Diarrheal Illness and Health Utilization in Guatemala: Factors Surrounding Oral Rehydration Therapy Use

By

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ABSTRACT

Objective: The present study seeks to obtain a better understanding of health-utilization patterns—particularly with regard to oral rehydration solutions (ORS) use—in response to diarrheal illness from data in two distinct regions of Guatemala. This study will provide information that health authorities may use to develop interventions aimed at reducing mortality associated with diarrhea, such as through targeted educational interventions to improve ORS use and household/community management of this common childhood illness in Guatemala.

Methods: Data from a population-based, lab-enhanced surveillance system in Guatemala, *Vigilancia Comunitaria* (ViCo), were utilized in the present analysis. Trained ViCo staff from governmental health-care facilities in the Santa Rosa and Quetzaltenango Departments of Guatemala collected demographic, clinical, laboratory and health-behavior data from patients diagnosed with diarrhea. All data were collected using personal digital assistants (PDAs) after obtaining informed consent/assent from participants enrolled in the study. The present analyses include 3,044 patients who were admitted to hospitals and ambulatory clinics in Santa Rosa or Quetzaltenango with diarrhea. Statistical analyses were carried out using SAS 9.2®.

Results: Sixty percent of patients who sought care at the public hospitals and ambulatory care centers in these two departments of Guatemala were considered to have had "moderate" cases of diarrheal illness. As anticipated, patients with more severe cases of illness were more likely to seek care at a hospital rather than an ambulatory care center, and children were more likely to be taken to the hospital for all levels of illness severity. Care-seeking patterns seemed to begin at local facilities, such as *tiendas* and pharmacies, where treatment could be purchased,

but no clinicians were available to evaluate the patient. Almost half of all participants (42%) had used some form of treatment prior to enrollment in the study. Prevalence of ORS use among young children was low, approximately 32%, of which 61% knew how to prepare ORS packets properly. Those least likely to use ORS were: Quetzaltenango residents, indigenous Mayan, two to four years of age, mild illness symptoms, low SES, and had sought prior care at a *tienda*. The majority of users obtained ORS from pharmacies (47%) or government-sponsored ambulatory clinics (28%). Those who obtained ORS packets from *tiendas* or pharmacies were most likely to improperly prepare ORS for use compared with those who obtained ORS packets from an ambulatory clinic.

Conclusion: In this population, ORS is low (32%) and care-seeking seems to begin at local pharmacies and *tiendas.* Those who obtain ORS packets from these facilities tend to use the ORS packets improperly. So, targeted educational interventions to community members, including these facilities, might increase the prevalence ORS use and improve the proper usage of ORS. The findings of this study suggest that further research looks at health utilization behaviors, especially ORS use, in the general community. Lessons learned from the present study in Guatemala provide a context for understanding factors associated with non-use and improper use of ORS in other countries around the world that are also burdened with a disproportionate level of diarrheal illness.

INTRODUCTION

Worldwide, diarrhea is recognized as a leading cause of death in children less than five years of age, second only to pneumonia.[1] In Guatemala, more than 13% of deaths in this age group are attributed to diarrheal disease.[2] In a two-week reporting period, it has been estimated that one fifth of children less than five years of age experience diarrheal symptoms, making diarrhea the most common childhood illness in Guatemala.[3] Although progress has been made in recent decades to reduce the number of deaths due to diarrhea, these current figures stand in the way of achievement of the Millennium Development Goal to reduce childhood mortality by two thirds by 2015.[1] Furthermore, it is troubling to humanity that approximately 1.5 million children worldwide die each year from a preventable and treatable disease that, in the developed world, is generally considered a mere inconvenience.[1]

Risk Factors

Factors that put children at greater risk for diarrheal diseases include unclean water, poor hygiene and sanitation, and malnutrition, all of which are factors that increase exposure to infectious agents and decrease human immune defense against such agents.[1] Lack of access to piped water or a private well, no sewage connection, high child-care needs, and mothers' illiteracy have also been identified as risk factors for diarrheal disease in children less than five years of age in the Guatemalan highlands.[4] The commonality of these factors in the developing world make poor children particularly susceptible to repeated episodes of diarrhea—they often have several episodes each year—and more likely to suffer severely and die from the symptoms.[1]

In socially unstable regions of Latin America, such as Guatemala, high fatality rates among poor children are attributed to the compounding health challenge of malnutrition coupled with infectious diseases, including diarrhea.[5] Children who become ill with diarrhea are at an increased risk of stunted growth (low height-for-age), a condition indicating malnutrition and chronic illness, which already disproportionately affects Guatemalan children (54% children less than five years old have moderate to severe stunting).[1] Similarly, diarrhea in young children contributes to the vicious cycle of malnutrition and disease in the developing world by increasing risk for malnutrition.[6] Furthermore, this cycle may be exacerbated by parental decisions not to seek care from a health-care provider or to unknowingly provide improper treatment.

Various prevention methods for diarrhea, including breastfeeding, sanitation, hygiene measures, adequate nutrition, clean water, and immunizations, have been thoroughly studied. Intervention strategies to reduce transmission of causal agents have focused on these preventive measures, specifically sanitizing drinking water, improving home and personal hygiene, and most recently, offering the Rotavirus vaccine.[1,7,8] Despite these efforts, persisting problems (unsanitary water, poor hygiene, malnutrition, infectious disease, and inadequately advised parental choices) have prompted the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) to propose the Integrated Management of Childhood Illnesses (IMCI) approach to improve child health care in the developing world.[9] By encouraging health-care providers, families, communities, and health systems to consider the multiple factors that put a child at risk for any disease, this approach aims to guide development of a plan to improve provision of preventive care (immunizations and adequate nutrition) and treatment for major childhood illnesses, including diarrhea.[9] In order to effectively promote appropriate health-care

utilization, it is essential to understand the rationale behind parents' and communities' illness-management choices for children with diarrheal illness.

Health Beliefs

In Guatemala, extensive anthropological research suggests that traditional health beliefs regarding diarrheal illness co-exist with biomedical views of infection and disease transmission.[10] Commonly held beliefs about the cause of diarrhea include: hot and cold imbalance, food quality and how food is eaten, tooth eruption, worms in the stomach, the "evil eye", poor hygiene and dirtiness.[10] While hygiene and cleanliness issues more closely reflect biomedical ideas of illness causation, the mechanism by which Guatemalan mothers understand poor hygiene and lack of cleanliness to cause diarrhea may stray from standard biomedical etiology. For example, Pebley, Hurtado, and Goldman (1999) have suggested that rural Guatemalan mothers are too busy to closely monitor their children and prevent them from eating dirt and putting other dirty things in their mouths. It is not well understood whether Guatemalan women's reference to dirt in this instance is related to the biomedical fecal-oral contamination process or rather to dirt as a direct cause of diarrheal symptoms.[10]

Health Utilization

Ultimately, beliefs form the basis for care-seeking decisions. In Guatemala, Goldman and Heuveline (2000) have demonstrated how such health beliefs impact decisions regarding where to seek care for child illnesses. As can be expected, women who have more modern health beliefs about the etiology of gastrointestinal symptoms are more likely to seek care from doctors and health providers at health centers and posts. On the other hand, women who believe in more traditional folk etiologies are more likely to seek care from a *curandero* (curer)

or another traditional healer.[11] Those who seek care from a biomedical provider tend to do so on the first or second day of illness, whereas *curanderos* are more frequently sought for illnesses with longer durations.[11]

Of the estimated 20% of children who experience diarrheal symptoms every two weeks, only one third seek are taken to be cared for by a provider, and less than one third seek care from a *curandero*.[11] In cases of child deaths, only approximately half of the children had been taken to a biomedical health-service facility between illness onset and death.[12] Very rarely are children taken to a provider more than once during the same illness episode.[3] Interestingly, people are more likely to seek biomedical care than they are to explicitly describe the causes of infectious diseases in terms biomedicine or to deliberately express biomedical health beliefs.[11]

Overall, illness symptoms, perceived severity of illness, and maternal beliefs about the causes of diarrhea are the most important determinants in whether professional medical care is sought.[10,11,13] Mothers are more likely to perceive gastrointestinal illnesses coupled with a fever as serious, and then seek care for the condition.[11,13] Mothers were also more likely to seek biomedical care for children with these symptoms than they were for children with respiratory symptoms.[11]

Factors beyond severity and symptoms have also been shown to play a role in mothers' decisions around care-seeking. Availability, acceptability, and accessibility of community care facilities, social networks and support systems, and economic resources all predict the likelihood of care-seeking for a child, and the type of provider sought.[13] Infants and low-parity children are more likely to be taken to see a provider when ill, but are less likely to be given medications from a pharmacy.[11] No differences in care-seeking decisions between child genders has been

observed, but it has been noted that children who are in otherwise good health are more likely to be taken to a provider than their chronically ill or weak counterparts.[11] It has been suggested that parents may be more willing to invest their limited financial resources into healthy kids who seem more likely to grow into productive adults.[11]

The existing literature concludes that mothers are the key actors in care-seeking decisions, types of remedies administered, types of providers sought out, and whether to heed provider's advice.[11] Maternal occupational status and overall community socioeconomic development have been identified as determinants of health-service utilization for typical childhood illnesses, including diarrhea.[12] Those of low socioeconomic status tend to seek care locally, whereas those families with greater financial means, particularly those with a vehicle, tend to travel farther to seek care.[14]

Although poverty is recognized as a major constraint in care-seeking, ethnicity and education by themselves do not seem to have a strong effect on such behavior.[11,14] Several sources have cited education status as a significant predictor of health utilization,[15,16] but Goldman, Pebley, and Gragnolati (2002) have suggested that after controlling for income, education and ethnicity are not significantly associated with the likelihood of visiting a provider in Guatemala.

Medical Choices

The anthropological literature has described medical choice and treatment behavior as multi-stage processes involving not just one parent of an individual, but several individuals, often times including in-laws and grandparents.[17-1920-22] In Guatemala, there are four main medical choices: (1) biomedical providers, including private doctors and providers at the government-sponsored hospitals, health centers and posts; (2) popular practitioners, including professional

and lay pharmacists; (3) traditional practitioners, including *curanderos*, *comadronas* (midwives), *hierberos* (herbalists), *brujos* (witch doctors), etc.; and (4) family, friends, and the home community.[3] Most mothers seek some form of advice for their children's illnesses. Mothers usually seek advice first from a family member or friend, most often their husband, mother, and/or mother-in-law.[18,23] Of those children who are taken to a provider, most went to a pharmacist, but others commonly went to a private doctor, or a health center or post.[11]

Although illnesses perceived as "severe" usually lead parents to take their children to a pharmacist or doctor, this is not necessarily a predictor of utilization of local government-sponsored health centers and health posts.[11] Children of all health statuses are equally likely to be taken in for care to a health center or post, and utilization of health centers and posts has not been observed to be related to family income.[12] Possible explanations for this observation include the financial decision that parents must make in balancing cost and health. Paying for health care with cash is one of the largest barriers to care in Guatemala.[24,25] These government-sponsored clinics offer care for a nominal fee, and may thereby make it seem worthwhile to take an only moderately ill child in to be seen by a provider.[11]

Previous research has documented reluctance among Guatemalan citizens to use the government-sponsored health facilities, perhaps due to the centers and posts having a history of being understaffed and short on medications.[3] However, there appears to have been an increase in the utilization of these facilities in the past decade, and a simultaneous decrease in the utilization of traditional *curanderos*.[3]

In decades past, traditional medicine and traditional health beliefs were described as playing a more central and important role in health-utilization patterns in Guatemala.[26] The transition

from folk medicines to biomedicine observed in developing countries internationally seems to be underway in Guatemala as well.[13,18,24-26,26] Heuveline and Goldman (2000) found that children who have one set of grandparents in their community are more likely to seek care at a health center or post than those with no grandparents living nearby, and that those children with two sets of grandparents living in their community are almost four times as likely to be taken to seek care from a *curandero* than other children. Similarly, if a physician is available in the community, parents are less likely to seek care from a *curandero*.[12]

The availability of facilities in the home community also significantly affects mothers' decisions about where to seek care. Parents are more likely to go to a health center, post, or private physician if there is one in their community. If private physicians are present near the home community, parents are less likely to seek care at a health center or post.[12]

Treatment Behavior

In Guatemala, nearly all children are treated with something during the course of their illness, most for which advice is sought and treatment is provided on the first day. Children are usually treated with more than one method during an illness episode.[11] Of those children who are treated with medications, pain relievers and fever reducers are taken most frequently. Antibiotics are estimated to be taken by about 9% of child illness episodes in Guatemala, most of which are obtained from doctors, pharmacies, and providers at health centers and posts.[11]

Overall, in Guatemala, home treatment, or treatment administered in the home without professional prescription, is the most prevalent form.[3,27] Heuveline and Goldman (2000) found that children whose grandparents live nearby are more likely to be treated with traditional

methods. Parents are more likely to recommend biomedical methods than their parents, but less likely to recommend biomedical methods than providers.[3]

Although doctors are most likely to examine the ill child than providers at health centers or posts, health centers or posts are more likely to distribute treatment than are doctors.[3] Furthermore, though they rarely examine the child, pharmacists distribute medications at nearly every encounter.[3] The existing literature has therefore concluded that modern biomedical care and Western pharmaceuticals play a central role in the treatment of infectious disease in young children, even in rural Guatemala. [3,13,18,25] Van der Stuyft (1996) and others have drawn attention to this conclusion by focusing on lay pharmacists as the distributors of many of these Western pharmaceuticals. These pharmacists are criticized in the literature for a general lack of formal training, improper use of medications (especially antibiotics), and little knowledge about oral rehydration salt (ORS) use and solution preparation.[13,18,28,29]

Oral Rehydration Salts

The primary treatment method for diarrhea, recommended by the UNICEF and the WHO, is ORS.[1] Since the 1970s, these two organizations have established programs to educate caregivers on how to effectively use ORS.[1] ORS is a simple solution of water, salt and sugar. Its low cost and ability to be mixed in the home make it seem like a simple treatment for diarrhea, accessible even to low-income and rural individuals in developing countries.

