female | 13 (39.4) | 26 (34.2) | |
| Maternal age | <30 | 15 (45.5) | 45 (59.2) | OR = 0.57; CI 0.23-1.41 |
| | >30 | 18 (54.5) | 31 (40.8) | |
| Maternal education | High* | 19 (57.6) | 34 (44.7) | OR = 1.68; CI 0.68-4.16 |
| | Low** | 14 (42.4) | 42 (55.3) | |
| Maternal occupation | High+ | 11 (33.3) | 23 (30.3) | OR = 1.20; CI 0.46-3.16 |
| | Low++ | 22 (66.7) | 53 (69.7) | |
| Mean number of bowel motions in the last 24 hrs | | 4.09 ± 2.7 | 4.8 ± 2.4 | T =1.37; p = 0.17 |
| Vomiting with feed refusal | Yes | 9 (27.3) | 19 (25.0) | OR = 1.13; CI 0.44-3.11 |
| | No | 24 (72.7) | 57 (75.0) | |
| ORT Use | Yes | 23 (69.7) | 33 (43.4) | OR = 3.0; CI 1.16-7.87; p = 0.012 |
| | No | 10 (30.3) | 43 (56.6) | |
| Use of other OCT*** | Yes | 17 (51.5) | 48 (63.2) | OR = 0.62; CI 0.25-1.53 |
| | No | 16 (48.5) | 28 (36.8) | |
| Dehydration | Yes | 20 (60.6) | 39 (51.3) | OR = 1.46; CI 0.59-3.56 |
| | No | 13 (39.4) | 37 (48.7) | |

** University and Post-secondary, **Secondary, Primary, None, ***Over the counter drugs*
*+Senior Civil Servant, Business Tycoon, Junior Civil Servant*
*++Artisans, Petty traders, unemployed*

**Table 4. Relationship between hydration status and clinico-demographic parameters**

| Parameters | | Dehydrated (n =59) | Not Dehydrated (n = 50) | Statistics |
|---|---|---|---|---|
| Age of children | <12 mo | 35 (59.3) | 25 (50.0) | OR = 1.46; CI 0.64 - 3.35 |
| | >12 mo | 24 (40.7) | 25 (50.0) | |
| Sex | Male | 35 (59.3) | 35 (70.0) | OR = 0.63; CI 0.29- 1.49 |
| | Female | 24 (40.7) | 15 (30.0) | |
| Maternal age | <30 | 32 (54.2) | 28 (56.0) | OR = 0.93; CI 0.41- 2.13 |
| | >30 | 27 (45.8) | 22 (44.0) | |
| Maternal education | High* | 28 (45.5) | 25 (50.0) | OR = 0.90; CI 0.40 - 2.58 |
| | Low** | 31 (55.5) | 25 (50.0) | |
| Maternal occupation | High$^{+}$ | 36 (61.0) | 13 (26.0) | OR = 4.46; CI 1.86 – 11.83; p = 0.000 |
| | Low$^{++}$ | 23 (39.0) | 37 (74.0) | |
| Mean number of bowel motions in the last 24 hrs | | 4.9 ± 2.9 | 4.2 ± 1.8 | T =1.48; p = 0.14 |
| Vomiting with feed refusal | Yes | 20 (33.9) | 8 (16.0) | OR = 2.69; CI 1.03 - 7.59; p = 0.003 |
| | No | 39 (66.1) | 42 (84.0) | |
| ORT Use | Yes | 27 (45.8) | 29 (58.0) | OR = 0.61; CI 0.27 – 1.40 |
| | No | 32 (54.2) | 21 (42.0) | |
| Use of other OCT*** | Yes | 39 (66.1) | 26 (52.0) | OR = 1.80; CI 0.77 – 4.21 |
| | No | 20 (33.9) | 24 (48.0) | |
| Zinc use | Yes | 20 (33.9) | 13 (26.0) | OR = 1.46; CI 0.59 - 3.64 |
| | No | 39 (66.1) | 37 (74.0) | |
| Use of ORS with Zinc | Yes | 14 (23.7) | 9 (18.0) | OR = 1.42; CI 0.51 - 4.03 |
| | No | 45 (76.3) | 41 (82.0) | |