ORS works by supplementing a sick child's small intestine with sodium and glucose, which travel together across the intestinal lining. Once sodium is at an increased concentration in the intestines, water absorption is improved and dehydration is prevented.[30] Children's bodies hold more water than adults, so when a child is sick with diarrheal symptoms, he or she is at a

heightened risk for dehydration.[1] Zinc supplementation has also been identified as an effective treatment for diarrhea, particularly in children who are otherwise deficient in this micronutrient necessary for normal growth and development.[1]

Although combined ORS and continued feeding during symptoms were identified decades ago as a life-saving treatment approach for diarrhea, only 11-22% of children less than five years of age in Guatemala are estimated to be treated for diarrhea with ORS.[1,30,31] These percentages did not seem to differ by gender or urban/rural residence.[1] ORS use has been recorded as very low in other regions of the Americas as well (< 2% in Chiapas, Mexico).[14] The existing literature cannot fully explain such low utilization rates, but reasons offered include: lack of effectiveness, lack of public-health message penetrance, lack of availability, and lack of utilization by physicians, pharmacists and traditional healers.[14]

Vigilancia Comunitaria

The present study seeks to describe the symptoms and severity of diarrheal illness in government-sponsored facilities in Guatemala, and to explore factors surrounding health-utilization patterns. Data from a prospective community surveillance system, *Vigilancia Comunitaria* (ViCo), was utilized to examine health-care-seeking behavior with a focus on ORS use. Specifically, factors which predict non-use of ORS and improper ORS preparation prior to diarrheal diagnosis in public care facilities in young children from the Departments (analogous to province/state) of Santa Rosa and Quetzaltenango in Guatemala were assessed. The findings intend to provide a better understanding of how interventions and educational messages might be tailored to be more effective in these regions of study in Guatemala.

METHODS

Study Regions

The ViCo surveillance project was carried out in two departments in Guatemala (see Figure 1). The Department of Santa Rosa (total population 319,963) is located approximately 50km south of Guatemala City. The department is composed of 14 *municipios* (municipalities; analogous to counties), and most people (65%) reside in the rural regions of the department. The Department of Santa Rosa is made up of nearly all non-indigenous (97%) people.[32,33]

Figure 1. Locations of the two surveillance sites (Santa Rosa and Quetzaltenango)

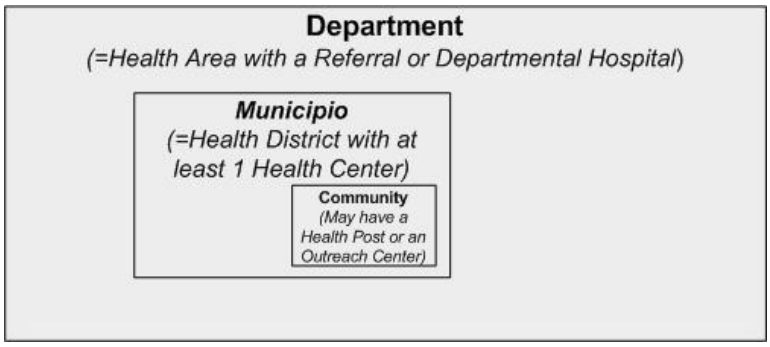
The Department of Quetzaltenango (total population 705,301) is located approximately 120 km northwest of the capital in the Guatemalan highlands. Quetzaltenango is known nationally for being the site of Guatemala's second largest city, locally referred to by its indigenous name, "Xela." This department covers 24 *municipios* and differs from the Department of Santa Rosa in that an estimated 54% of the population is indigenous.[32,33]

Overall, Guatemala is a developing country with both high under-five mortality (45 per 1,000 live births) and high adult mortality (276 and 152 per 1,000 people aged 15 to 60 for males and females, respectively). Life expectancy at birth for both sexes combined is 68 years.[34] Infectious diseases constitute a major cause of death and disability in Guatemala, accounting for 32% of all disability-adjusted life-years (DALYs) lost and 41% of all deaths in 2002.[35] Diarrhea is also one of the top two reasons for seeking care at a government health facility in Guatemala.

Public health care in Guatemala is organized regionally (see Figure 2). Hospitals, health centers (*centros de salud*), and health posts (*puestos de salud*) are spread throughout each departmental region. There are 23 departments in Guatemala, each of which is sub-divided into at least 10 *municipios*. In most cases, each department has one central referral hospital, and each *municipio* has at least one *centro de salud*, staffed by physicians and nurses. *Puestos de salud* are clinics located in outlying communities, towns, or plantations (*fincas*), and staffed by nurses. *Centros de salud* are generally 24-hour health centers, which offer care for emergency cases, a few labor beds and delivery ward, electricity, and a small laboratory. The centers are generally staffed by one physician and several nurses. The *puestos de salud* included in the present study are small facilities, some without electricity, and are staffed by one nurse and

nursing staff. At these public facilities, services and medicines are provided to patients free of charge, yet utilization of these governmental facilities is usually low.[3,13]

Figure 2. Model of the public health care service system in Guatemala



The Santa Rosa and Quetzaltenango departments were chosen for the project because these departments each represented unique populations of Guatemala, had referral hospitals with basic laboratory capacity, and had the Guatemalan Ministry of Health and Social Assistance (MSPAS, Spanish acronym) counterparts willing to collaborate on the project. ViCo was initiated at the National Hospital of Cuilapa (NHC) in the Department of Santa Rosa in 2007 and in the Western Regional Hospital (WRH) in Xela in early 2009. NHC is a 176-bed regional referral government hospital with two surgical wards, an emergency room, a laboratory, pediatric and adult intensive care units (ICU), and an outpatient clinic. WRH is a 425-bed facility with pediatric and adult ICUs. Surveillance is also conducted in *centros* and *puestos de salud* from two selected *municipios* within each department. Collectively, all governmental *centros* and *puestos de salud* involved in this diarrheal surveillance will be referred to as "ambulatory clinics."

Surveillance System Design

Surveillance systems are said to provide a factual basis for rational decision making.[36] The present study concerning diarrheal illness utilizes data collected by the prospective surveillance

system, ViCo, in two departments of Guatemala. A laboratory-enhanced, population-based surveillance system, such as ViCo, is particularly suited to assess disease-incidence trends in the developing world where infrastructure is lacking and incidence rates and disease etiologies are not well understood, and then to target the use of public-health resources and evaluate program effectiveness.[37] ViCo is funded by the Global Disease Detection Initiative of the Coordinating Office of Global Health at the U.S Centers for Disease Control and Prevention (CDC). The main objective of the ViCo project proposal was to establish baseline levels of disease for four particular illnesses, one of which is diarrhea. ViCo provides a means to measure the burden of diarrheal disease, obtain knowledge of disease etiology, and to understand the care-seeking patterns and treatment choices of each case of diarrheal admitted to a public health-care facility.

Identification of Cases

At the NHC and WRH, patients admitted with diarrheal symptoms were prospectively identified for eligibility screening for study participation by paid surveillance staff, all of who were nurses. These nurses searched the emergency room and reviewed inpatient ward registers to identify patients with signs and symptoms of diarrhea. At ambulatory clinics, all patients were assessed and referred to surveillance staff as they were seen by the facilities' medical professionals. Those patients who fit the case definition and inclusion criteria for "Diarrhea" were admitted into the project after obtaining written, informed consent or assent, if applicable.

Patients were identified as a case of "Diarrhea" in the ViCo project if they had experienced the acute onset of three or more loose or liquid stools in a 24-hour period during the course of the prior seven days (Figure 3). Hospitalized patient inclusion criteria were that the patient be a

resident of the Department of Santa Rosa or Quetzaltenango, accordingly, during the last 30 days before being admitted to the hospital with a diagnosis of diarrhea. Ambulatory clinic patient inclusion criteria required that the patient be a resident of the facility *municipio* during the last 30 days before presenting to the ambulatory clinic with the complaint of diarrhea. Patients who had used excessive drugs or alcohol, or whose diarrheal symptoms were attributed to non-infectious causes (including but not limited to inflammatory bowel disease, Crohn's disease, surgical bowel obstruction, ulcerative colitis, celiac disease, lactose intolerance, malabsorption syndromes) were excluded from the study.

Figure 3. Diarrhea Case Definition and Inclusion Criteria for Study Participation

	Hospital Inpatient	**Health Center**	**Health Post**
Case definition:	≥3 loose or liquid stools in 24 hours in last 3 days		
Inclusion criteria:	Residents of project catchment area admission diagnosis of diarrhea	Residents of participating *municipios*, complaint of diarrhea	Residents of participating *municipios*, complaint of diarrhea
Exclusion criteria:	Another episode of diarrhea in the 7 days before the start of this episode		

Data and Sample Collection

An in-depth questionnaire concerning demographic, risk factor, health history, and health-behavior topics was administered to the patient by surveillance nurses. All interviews relied on a structured questionnaire read from a personal digital assistant (PDA) with pre-programmed logic checks and skip patterns. Questionnaires were administered face-to-face by trained study nursing staff, and monitored closely by the project's clinical director.

Stool samples were collected from each patient to identify the etiologic agent of each patient's disease. Stool specimens were tested at the International Emerging Infections Program (IEIP)

Laboratory at the Universidad del Valle de Guatemala (UVG) in Guatemala City, and at the U.S. CDC's laboratories in Atlanta and Fort Collins, USA. Results were provided to the participating health facilities and the MSPAS on a quarterly basis.

Unique identifiers were used to link epidemiological data with laboratory diagnoses to simplify data merging. Data were managed in Microsoft SQL Server v. 2008® (Redmond, VA, USA), and imported to SAS 9.2® (Cary, NC, USA) for statistical analyses.

Data Analysis

Participants of all ages who met the case definition for diarrhea were enrolled in the ViCo study and were included in the present analyses. In Santa Rosa, data collected between October 1, 2007 and February 28, 2010 were analyzed, and in Quetzaltenango between February 1, 2009 and February 28, 2010. The overall sample size of 3,194 diarrheal participants was reduced to a total sample of 3,044 (95% of the sample retained) after excluding participants for who demographic, illness severity, or health-utilization data were missing (Appendix 1 (a)). Statistical analyses were carried out using SAS 9.2® statistical data analysis software. Data analyses plans and sample sizes are charted in Appendix 1 (b).

Education was described for the patient if he or she was at least 18 years of age; otherwise, education level was of the patient's parent. A durable asset score to describe socioeconomic status (SES) was calculated as a simple count of the nine durable assets listed in Appendix 2 (a) which the participant's family owned. Comparisons of categorical variables between Santa Rosa and Quetzaltenango were made using the Pearson chi-square test, and the Fischer's Exact Test when appropriate. Continuous variables were compared using the t-test.

Diarrheal cases were categorized into three levels of severity (mild, moderate, or severe) based on an adapted severity index score cited in the literature (Appendix 1(d)).[38] The Brighton Collaboration Diarrhea Working Group has outlined references to severity indexes generated for diarrheal illness (Appendix 1 (c)). The currently proposed 20-point Vesikari Numerical Scale for Diarrhea Severity[38] was adapted to a 9-point index to fit the available data in the present study, which included duration of illness, number of stools per 24 hours on the worst day, and the number of days with vomiting symptoms (Appendix 1 (d)). Patients were classified as having respiratory symptoms based on the ViCo protocol case definition for a respiratory patient, which included patients with pneumonia and influenza-like illness (ILI).

Prior care-seeking of participants was described for those who responded to the study questions regarding prior care-seeking behaviors (N=2,469; missing 575 from SR). Those who reported having sought prior care (N=569) were asked where they had sought that care and what, if any, treatment they received at that facility. Methods used to treat diarrhea were also assessed by inquiring of all participants whether or not he or she had taken any medications in the 72 hours prior to enrollment in the ViCo study (N=2,812; 232 missing responses).

Children less than five years of age who identified with the *ladino* or indigenous Mayan ethnicity were included in the analysis of ORS use (N=1,868). Those belonging to the indigenous Xinca ethnic group (n=237) were excluded from this sub-analysis because no comparable ethnic group existed in Quetzaltenango. In Santa Rosa, data from October 2007 through February 2010 were analyzed, and in Quetzaltenango, data were analyzed from February 2009 through February 2010. At both sites, between February 2009 and February 2010, parents who reported having

used ORS to treat their young child (N=343) were asked to describe where they obtained the ORS, the duration of use, and how they prepared the packets.

Proper use of ORS packets was assessed based on the brand of ORS used and the quantity of water used to make the mixture, according to the directions for use on the packets (Appendix 1 (e)). Participants less than five years of age who had been treated with ORS packets were included in this sub-analysis (N=200). Logistic regression analysis was used to evaluate the contribution of various demographic, SES, illness severity, and health-utilization behaviors upon the binary outcome of interest: (1) ORS non-use/ORS use, and (2) improper use of ORS packets/ proper use of ORS packets.

Binary logistic regression models were built for ORS non-use and improper use of ORS packets. Purposeful selection was used to manually select each model. Univariate logistic regression analyses were run for each predictor variable and the outcome (ORS non-use and improper use of ORS packets). Modeling was begun by including all variables significant in the univariate analyses with $p<0.25$. Variables were then deleted one by one, based on the Likelihood Ratio Test (LRT) statistic, until all variables in the model were significant with $p<0.05$. All variables excluded from the model at that point were then added back in one by one and evaluated for statistical significance and confounding effects. Variables that were significant at $p<0.05$ or those that were considered important confounders were added back into the model. All possible two-way interactions involving the variables included in the model were tested for effect modification. Significant interaction terms at $p<0.05$ were included in the final model.

Institutional Review Board Approval

The original study protocol and forms for the ViCo study were reviewed and approved by the Institutional Review Boards (IRB) at the U.S. CDC and the UVG and approved by the MSPAS. Verbal consent was obtained from all patients prior to the screening for study eligibility. Eligible participants were asked for written, informed consent before they were enrolled in the study. For children less than 18 years of age, parents or guardians were asked to provide written, informed consent for the child participant, and children aged 7 through 17 years were asked to provide written, informed assent. Each study participant's health information was kept confidential, and all recorded identifying information was stored with an anonymous identification code prior to data use in the present analysis. Documents containing identifying information have been locked in a file cabinet in a secure office at the CDC/UVG in Guatemala City, Guatemala.

RESULTS

Study Population

The study sample included in the present analyses is described by departmental study site: Santa Rosa and Quetzaltenango (Table 1). Most participants were enrolled in the present study at an ambulatory clinic. When compared with Santa Rosa, a greater proportion of participants sought care at the hospital than at an ambulatory clinic in Quetzaltenango (p<0.0001).

Table 1. Study Sample Demographics by Department

	Santa Rosa (N=2,607) 10/1/07-2/28/10	**Quetzaltenango** (N=437) 2/8/09-2/28/10	**TOTAL** (N=3,044)	**Study Site Comparison**
	n (%)	**n (%)**	**N (%)**	**χ2 (p-value)**
Enrollment Facility				35.15 (<0.0001)
Hospital	513 (20)	141 (32)	654 (21)	
Ambulatory Clinic	2,094 (80)	296 (68)	2,390 (79)	
Age				1.68 (0.64)
0-4	1,803 (69)	310 (71)	2,113 (69)	
5-15	345 (13)	55 (13)	400 (13)	
16-59	378 (15)	63 (14)	441 (14)	
60+	81 (3)	9 (2)	90 (3)	
Gender				1.03 (0.31)
Female	1,363 (52)	217 (50)	1,580 (52)	
Male	1,244 (48)	220 (50)	1,464 (48)	
Ethnicity				(<0.0001) †
Ladino	2,245 (86)	90 (21)	2,335 (76)	
Indigenous Mayan	41 (2)	346 (79)	387 (13)	
Indigenous Xinca	321 (12)	1 (0)	322 (11)	
Education*				236.80 (<0.0001)
none	1,193 (46)	72 (16)	1,265 (42)	
Some primary	843 (32)	142 (32)	985 (32)	
Primary completed	420 (16)	130 (30)	550 (18)	
Básico completed	80 (3)	36 (8)	116 (4)	
Secondary completed	71 (3)	57 (13)	128 (4)	

*if patient <18 years of age, education = level of the parent; if patient ≥ 18 years of age, education = level of the patient
† Fisher's Exact Test

Overall, most of the enrollees were less than five years of age. The age and gender distributions were similar in both sites (p>0.05). The proportion of male and female participants was

approximately equal in both sites ($p>0.05$). Guatemala is an ethnically diverse country. The indigenous Mayans mostly live in the Western highlands. The Spanish-speaking *ladinos*, the mixed race, are spread throughout the country. So, ethnicity of study participants varied significantly between sites ($p<0.0001$). The Quetzaltenango sample was mostly indigenous Maya, whereas the Santa Rosa sample was predominantly *ladino*. The Xinca population is an indigenous group residing in southern Guatemala, and were therefore only recruited in Santa Rosa. Participants from Quetzaltenango seemed to have a higher level of education compared with the Santa Rosa participants ($p<0.0001$); nearly half of the Santa Rosa participants had not attended school at all.

Socioeconomic Status

SES was measured by collecting data that reflect living standards, such as ownership of durable assets, home infrastructure, and housing assets (see Table 2). By some measurements, SES was significantly different between Santa Rosa and Quetzaltenango participants ($p<0.05$). However, nearly three quarters of families in both departments reported a family income of less than Q1,000 per month (equivalent of $123; 1 USD=8 GTQ in March 2010) ($p>0.05$). The average household size was the same for both study sites, equal to about three people per room in a two- to three-room house ($p>0.05$).

In both locations, most houses were constructed of *lamina* (metal sheet) roofs and cement floors. In Santa Rosa, more than one third of the households had a dirt floor, whereas in Quetzaltenango, approximately one quarter reported having a rock or a floor made out of a different material, and very few had a dirt floor ($p<0.0001$). More Quetzaltenango study participant households had electricity than Santa Rosa participants' households ($p<0.0001$).

Table 2. Socioeconomic Indicator Components by Department

	Santa Rosa (N=2,607) 10/1/07-2/28/10	**Quetzaltenango** (N=437) 2/8/09-2/28/10	**TOTAL** (N=3,044)	**Study Site Comparison**
	n (%)	**n (%)**	**N (%)**	**χ2 (p-value)**
Monthly family income				95.11 (<0.0001)
<Q1,000	1,902 (73)	277 (63)	2,179 (72)	
Q1,001 - Q3,000	615 (24)	103 (24)	718 (24)	
> Q3,001	42 (2)	12 (3)	54 (2)	
No response	48 (2)	45 (10)	93 (3)	
Household Characteristics				
Roof material				189.66 (<0.001)
Shingles/roof tiles	175 (7)	66 (15)	241 (8)	
Lamina (metal)	2,341 (90)	274 (63)	2,615 (86)	
Palm/other	91 (3)	97 (22)	188 (6)	
Floor material				277.31 (<0.0001)
Dirt	928 (36)	39 (9)	738 (27)	
Cement	1,515 (58)	306 (70)	1,717 (64)	
Rock/other	164 (6)	92 (21)	256 (9)	
# rooms				15.10 (<0.001)
1 room	706 (27)	105 (24)	811 (27)	
2-3 rooms	1,582 (61)	249 (57)	1,831 (60)	
>3 rooms	319 (12)	83 (19)	402 (13)	
Electricity	2,265 (87)	426 (97)	2,691 (88)	41.03 (<0.0001)
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**t-test (p-value)**
Durable Asset Score	2.91 (1.59)	3.32 (1.72)	3.0 (1.6)	-5.02 (<0.0001)
# people/room	2.84 (1.60)	2.90 (1.73)	2.9 (1.6)	-0.60 (0.55)

The average durable-asset score was approximately 3.2, but was significantly higher in Quetzaltenango ($p<0.0001$). In Santa Rosa and Quetzaltenango, most people reported possession of a radio, telephone and television (Appendix 2 (a)). Ownership of a computer, microwave, washing machine, laundry dryer, personal vehicle, or refrigerator seemed to set apart those of higher socioeconomic status in both locations. Although few participants in both locations owned these items, significantly more Quetzaltenango participants possessed them (not including a refrigerator) than Santa Rosa participants ($p<0.05$).

Description of Illness Episodes

Diarrheal symptoms varied slightly between Santa Rosa and Quetzaltenango (see Table 3). Very few participants had observed blood in their stools in either site, but approximately half had noted mucus in the stools. More participants noticed mucus in the stools in Santa Rosa than in Quetzaltenango (p=<0.0001). Vomiting symptoms were also fairly common in both locations (p>0.05). A small proportion of diarrheal cases also met the case definition for a respiratory illness, such as pneumonia or influenza-like illness, in Santa Rosa. A significantly greater proportion ($p<0.001$) of the diarrheal cases in Quetzaltenango than in Santa Rosa suffered from such symptoms.

Table 3. Diarrheal Symptoms by Department

	Santa Rosa (N=2,607) 10/1/07-2/28/10	**Quetzaltenango** (N=437) 2/8/09-2/28/10	**TOTAL** (N=3,044)	**Study Site Comparison**
	n (%)	***n (%)***	**N (%)**	**χ^2 (p-value)**
Blood in stools	185 (7)	29 (7)	214 (7)	0.1212 (0.73)
Mucus in stools	1,495 (57)	206 (47)	1,701 (56)	15.81 (<0.0001)
Vomiting	1,078 (41)	200 (46)	1,278 (42)	3.00 (0.08)
Respiratory case def.	100 (4)	86 (20)	186 (6)	163.76 (<0.0001)

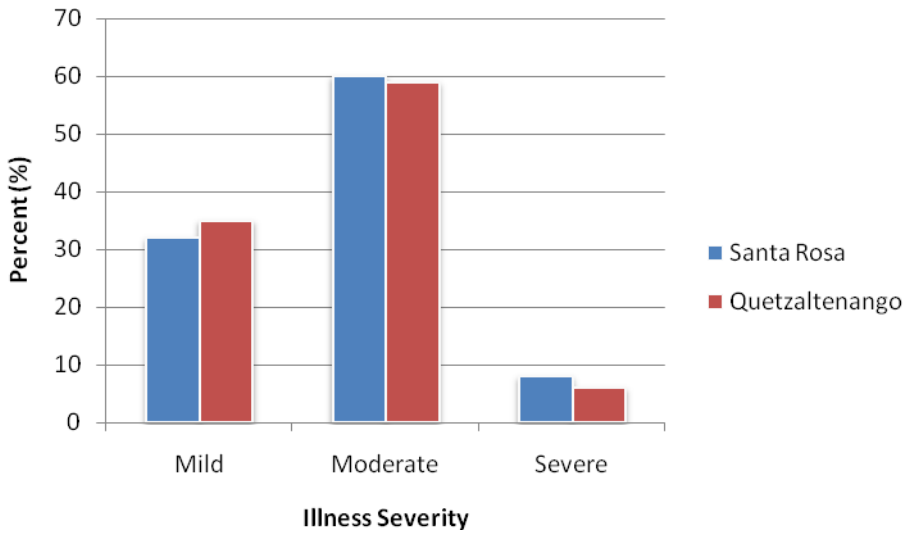
The average severity index score for both departments was 4.2, equivalent to a moderate case of diarrhea as defined by the 9-pt severity index (p>0.05) (Appendix 1(d)). The study sites differed in severity only in the number of stools reported on what was considered the worst day of illness (p<0.01). Participants in Santa Rosa reported nearly seven stools per day whereas their Quetzaltenango counterparts reported approximately six. Both locations reported that an average of two and half days had passed since illness onset, and for the nearly half of the study sample that experienced vomiting symptoms, these symptoms occurred for about two days (p>0.05) (Table 4).