** University and Post-secondary, **Secondary, Primary, None, ***Over the counter drugs*
*$^{+}$Senior Civil Servant, Business Tycoon, Junior Civil Servant*
*$^{++}$Artisans, Petty traders, unemployed*

Although the present study did not examine acceptability of zinc by the caregivers, it is plausible that low awareness may be the resultant effect of low prescription rate and low acceptability (administration of zinc over ten days may be problematic). Although, a Bangladeshi study reported 77% acceptability and 62% compliance, [15] an Indian study reported 98% adherence to zinc use on the third day of therapy which dropped to 18% by the seventh day, particularly for reasons of cessation of symptoms [17]. The high initial adherence rate may not be completely strange as a Kenyan study [16] had also reported 88% satisfaction with zinc use among mothers whose children had diarrhoea. Effective as zinc therapy has been shown to be in the management of childhood diarrhoea, [7] the uptake rate needs to be increased using a multi-pronged approach involving more prescription by health workers, intense health education and more availability of zinc at the local drugs stores.

However, it is encouraging that the use of ORT was associated with zinc use in the present study. This observation implies that caregivers who administer ORT are likely to use zinc as well. Therefore, it is attractive to postulate that caregivers who did not administer zinc along with ORT may have problems with availability or acceptability of zinc. This should be the focus of further research and community-based interventions. Close to two-third of the children in the present study had received various medications ranging from antibiotics, multivitamins to anti-diarrhoeal agents prior to presentation. This high rate of drug use in the present study was similar to previous Nigerian reports, [12,13,18] as well as reports from outside the country [15,19,20]. This appears to be a recurrent challenge in the management of childhood diarrhoea probably due to unrestricted access to drugs and indiscriminate use of medications without prescriptions in this part of the world. The use of medications may worsen vomiting, impair rehydration, encourage the development of antibiotic resistance by microbes and contribute to the development of complications. Health education strategies are important to discourage

the use of unprescribed medications during childhood diarrhoea.

It is remarkable that most (39.4%) of the caregivers did not administer ORT or zinc prior to hospital visit while a similar proportion administered ORT without zinc thus, reinforcing the need to improve zinc use. This may explain why more than half of the children presented with dehydration similar to 59.4% in a previous Nigerian study [13]. The significant association between ORT without zinc and dehydration is interesting because this observation may be a reflection of the missing role of zinc in reducing stool volumes. On the other hand, the comparable proportions of children with or without dehydration among the users of ORT with zinc may suggest the role of a confounder such as continuing fluid loss from vomiting and poor intake as previously reported [13]. In addition, mothers may ignorantly stop ORT administration if vomiting occurs as previously reported from South Africa that 26.1% of caregivers stopped ORT because of vomiting [14]. Therefore, it is imperative to counsel caregivers on how to administer ORT when vomiting occurs during diarrhoeal episodes. Such information may be included in the instructions guiding preparation of the oral rehydration solution.

The higher preponderance of dehydration among the children of caregivers who belonged to the highly-rated occupations (professionals, senior civil servants and high scale trader) suggests poor adherence to the use of ORT in the management of dehydration. It may reflect the busy nature of such occupations and lack of time to attend to the care of the ill children unlike caregivers who stay at home either as unemployed or home-working self-employed individuals and who have much time at their disposal to administer ORT and zinc during diarrhoeal illnesses in their children. The professionals and the executive workers may form a special risk group which deserves special interventions with regards to home care of diarrhoeal diseases in their children. Home-based care by health workers may be arranged with appropriate remuneration such that while the caregivers are away on duty, skilled health workers can be temporarily engaged to provide the required care including ORT with zinc, during diarrhoeal diseases in their children. This will improve the success of ORT and further reduce the need for hospitalization from dehydration and other morbidities.

## 5. CONCLUSION

In conclusion, more than half of the children studied at the secondary care level in Ogun State, Nigeria, presented with dehydration despite high caregivers' awareness and use of ORT. Zinc therapy awareness and use were low in this population. Vomiting and feed refusal were significantly associated with the occurrence of dehydration and this may obscure the possible role of ORT and zinc in the prevention of dehydration. Interventions including health education on the use of ORT and zinc in childhood diarrhoeal diseases are highly desired.

## CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

## ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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