Table 4. Severity Index by Department

	Santa Rosa (N=2,607) 10/1/07-2/28/10		Quetzaltenango (N=437) 2/8/09-2/28/10		TOTAL (N=3,044)	Study Site Comparison
	Mean (SD)	**Range**	**Mean (SD)**	**Range**	**Mean (SD)**	**t-test (p-value)**
9-pt Severity Index						
Score	4.2 (1.4)	1-9	4.2 (1.4)	1-9	4.2 (1.4)	0.02 (0.98)
Index Components						
Days since illness onset	2.5 (1.5)	0-7	2.5 (1.5)	0-7	2.5 (1.5)	0.63 (0.53)
# days vomiting (n=1,279)	2.0 (1.4)	0-8	1.8 (1.1)	1-6	2.0 (1.4)	1.88 (0.06)
# stools on worst day	6.8 (4.4)	3-50	6.2 (3.4)	3-25	6.7 (4.3)	2.94 (<0.01)

Overall, most participants had a moderate case of diarrhea, while a third had a mild case, and less than 10% had a severe case. The distribution of the severity index was similar in both study sites ($p>0.05$) (Figure 4).

Figure 4. Diarrheal Cases by Severity and Study Site (Appendix 3 (a))



Healthcare Utilization Trends

The study sites were significantly different in the distribution of case severity by enrollment facility. As could be anticipated, the overall trend indicates that more severe cases are more

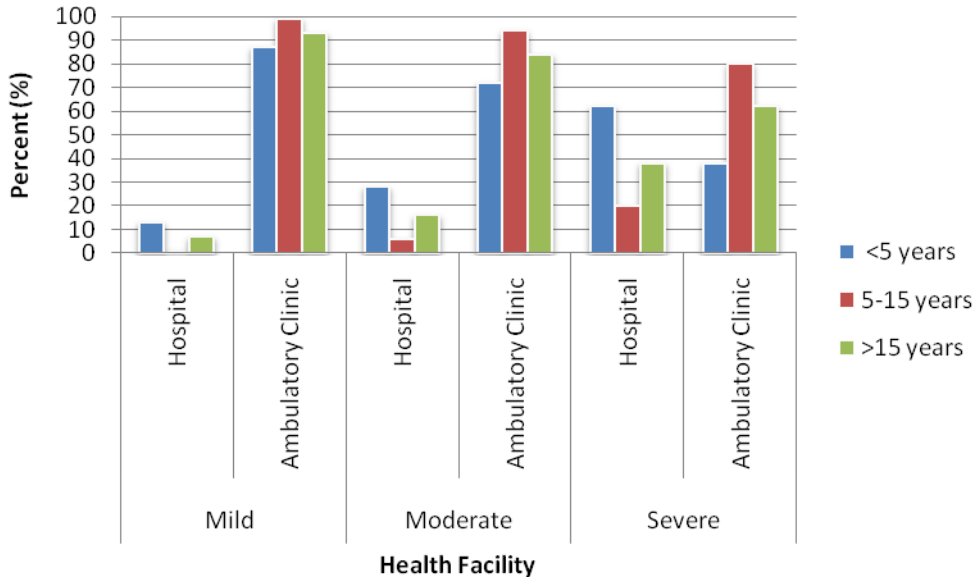
likely to seek care at the hospital than at ambulatory clinics ($p<0.0001$) (Appendix 4 (a)). In Quetzaltenango, however, participants were more likely to seek care at the hospital than were participants in Santa Rosa for all levels of illness severity ($p<0.05$) (Table 5).

Table 5. Severity by Enrollment Facility and Department

Severity Index	**Santa Rosa** (N=2,607) 10/1/07-2/28/10	**Quetzaltenango** (N=437) 2/8/09-2/28/10	**TOTAL** (N=3,044)	**Study Site Comparison**
	n (%)	**n (%)**	**N (%)**	**χ^2 (p-value)**
Mild			**998**	
Hospital	65 (8)	36 (24)	101 (11)	35.72 (<0.0001)
Ambulatory Clinic	780 (92)	117 (76)	897 (90)	
Moderate			**1,814**	
Hospital	240 (22)	84 (33)	424 (23)	14.83 (0.0001)
Ambulatory Clinic	1,218 (78)	172 (67)	1,390 (77)	
Severe			**232**	
Hospital	108 (53)	21 (75)	129 (56)	4.85 (0.03)
Ambulatory Clinic	96 (47)	7 (25)	103 (44)	

Children less than five years of age were more likely to have had a moderate or severe case of diarrhea than older children and adolescents between five and fifteen years of age ($p<0.01$), but had an equal likelihood of having a moderate or severe case of illness when compared with adults ($p>0.05$) (Appendix 4 (b)). Yet, for all levels of illness severity, children less than five years of age were more likely to be taken to the hospital than were older children ($p<0.01$) and adults ($p<0.05$) (Figure 5).

Figure 5. Severity by Enrollment Facility and Age Category (Appendix 4 (c))



*percentages represent the proportion of cases within each severity category (mild, moderate, severe)

Care-Seeking Patterns

For three quarters of the total participants who responded to the study questions regarding prior care-seeking behaviors, the enrollment was their first reported care-seeking endeavor for that illness episode. A significantly greater proportion of participants from Quetzaltenango than Santa Rosa had sought prior care for the same illness episode at a facility other than the one in which he or she was enrolled in the ViCo study ($p<0.0001$) (Table 6).

Table 6. Summary of Care-Seeking by Department

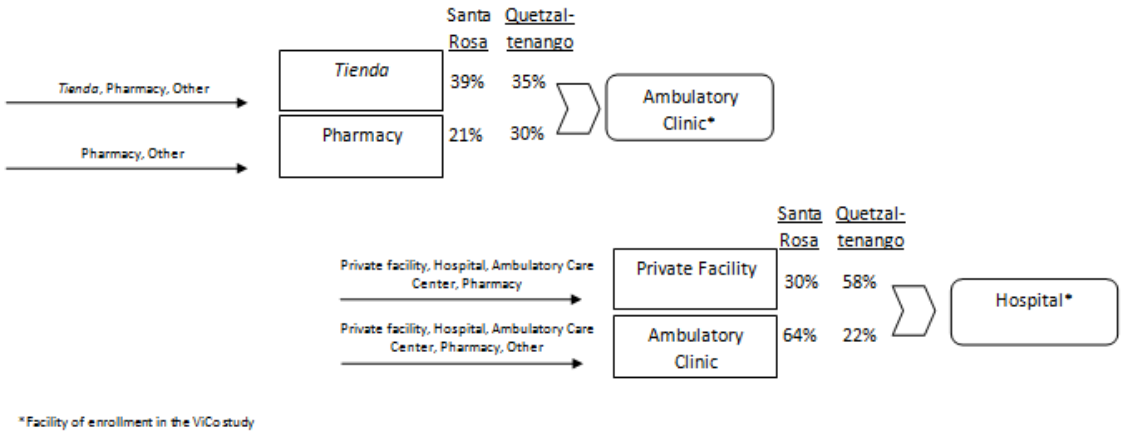
	Santa Rosa (N=2,032) 10/1/07-2/28/10	**Quetzaltenango** (N=437) 2/8/09-2/28/10	**TOTAL** (N=2,469)	**Study Site Comparison**
	n (%)	**n (%)**	**N (%)**	**χ^2 (p-value)**
No prior care-seeking	**1,640 (81)**	**260 (59)**	**1,900 (77)**	**89.65 (<0.0001)**
ViCo hospital	213 (13)	44 (17)	257 (14)	2.93 (0.09)
ViCo ambulatory clinic	1,427 (87)	216 (83)	1,640 (86)	
Sought care prior to ViCo	**392 (19)**	**177 (41)**	**569 (23)**	

Approximately one quarter of these participants reported having sought care prior to arriving at their enrollment facility. Of those who sought care prior to ViCo enrollment, prior care-seeking locations differed by enrollment facility (Appendix 4 (d)). Overall, participants who were enrolled at a hospital were most likely to have sought prior care at a private facility or an ambulatory clinic. Participants who were enrolled at an ambulatory clinic were most likely to have sought care at a local pharmacy (lay and professional pharmacies cannot be differentiated in the present data) or *tienda* (small grocery shop).

Care-seeking patterns seemed to also differ by study site. Participants enrolled in the hospital in Santa Rosa were most likely to have sought prior care at an ambulatory clinic, whereas Quetzaltenango participants were most likely to have sought care at a private facility prior to arriving at the ViCo enrollment hospital. Care-seeking patterns prior to enrollment in an ambulatory clinic seemed more similar between sites. Participants from both study sites were likely to have sought prior care at a local *tienda* or pharmacy.

Some of these participants (n=61) reported having sought care at more than one facility before arriving at the ViCo enrollment facility. These care-seeking patterns are displayed in Figure 6 by enrollment facility and study site.

Figure 6. Care-Seeking Patterns by Enrollment Facility and Study Site (N=569) (Appendix 4(d))



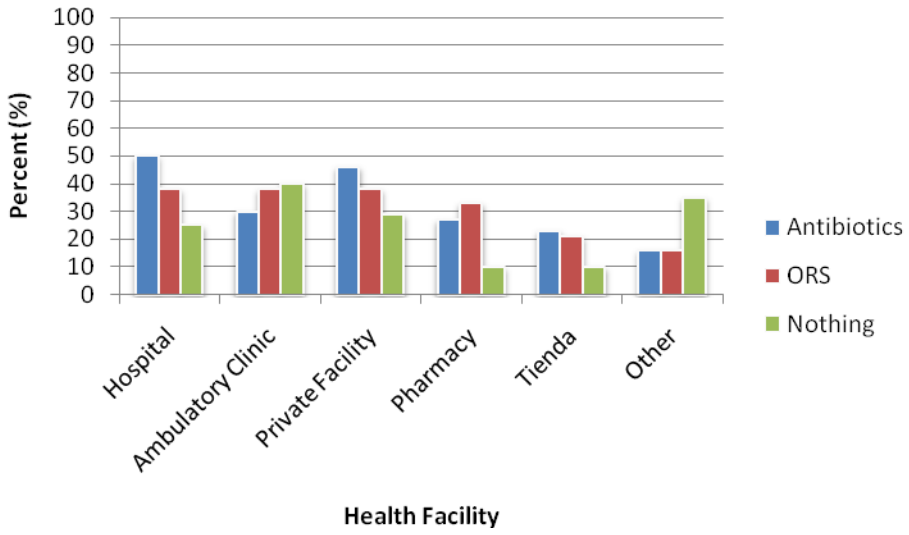
For children less than five years of age compared with older children and adults, these patterns differed slightly. Overall, older children and adults seem to have sought care at private facilities, before enrollment at a ViCo hospital facility. Young children, however, sought care at both private facilities and ambulatory clinic before enrollment at a ViCo hospital facility. In Quetzaltenango, young children were most likely to have sought care at a private facility, while in Santa Rosa, young children were most likely to have sough care at an ambulatory clinic. Ambulatory clinic enrollees who were five years and older had primarily sought prior care at pharmacies and *tiendas*. Young children enrolled at ambulatory clinics had sought prior care at pharmacies and *tiendas* as well, but also at ambulatory clinics in Santa Rosa (Appendix 4(e,f)).

Treatment Trends

Among the 569 patients who sought care prior to enrollment in ViCo, three quarters reported having received some form of treatment at the facility where they sought care. While some reported having received both medications and ORS, overall, approximately one third reported receipt of ORS and one third reported receipt of antibiotics (Appendix 4 (g)).

Those who sought care at a pharmacy or *tienda* were the most likely to receive some form of treatment, yet those who sought care at these facilities were reportedly the least likely to receive ORS. Governmental and private facilities seemed most likely to distribute ORS, and the hospitals and private facilities were most likely to distribute antibiotics (Figure 7).

Figure 7. Percent of Patients Reporting Receipt of Treatment at Health Facilities (Appendix 4 (g))



Not all participants obtained medications or ORS through formal care-seeking. For example, some already had the ORS packets in their homes. All individuals were asked if they had used any treatment for diarrhea during the 72 hours prior to enrollment in the ViCo study. Of those who responded, almost half of the study participants in Santa Rosa and in Quetzaltenango reported having taken medication of some type during the 72 hours prior to enrollment in the ViCo study (Table 7). Some participants reported taking more than one type of medication. Quetzaltenango participants were most likely to have taken antibiotics, and Santa Rosa

participants were most likely to have taken an "other" type of medication, including but not limited to antipyretics, antimalarials and steroids.

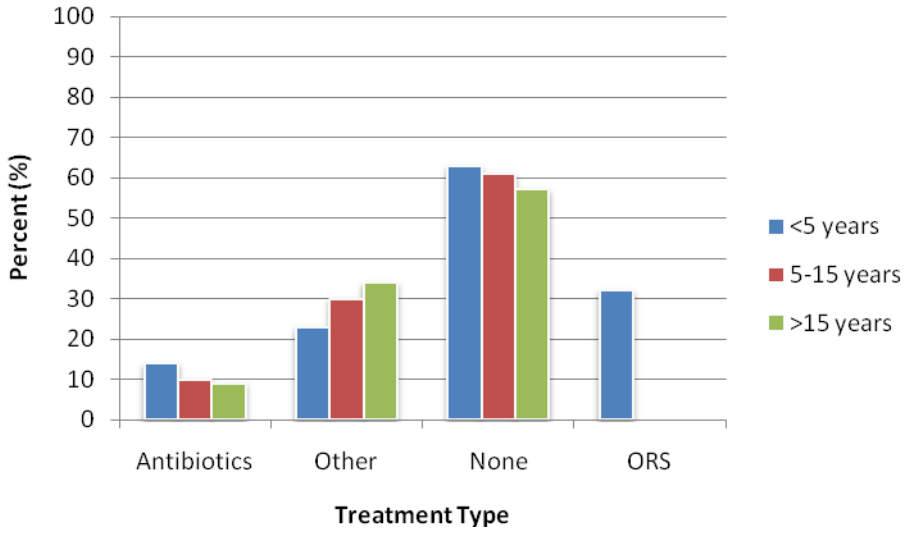
Overall, participants enrolled at hospitals were less likely to have taken medications in the 72 hours prior to enrollment. Those who were enrolled at the hospital and did take medications were most likely to have taken antibiotics. In both locations, few ambulatory clinic participants reported having taken antibiotics, but more reported having taken some "other" kind of medication.

Table 7. Treatment Methods for Diarrhea Utilized by Enrollment Facility and Department

	Hospital (N=613) 10/1/07-2/28/10		**Ambulatory Clinic** (N=2,199) 2/8/09-2/28/10		**TOTAL** (N=2,812)	**Study Site Comparison**
	Santa Rosa	**Quetzal-tenango**	**Santa Rosa**	**Quetzal-tenango**		
	n (%)	**n (%)**	**n (%)**	**n (%)**	**N (%)**	**χ^2 (p-value)**
Medications Used						8.97 (0.01)
Antibiotics	89 (19)	47 (34)	215 (11)	30 (10)	381 (14)	
other	36 (8)	34 (25)	643 (34)	73 (25)	786 (28)	
did not take meds	351 (74)	56 (41)	1,048 (55)	190 (65)	1,645 (58)	
ORS (<5 years old)	303/434 (70)	58/122 (48)	274/1,369 (20)	34/188 (18)	669/2,113 (32)	0.66(0.42)

Of the overall sample, 2,113 participants were less than five years of age. Within this age group, nearly one third of the children had been treated with ORS in both study sites. A greater proportion of children had been treated with ORS in the group that had been enrolled in a hospital than in the group that had been enrolled in an ambulatory clinic. Treatment of children with ORS did not differ by study site, but treatment given to children less than five years of age was different that that given to older children or adults ($p<0.05$) (Figure 8).

Figure 8. Use of medications 72 hours prior to enrollment in ViCo (Appendix 4 (h))



Oral Rehydration Therapy Use in Young Children

Use of oral rehydration therapy to treat diarrhea was assessed in indigenous Mayan and *ladino* children less than five years of age from this study sample. Thirty-five percent of these mothers reported having used ORS to treat her child's diarrhea. In Quetzaltenango, these young children were more likely to be enrolled at a hospital than they were in Santa Rosa ($p<0.0001$). There was no difference in gender between the two study sites ($p>0.05$), but ethnicity varied greatly ($p<0.0001$). The Quetzaltenango sample was mostly indigenous Maya, whereas the Santa Rosa sample was mostly *ladino*. Participants from Quetzaltenango seemed to have a higher level of education overall ($p<0.0001$). The distribution of exact age in years, for those less than five years of age, varied slightly by study site ($p<0.01$). Most participants in Santa Rosa and Quetzaltenango were less than three years of age (Appendix 5 (a)).

Factors Predicting Non-Use of ORS

In the univariate analysis, multiple variables were independently significant predictors of ORS non-use ($p<0.05$): Quetzaltenango study site, enrollment in an ambulatory clinic, female gender, indigenous Mayan ethnicity, illness episode during non-flu season (March through September), dirt floors, shingled roof, absence of mucus in stools, mild severity of illness, no prior treatment, older age (ie, two to four years), no prior care-seeking or prior care-seeking at a *tienda*, and low durable asset score, high proportion of people per room, and no access to electricity in the home (SES indicators) (Appendix 5 (b)).

The results of the binary logistic regression model are shown below (Table 8). In the multivariate analysis, study site was accounted for as well as other variables included in the model. The Quetzaltenango study site, indigenous Mayan ethnicity, older age (ie, two to four years), absence of mucus in stools, severity of illness, prior treatment choice, prior care-seeking location, and a low durable asset score (SES indicator) remained significant predictors of ORS non-use. The effects of ethnicity and the absence of mucus in the stools on ORS non-use were modified by enrollment facility, but were significant predictors of ORS non-use ($p<0.05$).

Table 8. Binary Logistic Regression Model: Non-Use of ORS

	No. (%) of Non-Users	OR (95% CI)[a]	P[a]	Adjusted P[b]
Study Site				
Santa Rosa	995 (64)	--	--	--
Quetzaltenango	217 (70)	1.34 (1.03, 1.74)	0.03	<0.01
Enrollment Facility				
Hospital	195 (35)	--	--	--
Ambulatory Clinic	1,017 (78)	6.38 (5.14, 7.93)	<0.0001	0.97
Age				
Less than one year	409 (61)	--	--	--
One year	438 (62)	1.04 (0.84, 1.29)	0.73	NA
Two years	182 (73)	1.72 (1.25, 2.34)	0.0009	NA
Three years	111 (76)	2.03 (1.35, 3.06)	0.0007	NA
Four years	72 (77)	2.20 (1.32, 3.66)	0.0025	NA
Gender				
Male	627 (62)	--	--	--
Female	585 (68)	1.28 (1.05, 1.55)	0.0125	NA
Ethnicity**				
Ladino	1,006 (63)	--	--	--
Indigenous Mayan	206 (75)	1.71 (1.28, 2.29)	0.0003	<0.0001
Enrollment Facility X Ethnicity**				<0.0001
Hospital (*Ladino*)	146 (31)	--	--	--
Hospital (Indigenous Mayan)	49 (58)	3.03 (1.89, 4.86)	<0.0001	--
Ambulatory Clinic (*Ladino*)	860 (77)	--	--	--
Ambulatory Clinic (Indigenous Mayan)	157 (82)	1.40 (0.94, 2.08)	0.09	--
Education				
none	461 (66)	--	--	--
Some primary	405 (67)	1.04 (0.82, 1.30)	0.77	NA
Primary completed	250 (63)	0.86 (0.67, 1.11)	0.25	NA
Básico completed	45 (61)	0.80 (0.49, 1.31)	0.38	NA
Secondary completed	51 (58)	0.71 (0.45, 1.12)	0.14	NA
Monthly Income				
<Q1,000	853 (65)	--	--	--
Q1,001 - Q3,000	292 (63)	0.95 (0.76, 1.18)	0.65	NA
> Q3,001	15 (71)	1.37 (0.53, 3.54)	0.52	NA
No response	52 (76)	1.77 (1.00, 3.14)	0.05	NA
Roof				
Shingles	100 (75)	--	--	--
Lamina (metal)	1024 (64)	0.59 (0.39, 0.87)	0.01	NA
Other/palm	88 (64)	0.58 (0.34, 0.98)	0.04	NA
Floors				
Cement	734 (65)	--	--	--
Dirt	391 (69)	1.23 (0.99, 1.53)	0.06	NA
Rock/other	87 (52)	0.61 (0.34, 0.84)	0.0026	NA
People/Room	--	1.10 (1.04, 1.17)	0.0023	NA
Electricity	1,062 (64)	0.71 (0.52, 0.98)	0.0356	NA
Durable Asset Score	--	0.90 (0.84, 0.95)	0.0003	0.02
Season				
October-February	651 (62)	--	--	--
March-September	561 (69)	1.33 (1.10, 1.61)	0.0039	NA

Table 8 Continued

Symptoms				
Blood in stools	85 (67)	1.13 (0.77, 1.66)	0.53	NA
Respiratory symptoms	100 (69)	1.25 (0.87, 1.81)	0.23	NA
Mucus in stools	713 (63)	0.79 (0.65, 0.96)	0.02	0.04
Enrollment Facility X Mucus in stools				<0.01
Hospital (No Mucus)	83 (35)	--	--	--
Hospital (Mucus)	112 (35)	0.99 (0.70, 1.41)	0.96	--
Ambulatory Clinic (No Mucus)	416 (84)	--	--	--
Ambulatory Clinic (Mucus)	601 (74)	0.54 (0.40, 0.72)	<0.0001	--
Severity				
Mild severity	453 (83)	--	--	--
Moderate severity	702 (61)	0.32 (0.25, 0.41)	<0.0001	0.20
Severe severity	57 (33)	0.10 (0.07, 0.15)	<0.0001	<0.0001
Treatment				
No use of meds	660 (68)	--	--	--
Use of Antibiotics	118 (43)	0.35 (0.27, 0.46)	<0.0001	<0.0001
Use of other meds	338 (71)	1.15 (0.90, 1.46)	0.26	0.10
Prior Care-Seeking				
None	1,023 (71)	--	--	--
Public Hospital	3 (38)	0.25 (0.06, 1.04)	0.06	0.46
Ambulatory Clinic	38 (27)	0.15 (0.10, 0.23)	<0.0001	0.26
Private facility	35 (35)	0.22 (0.15, 0.34)	<0.0001	0.67
Pharmacy	27 (51)	0.43 (0.25, 0.74)	<0.01	0.16
Tienda	56 (76)	1.28 (0.74, 2.20)	0.37	0.09
Other	30 (61)	0.65 (0.36, 1.17)	0.15	0.61

NA, not applicable as variable was not included in final model

[a] From univariate analysis

[b] From a multivariate model incorporating all univariate factors with P values ≤0.05; only age and location where ORS was obtained remain significant

**Indigenous Xinca group was excluded from the analysis

Participants from Quetzaltenango were significantly more likely to not use ORS than their Santa Rosa counterparts (<0.01). Even after adjusting for study site, indigenous Mayan people were more likely not to use ORS than their *ladino* counterparts (p<0.0001). After accounting for prior care-seeking, the indigenous Mayan people who were enrolled in a hospital were more likely not to use ORS than their ladino counterparts who were enrolled in a hospital, but this difference was not observed between ethnic groups who were enrolled in ambulatory clinics. Enrollment facility alone was not a significant predictor of ORS non-use in the multivariate

analysis ($p>0.05$). Those of lower SES, as determined by the durable asset score, were unlikely to use ORS to treat diarrhea in children less than five years of age ($p<0.05$).

It seemed that patients with milder cases of diarrhea were more likely to not use ORS, but this observation was only significant in comparison to those with severe illness ($p<0.0001$). Interestingly, the presence of mucus in the child's stools and enrollment facility together played a significant role in predicting ORS use ($p<0.01$). Among those who sought care in an ambulatory clinic, those who observed mucus in the child's stools were more likely to use ORS than those who did not detect mucus in the stools. In those who sought care at a hospital, the presence of mucus in the stools did not differentially affect likelihood to use ORS.

Parents who had reported not treating their child with any medication were unlikely to have used ORS either. Treatment with antibiotics, specifically, was a significant predictor of ORS use when compared with those children who were not treated with any medication ($p<0.0001$).

Improper Preparation of ORS Packets

Between February 2009 and February 2010, 343 children less than five years of age were reported as having been treated with ORS in the 72 hours prior to enrollment in the ViCo study. Among those who were treated with ORS, approximately half (58%) were given the powdered mixture of ORS sold in small bags. In Santa Rosa, the majority of ORS users used these bags (59%), but in Quetzaltenango, less than half (42%) of ORS users used these bags and most (57%) used the prepared liquid solution sold in bottles. Some (3% overall) parents of ORS users reported having given their children both forms of ORS (Table 9).

Table 9. Proper Use of ORS by Study Site

	Santa Rosa 2/8/09-2/28/10	Quetzaltenango 2/8/09-2/28/10	TOTAL	Study Site Comparison
	n (%)	n (%)	N (%)	χ^2 (p-value)
Type	**(n=258)**	**(n=85)**	**(N=343)**	**(<0.01)** †
Packet	152 (59)	36 (42)	188 (55)	
Prepared solution	95 (37)	48 (57)	143 (42)	
both	11 (4)	1 (1)	12 (3)	
Packets of Powder				
Where obtained	**(n=163)**	**(n=37)**	**(N=200)**	**(<0.0001)** †
Centro or puesto de salud	88 (54)	10 (27)	98 (49)	
"Pharmacy"	25 (15)	16 (43)	41 (20)	
Tienda	16 (10)	6 (16)	22 (11)	
Already had it in the house	13 (8)	0	13 (7)	
Other source	21 (13)	5 (14)	26 (13)	
Number of Packets Used				1.68 (0.43)
1 packet	94 (58)	17 (46)	111 (56)	
2 packets	42 (26)	12 (32)	54 (27)	
3+ packets	27 (17)	8 (22)	35 (17)	
Duration of use				1.93 (0.38)
1 day	112 (69)	21 (57)	133 (67)	
2 days	32 (20)	10 (27)	42 (21)	
3+ days	19 (12)	6 (16)	25 (12)	
Liquid Solution				
Where obtained	**(n=106)**	**(n=49)**	**(N=155)**	**(0.03)** †
"Pharmacy"	86 (81)	39 (80)	125 (81)	
tienda	12 (11)	1 (2)	13 (8)	
Already had it in the home	0	1 (2)	1 (1)	
Other source	8 (8)	8 (16)	16 (10)	

† Fisher's Exact Test

Of those parents in Santa Rosa who used the bag form of ORS, most obtained the bag from their local ambulatory clinic (54%) or private pharmacy (15%). Eight percent reported already having the bags in their homes. In Quetzaltenango, ORS users reported obtaining the bag form of ORS in pharmacies (43%) or in ambulatory clinics (27%). None of these parents reported having already had bags of ORS on hand in their homes. At both study sites, participants rarely (67%) used ORS therapy for more than two days, or used more than two packets (17%) before seeking care at the health facility where they were enrolled in the present study.

For those who used the bottled form of already-prepared liquid ORS solution, most had obtained these bottles at their local pharmacies in Santa Rosa and Quetzaltenango (80% overall), but some Santa Rosa participants had obtained the prepared solution of ORS in local *tiendas*.

Proper use of the bag form of ORS was assessed based on the brand of the bag and the amount of water the parent reported having mixed with the powder. Of the 200 patients who were treated with ORS therapy at home using the packet powder form (not bottled solution), it was determined that 39% administered the therapy improperly.

Factors Predicting Improper Use of ORS Packets

Before adjusting for any other variables, enrollment in an ambulatory clinic, monthly income episode during the non-flu season (March through September), older age (ie, two to four years), and where the ORS packets were obtained were independently significant predictors of improper use of ORS packets ($p<0.05$) (Appendix 5 (c)).

The results of the binary multiple logistic regression model of improper use of ORS packets are shown in Table 10. In the multivariate analysis, age of the ill child and where the packets were obtained from remained significant predictors of improper use of ORS packets ($p<0.05$).

Table 10. Binary Logistic Regression Model: Improper Use of ORS Packets

	No. (%) of Improper Users (n=77)	OR (95% CI)[a]	P[a]	Adjusted P[b]
Study Site				
Santa Rosa	63 (39)	--	--	--
Quetzaltenango	14 (38)	0.97 (0.46, 2.02)	0.93	NA
Enrollment Facility				
Hospital	29 (28)	--	--	--
Ambulatory Clinic	48 (50)	2.59 (1.44, 4.65)	<0.01	NA
Age				
Less than one year	31 (45)	--	--	--
One year	21 (26)	0.43 (0.22, 0.85)	0.02	<0.01
Two years	17 (47)	1.10 (0.49, 2.46)	0.82	0.46
Three years	4 (50)	1.23 (0.28, 5.30)	0.79	0.80
Four years	4 (67)	2.45 (0.42, 14.28)	0.32	0.13
Gender				
Male	35 (34)	--	--	--
Female	42 (44)	1.53 (0.87, 2.72)	0.14	NA
Ethnicity**				
Ladino	67 (39)	--	--	--
Indigenous Mayan	10 (13)	0.87 (0.38, 2.00)	0.74	NA
Education				
none	13 (43)	--	--	--
Some primary	24 (33)	0.64 (0.27, 1.53)	0.32	NA
Primary completed	26 (37)	0.76 (0.32, 1.80)	0.53	NA
Básico completed	8 (80)	5.23 (0.95, 28.91)	0.06	NA
Secondary completed	6 (38)	0.79 (0.23, 2.72)	0.70	NA
Monthly Income				
<Q1,000	47 (33)	--	--	--
Q1,001 - Q3,000	25 (50)	2.04 (0.13, 33.38)	0.62	NA
> Q3,001	1 (50)	2.04 (1.06, 3.93)	0.03	NA
No response	4 (80)	8.17 (0.89, 75.14)	0.06	NA
Roof				
Shingles	4 (50)	--	--	--
Lamina (metal)	67 (38)	0.62 (0.15, 2.54)	0.50	NA
Other/palm	6 (38)	0.60 (0.11, 3.34)	0.56	NA
Floors				
Cement	45 (38)	--	--	--
Dirt	20 (38)	0.98 (0.50, 1.92)	0.96	NA
Rock/other	12 (41)	1.15 (0.50, 2.62)	0.10	NA
People per Room	--	1.10 (0.93, 1.31)	0.27	NA
Electricity	65 (37)	0.53 (0.22, 1.27)	0.16	NA
Durable Asset Score	--	0.94 (0.79, 1.13)	0.53	NA
Season				
October-February	32 (29)	--	--	--
March-September	45 (51)	2.62 (1.46, 4.70)	<0.01	NA
Symptoms				
Blood in stools	6 (67)	3.38 (0.82, 13.94)	0.09	NA
Mucus in stools	45 (37)	0.81 (0.45, 1.45)	0.48	NA
Respiratory symptoms	4 (24)	0.46 (0.15, 1.48)	0.19	NA

Table 10. Continued

Severity				
Mild severity	14 (48)	--	--	--
Moderate severity	52 (38)	0.66 (0.30, 1.49)	0.32	NA
Severe severity	11 (31)	0.49 (0.18, 1.36)	0.17	NA
Treatment				
No use of meds	34 (37)	--	--	--
Use of Antibiotics	15 (31)	0.79 (0.38, 1.66)	0.53	NA
Use of other meds	26 (50)	1.74 (0.87, 3.45)	0.12	NA
Facility Where Obtained				
Ambulatory Clinic	21 (21)	--	--	--
Already had it in the house	2 (15)	0.67 (0.14, 3.24)	0.62	<0.05
Pharmacy	28 (68)	7.90 (3.49, 17.86)	<0.0001	<0.01
Tienda	16 (73)	9.78 (3.40, 28.08)	<0.0001	<0.001
Other source	10 (38)	2.29 (0.91, 5.78)	0.08	0.54

NA, not applicable as variable was not included in final model

[a] From univariate analysis

[b] From a multivariate model incorporating all univariate factors with P values ≤0.05; only age and location where ORS was obtained remain significant

**Indigenous Xinca group was excluded from the analysis

Compared with children less than one year of age who were treated with ORS, one year old children were significantly more likely to be treated properly (p<0.01). Children two to four years of age seemed more likely to be treated improperly with ORS packets when compared with children one year of age and younger, although this difference was not significant. Compared with parents who received ORS packets from their local health center or post, those who purchased the packets at a pharmacy or *tienda* were eight and ten times more likely to use the ORS improperly (p<0.01).

DISCUSSION

Exploration of this laboratory-enhanced, population-based surveillance data of patients diagnosed with diarrhea in the Santa Rosa and Quetzaltenango Departments of Guatemala has provided a better understanding of the current health-utilization trends for diarrheal symptoms in these regions in Guatemala, particularly with regard to ORS use. Some of these findings were geographically unique to each study site, the Departments of Santa Rosa and Quetzaltenango.

Patients who sought care for diarrhea at the public hospitals and ambulatory clinics in these two regions of Guatemala were considered to have had "moderate" cases of diarrheal illness, defined by a 9-pt severity index as having had diarrhea for approximately five days, experiencing four to five stools per day with vomiting symptoms for approximately two days. Participants had been sick for two to three days, reported an average of nine stools per day, and approximately half had experienced vomiting symptoms for an average of two days. The existing knowledge similarly indicates that parents usually seek care for their children's gastrointestinal symptoms during the first couple of days of illness.[11]

As anticipated, patients with more severe cases of illness were more likely to seek care at a hospital rather than an ambulatory clinic, another finding consistent with the existing literature.[11] Assuming parents' propensity to seek care at the hospital is based on their perception of illness severity,[39] the severity index supports the finding that more symptoms are often perceived as an indication that the illness is serious.[11] Young children were more likely to be taken to the hospital for all levels of illness severity than were participants from other age groups.

It seems that Guatemalans look to a diverse selection of local care facilities when presented with an episode of diarrhea. Care-seeking patterns seemed to begin at local facilities, such as *tiendas* and pharmacies, where treatment can be purchased, but no care providers are available to see the patient. Other studies have found, similarly, that the pharmacy is the most commonly accessed provider in seeking care for sick children.[11] Those who do not recover seem to go on to seek care from clinical providers at organized health-care facilities and clinics, such as private facilities or public hospitals and ambulatory clinics, where nurses and doctors are present to diagnose and treat the patient. A possible explanation for this trend may include the generalization that there is no line to wait in at pharmacies and *tiendas*, whereas there may be a long wait at government sponsored clinics and hospitals. However, considering cost as a major barrier to care,[24,25] it is possible that care is sought at pharmacies, *tiendas,* and ambulatory clinics for mild cases whereas more severe cases seek care at private facilities. Mothers must always balance benefit and cost in their decision-making around treating their children's' illnesses. Assuming that participants are familiar with diarrhea episodes because of the prevalence of the illness in Guatemala, it may be that care is sought at pharmacies and *tiendas* in a cost-effective effort to home treat based on the experiential and health knowledge gained during their experience with prior illness episodes.

In the present data it was noticed that children are most commonly taken to ambulatory clinics while adults seem to be more likely to seek care at a private facility. Others have also noticed that children are frequently taken to ambulatory clinics, even sickly and weak children that are otherwise not taken to care providers when they are ill.[11] Similarly, the commonality of the children in the present study having sought care at an ambulatory clinic is probably a function of free care making the trip and time to go to the clinic worth the while for parents.

Of those participants who had sought prior care, most reported receiving medications, and slightly nearly a third reported having been provided ORS and/or antibiotics at their respective prior care-seeking locations. Only one quarter of all prior care-seekers did not receive any kind of treatment. The present study found that 14% of people choose to treat diarrhea with antibiotics, consistent with existing estimate of 9%.[3] The present study found that antibiotics were most often distributed at public hospitals and private facilities. One quarter to one third of participants who sought care at health centers, posts, and pharmacies reported receipt of antibiotics as well, supporting suspicions in the literature that distribution of inappropriate medications may be occurring at lay pharmacies and *tiendas*.[11,13,28,29,40]

Those who sought prior care at a pharmacy or *tienda* were least likely to receive no treatment. It is understood that there is a current dependence on Western biomedicine in Guatemala,[13,18,25] so it may be that obtaining medication is thought to be the priority for helping an ill child. Goldman & Heuvaline (2000) also found that pharmacies distribute medications to almost every care-seeker. Unfortunately, these two care-seeking facilities where treatment frequently begins — pharmacies and *tiendas* — are where parents who obtain ORS packets there are most likely to use the salts improperly.

Nearly half of all participants had reported taking a medicine during the 72 hours prior to enrollment in this study. Other studies in Guatemala have found that few children go completely untreated during an illness episode.[11] Some parents even reported giving their child more than one treatment, which seems to be a common occurrence in Guatemala.[11] Children were more likely than adults to be treated with antibiotics, and were also more likely to be treated with ORS than antibiotic or any other medication.

In the present study, 32% of mothers of children less than five years of age reported having used ORS to treat her child's diarrhea. This prevalence of use estimate seems to fall in line with existing estimates cited in the literature.[1,30,31] Of those who had reportedly used ORS in the present study, slightly more than half had used the packet powder form, and the rest had used the prepared solution form sold in a bottle. Most of those who used the ORS packets had obtained them from an ambulatory clinic, a local pharmacy or a *tienda*. Of those who had used the prepared solution, nearly all had obtained it at their local pharmacy. Heuveline and Goldman (2000) found that health centers, posts and hospitals were most likely to recommend ORS as treatment compared with the advice of friends, relatives, pharmacists, doctors or curers. More than half of these participants had only used one packet for the duration of the illness, and most participants had used these packets for just one day, suggesting that ORS use was interpreted by patients as a curative treatment for diarrheal symptoms rather than a supportive method to prevent dehydration. The sporadic and short duration of use may suggest that the therapy was perceived as not curing the symptoms. It is of importance to note that governmental health facilities in Guatemala distribute ORS packets free of charge, and so it is curious that people are purchasing ORS at *tiendas* and pharmacies, and that those of lower SES seem less likely to use ORS though in theory it can be obtained in the community free of charge. This may be because there are long waiting times at the local ambulatory clinics that defer community members from seeking care at these facilities. It may also be that some of these facilities are not always stocked with ORS and other medications,[3] so members of the community do not depend on them as a health resource.

Among children less than five years of age, children in Quetzaltenango were more likely not to be treated with ORS, even after accounting for ethnic differences between regions. Children

from families of lower SES, as measured by ownership of fewer durable assets, also seem more likely not to have used ORS. Although the enrollment facility was a significant factor in predicting non-use of ORS, its effect was modified by ethnicity as well as by the reported presence of mucus in the child's stools. Mayan parents were more likely not to use ORS than *ladino* parents, especially for those enrolled in ambulatory clinics. The presence of mucus in the stool of a child seemed to make the parent more likely to have used ORS, especially for those who were enrolled in an ambulatory clinic. Those who had a severe episode of diarrhea were more likely to have used ORS than those with only mild symptoms. Use of antibiotics to treat a child's diarrheal illness seemed to be a strong predictor of also using ORS to treat the illness.

The majority of participants (61%) who used ORS packets reportedly mixed them with the appropriate quantity of water. It seemed that parents of one-year-old children were much less likely to use the ORS packets improperly compared with parents of children less than one year, suggesting that experience over the course of the child's year of life may have allowed parents to learn proper use of ORS packets. Most shocking was that parents who obtained packets from the *tienda* or the local pharmacy were eight and ten times more likely to improperly use ORS compared with parents who obtained the ORS packets from their community's government-sponsored ambulatory clinic.

Site Comparison

The study samples from Santa Rosa and Quetzaltenango were unique in their ethnicity, level of education, and the facility of study enrollment. Overall, in comparing these two geographically and demographically distinct study sites, Santa Rosa and Quetzaltenango did not seem to differ in the severity of diarrhea that cases presented with in the public hospitals and ambulatory

clinics. In Santa Rosa, there was a greater proportion of cases which reported mucus in the stools, and in Quetzaltenango, there was a greater proportion of diarrheal patients with respiratory illness.

Most Santa Rosa participants had not sought care prior to seeking care at the ViCo enrollment facility. Quetzaltenango residents may be more persistent care-seekers than those in Santa Rosa, but it may also be that care-seeking patterns are less established in this region or that there are so many options, especially for private facilities, in a large urban setting that residents did not necessarily follow the same care-seeking patterns. Quetzaltenango participants also seemed more likely to have been enrolled in the hospital than Santa Rosa participants for all levels of illness severity. Quetzaltenango participants also seemed more likely to have sought prior care at a private facility, whereas Santa Rosa participants were more likely to utilize government-sponsored ambulatory clinics. This may be explained by a general mistrust of the public sector by the indigenous Mayans as a consequence of the violent, civil war which ended in 1996.[3,10,15,22]

In Santa Rosa, participants reported having used more ORS packets than ORS solution, and vice versa in Quetzaltenango. Of those who used ORS packets, most Santa Rosa residents had obtained them in ambulatory clinics, followed by pharmacies. In Quetzaltenango, however, most participants reported having obtained the ORS packets in pharmacies, then ambulatory clinics. There did not seem to be a difference between the sites in the number of packets used or the length of days the packets were used to treat the illness.

Study site alone was a significant predictor of ORS non-use, with Quetzaltenango participants more likely to not use ORS than Santa Rosa participants. The ethnic traits of Santa Rosa and

Quetzaltenango also had unique effects on use and non-use of ORS. There did not seem to be a difference in the proportion of participants who used the ORS packets improperly between the two study sites, and study site did not seem to modify the effect of other variables in predicting improper ORS use.

Limitations

This study is limited by a potential selection bias. Information is not known about community members who did not seek care at all for diarrheal symptoms or for those who sought care outside of the facilities included in the ViCo surveillance project, such as at a non-governmental (NGO) care facility. Nevertheless, these limitations lend to supporting the present study's findings as conservative conclusions since participants enrolled in ViCo were "care-seekers", which may indicate that they have access to care, are of higher SES, or have more education. Being "care-seekers" might also indicate that participants were more likely also to utilize other health treatments, such as ORS, than their non-care-seeking counterparts. However, it is also possible that those community members who use ORS often recover from diarrhea and do not need to seek care in such health facilities, and thus would not have been included in the ViCo project, creating a selection bias in the other direction, toward those who do not use ORS often.

Participants could have been enrolled in the study more than one time since the data was collected as part of a surveillance system where the numerator represents a case rather than a unique person. Regardless of these limitations, exploratory analyses of these data are particularly valuable in such a resource-poor, developing country. ViCo is the only active surveillance system of its kind in any other Guatemalan or Central American population, and it is enhanced by laboratory testing of specimens to confirm biological etiology. Findings have

provided information about a sub-population that is already seeking care in locations where programs/changes can be implemented by the Guatemalan MSPAS to improve health-utilization practices.

Measures were taken to minimize data entry errors and missing values through in-depth interview training of qualified nursing staff, use of PDAs to record data, and electronic data management tools. The ability to accurately categorize severity of illness, however, was compromised by a lack of data concerned with whether or not the patient had a fever during the course of his or her illness. The results concerned with severity of illness, however, make sense in medical terms and with regard to the existing literature, suggesting that the index we used served its purpose sufficiently. Additionally, improper use of ORS packets may not have been consistently or accurately classified, because the classification was based on the parental report of which brand of ORS packets they used and the precise amount of water they mixed with the powder.

It is important to understand what factors predict non-use of ORS in patients, because these factors may determine the health and well-being of diarrheal patients, particularly young children. Caution should be taken, however, when making generalizations to the entire population within one of the study sites as well as to other populations in Guatemala and Latin America due to demographic, structural, cultural, and geographic differences.

CONCLUSIONS

Implications

The ViCo surveillance system is the first of its kind in Guatemala. The findings of the present study have provided information which the Guatemalan MSPAS might use to prioritize interventions and guide decisions surrounding the allocation of limited resources for managing diarrheal diseases in children. It is important for the MSPAS to know whom to target with educational messages about ORS use, and it will be especially important to include local *tiendas* and pharmacies in health interventions concerned with diarrhea, knowing the importance of these facilities in providing treatment for diarrheal illness in these two regions of Guatemala.

Lessons learned from the present study in Guatemala also provide context for understanding health utilization trends and factors associated with non-use and improper use of ORS in other countries around the world that also are burdened with a disproportionate amount of diarrheal illness. The findings of this study suggest that further studies be designed to assess health-utilization behaviors, especially ORS use, in the community. To understand ORS use in Guatemala more in-depth, it is suggested that the next step be a community cross-sectional study be carried out to learn what the overall ORS use is in the community. This study may be followed up with a cohort study which tracks a sample of children, inquiring regularly (i.e. weekly) about the diarrheal illness, care-seeking, and ORS use by these individuals.

Recommendations

The IMCI emphasizes the importance of appropriate recognition and treatment of child illnesses at the home and community level. In Guatemala, targeted educational interventions to community members and a variety of health-care facilities and providers might increase the

prevalence ORS use and improve its proper usage. Because parents seem to begin care-seeking at local *tiendas* or pharmacies, including community members who work at these locations in the educational intervention plan is highly suggested. The message should also be spread that ORS packets are distributed free of charge at government-sponsored facilities to prompt those of lower SES to use ORS.

Since a low use of ORS and a short duration of use are observed in this population, it is important to incorporate educational messages to address such issues within future intervention campaigns. Such messages should include the benefits of ORS, where to obtain packets or solutions, and how to use this therapy appropriately. In addition, it is important to communicate to the population that ORS is not a quick cure for diarrhea, but rather must be used consistently as a supportive treatment to prevent dehydration until the diarrheal symptoms wane.

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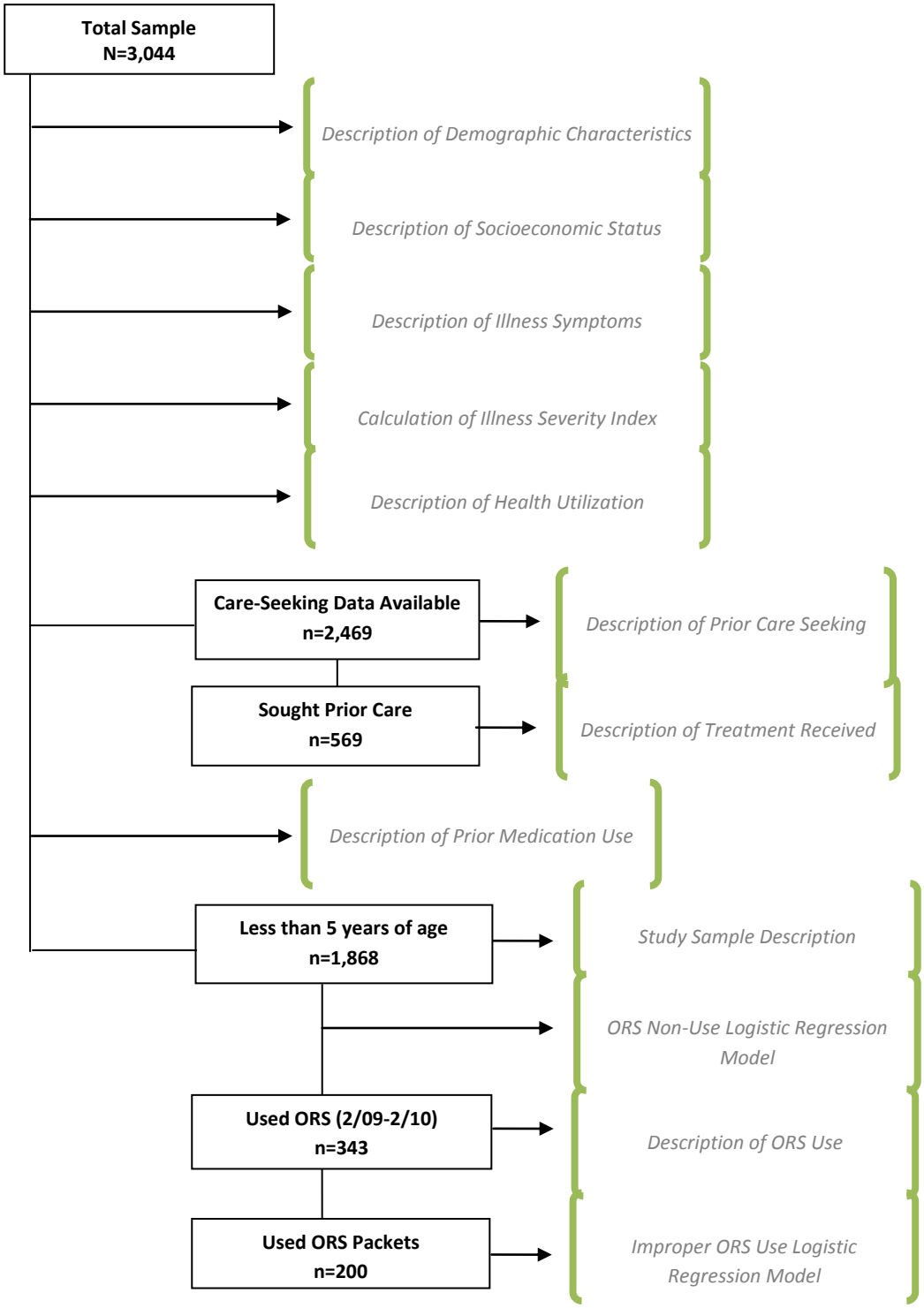
APPENDIX

1. Methods

a. Data Cleaning Process

Description of Data Cleaning Procedure	Sample Size
All respiratory & diarrheal cases *(6/07 to 3/10 in Santa Rosa; 2/09 to 3/10 in Quetzaltenango)*	6,116
Keep if meets ViCo diarrhea case definition	3,293
Keep if admitted after Oct 1, 2007	3,194
Keep if no demographic data missing (2 variables)	3,181
Keep if no SES components missing (6 variables)	3,174
Keep if no illness severity data missing (3 variables)	3,136
Keep if no 72-hr prior med use missing	3,060
Keep if <5 yrs and no ORS use data missing	3,055
Keep if <5, ORS user, enrolled in/after 2/09, and ORS type data missing	3,044
Total Sample	**3,044**

b. Diagram of Data Analyses and Sample Sizes



c. Brighton Collaboration Diarrhea Working Group: Cited Severity Indexes*

Symptom or Sign	9 Points (Hjelt et al. [84])		14 Points (Flores et al [41])		20 Points (Now Proposed)	
	A	B	A	B	A	B
Duration of diarrhea (days)						
1	1	24%	1	25%		
1-4					1	22%
2-4	2	28%	2	49%		
>4	3	48%	3	26%		
5					2	40%
≥6					3	38%
Max no. diarrheal stools/24 h						
1-3	1	12%	1	12%	1	23%
4-5	2	34%	2	34%	2	29%
≥6	3	40%	3	40%	3	35%
Duration of vomiting (days)						
1					1	31%
2					2	25%
1-2	1	55%	1	55%		
≥3	2	32%	2	32%	3	32%
Max no. vomiting episodes/24 h						
0					0	12%
1					1	28%
2-4					2	32%
≥5					3	28%
Fever						
<37.0°C						
<37.5°C	0	20%				
<38.1°C			0	34%		
>37.5°C	1	80%				
37.1°C-38.4°C					1	15%
≥38.1°C			1	66%		
38.5°C-38.9°C					2	28%
≥39°C					3	34%
Dehydration						
None			0	66%	0	66%
1-5%			2	28%	2	28%
≥6%			3	6%	3	6%
Treatment						
None			0	82%	0	30%
Polyclinical						
Rehydration					1	51%
Hospitalization			2	19%	2	19%

*Referenced by the Brighton Collaboration Diarrhea Working Group [41, 42, 39]

d. 9-point Severity Index (SI = I + II + III): Diarrhea*

Score	Adapted "20-point Vesikari Numerical Scale" *
	I. Duration of diarrhea (days)
1	1-4
2	5
3	>5
	II. Maximum number of stools/24 hrs
1	3
2	4-5
3	>5
	III. Duration of vomiting (days)
0	0
1	1
2	2
3	>2

*Referenced by the Brighton Collaboration Diarrhea Working Group[39]

e. Oral Rehydration Salt Packet Instructions and Packets

A) 1 packet per liter of water	B) 1 packet per liter of water
C) 1 packet per liter of water	D) 4 packets per liter of water
E) 4 packets per liter of water	F) 4 packets per liter of water
G) 4 packet per liter of water	H) 4 packets per liter of water
I) 4 packets per liter of water	J) 4 packets per liter of water
K) 1 packet per liter of water	L) 1 packet per liter of water

2. Results: Study Population

a. Durable Asset Score Components by Study Site

	Santa Rosa (N=2,607) 10/1/07-2/28/10	**Quetzaltenango** (N=437) 2/8/09-2/28/10	**TOTAL** (N=3,044)	**Study Site Comparison**
	n (%)	**n (%)**	**N (%)**	**χ^2 (p-value)**
Refrigerator	698 (27)	111 (25)	809 (27)	0.36 (0.55)
Computer	104 (4)	72 (16)	176 (6)	107.12 (<0.0001)
Radio	2,034 (78)	377 (86)	2,411 (79)	15.46 (<0.0001)
Washing machine	102 (4)	32 (7)	134 (4)	10.34 (<0.01)
Car or truck	350 (13)	76 (17)	426 (14)	4.89 (0.03)
Television	1,981 (76)	349 (80)	2,330 (77)	3.13 (0.08)
Landry dryer	5 (0)	6 (1)	11 (0)	14.50 (<0.001)
Telephone	2,015 (77)	358 (82)	2,373 (78)	4.67 (0.03)
Microwave	285 (11)	71 (16)	356 (12)	10.24 (<0.01)

3. Results: Description of Illness Episodes

a. Distribution of Diarrheal Cases by Severity* and Study Site (Figure 4)

	Santa Rosa (N=2,607) 10/1/07-2/28/10	**Quetzaltenango** (N=437) 2/8/09-2/28/10	**TOTAL** (N=3,044)	**Study Site Comparison**
	n (%)	**n (%)**	**N (%)**	**χ^2 (p-value)**
Mild	845 (32)	153 (35)	998 (33)	1.85 (0.40)
Moderate	1,558 (60)	256 (59)	1,814 (60)	
Severe	204 (8)	28 (6)	232 (8)	

*Mild (score=1-3); Moderate (score=4-6); Severe (score=7-9)

4. Results: Healthcare Utilization Trends

a. Severity* by Care-Seeking Facility

	Hospital (n=654)	**Ambulatory Clinic** (N=2,390)	**TOTAL** (N=3,044)	**Study Site Comparison**
	n (%)	**n (%)**	**N (%)**	**χ^2 (p-value)**
Mild	101 (15)	897 (38)	998 (33)	240.34 (<0.0001)
Moderate	424 (65)	1,390 (58)	1,814 (60)	
Severe	129 (20)	103 (4)	232 (8)	

*Mild (score=1-3); Moderate (score=4-6); Severe (score=7-9)

b. Severity* by Age Category

	Young Children (<5 y) (N=2,113)	**Older Children (5-15 y)** (N=400)	**Adults (>15 y)** (N=526)	**Young to Older Children Comparison**	**Young Children to Adults Comparison**
	n (%)	**n (%)**	**n (%)**	**χ^2 (p-value)**	**χ^2 (p-value)**
Mild	666 (32)	167 (42)	165 (31)	22.73 (<0.0001)	2.45 (0.2938)
Moderate	1,267 (60)	218 (54)	329 (63)		
Severe	180 (8)	15 (4)	32 (6)		

*Mild (score=1-3); Moderate (score=4-6); Severe (score=7-9)

c. Severity* by Enrollment Facility and Age Category (N=3,044) (Figure 5)

	Young Children (<5 y) (N=2,113)	**Older Children (5-15 yrs)** (N=400)	**Adults (>15 y)** (N=531)	**Young to Older Children Comparison**	**Young Children to Adults Comparison**
	n (%)	**n (%)**	**n (%)**	**χ^2 (p-value)**	**χ^2 (p-value)**
Mild	**666**	**167**	**165**		
Hospital	87 (13)	2 (1)	12 (7)	(<0.0001) †	4.22 (0.04)
Ambulatory Clinic	579 (87)	165 (99)	153 (93)		
Moderate	**1,267**	**218**	**329**		
Hospital	357 (28)	14 (6)	53 (16)	46.97 (<0.0001)	19.92 (<0.0001)
Ambulatory Clinic	910 (72)	204 (94)	276 (84)		
Severe	**180**	**15**	**37**		
Hospital	112 (62)	3 (20)	14 (38)	(<0.01) †	7.49 (<0.01)
Ambulatory Clinic	68 (38)	12 (80)	23 (62)		

† Fisher's Exact Test

*Mild (score=1-3); Moderate (score=4-6); Severe (score=7-9)

d. Prior Care-Seeking by Enrollment Facility and Study Site (N=569) (Figure 6)

	Hospitalized Participants (N=232)			Ambulatory Clinic Participants (N=337)		
	Santa Rosa (N=135)	Quetzal-tenango (N=97)	TOTAL (N=232)	Santa Rosa (N=257)	Quetzal-tenango (N=80)	TOTAL (N=337)
	n (%)	n (%)	N (%)	n (%)	n (%)	N (%)
Hospital	1 (1)	3 (3)	4 (2)	1 (0)	3 (4)	4 (1)
Ambulatory Clinic	87 (64)	21 (22)	108 (46)	41 (16)	2 (3)	43 (13)
Private facility	41 (30)	56 (58)	97 (42)	21 (8)	10 (13)	31 (9)
Pharmacy	3 (2)	10 (10)	13 (6)	54 (21)	24 (30)	78 (23)
Tienda	0	0	0	101 (39)	28 (35)	129 (38)
Other	3 (2)	7 (7)	10 (4)	39 (15)	13 (16)	52 (16)

e. Prior Care-Seeking by Enrollment Facility and Study Site for Children Less Than Five Years of Age (N=433)

	Hospitalized Participants (N=210)			Ambulatory Clinic Participants (N=223)		
	Santa Rosa (N=121)	Quetzal-tenango (N=89)	TOTAL (N=210)	Santa Rosa (N=169)	Quetzal-tenango (N=54)	TOTAL (N=223)
	n (%)	n (%)	N (%)	n (%)	n (%)	N (%)
Hospital	1 (1)	3 (3)	4 (2)	1 (0)	3 (6)	4 (1)
Ambulatory Clinic	84 (69)	21 (24)	105 (45)	33 (17)	2 (4)	35 (10)
Private facility	30 (25)	51 (57)	81 (35)	16 (8)	5 (9)	21 (6)
Pharmacy	3 (2)	8 (9)	11 (5)	29 (15)	15 (28)	44 (13)
Tienda	0	0	0	58 (30)	19 (35)	77 (23)
Other	3 (2)	6 (7)	9 (4)	32 (16)	10 (19)	42 (12)

f. Prior Care-Seeking by Enrollment Facility and Study Site for Children Five Years of Age and Older (N=136)

	Hospitalized Participants (N=22)			Ambulatory Clinic Participants (N=114)		
	Santa Rosa (N=14)	Quetzal-tenango (N=8)	TOTAL (N=22)	Santa Rosa (N=88)	Quetzal-tenango (N=26)	TOTAL (N=114)
	n (%)	n (%)	N (%)	n (%)	n (%)	N (%)
Hospital	0	0	0	0	0	0
Ambulatory Clinic	3 (21)	0	2 (14)	8 (7)	0	8 (7)
Private facility	11 (79)	5 (63)	16 (73)	5 (6)	5 (19)	10 (9)
Pharmacy	0	2 (25)	2 (9)	25 (28)	9 (35)	34 (30)
Tienda	0	0	0	43 (49)	9 (35)	52 (46)
Other	0	1 (13)	1 (5)	7 (8)	3 (12)	10 (9)

g. Receipt of Various Treatments at Prior Care-Seeking Facilities (Figure 7) (N=569)

	Received Any Treatment	**Received ORS**	**Received Antibiotics**
	N (%)	**n (%)**	**n (%)**
Governmental Facility (n=159)	97 (61)	61 (38)	50 (31)
Hospital (n=8)	6 (75)	3 (38)	4 (50)
Ambulatory Clinic (n=151)	91 (60)	58 (38)	46 (30)
Private Facility (n=128)	91 (71)	49 (38)	59 (46)
Pharmacy (n=91)	82 (90)	30 (33)	25 (27)
Tienda (n=129)	116 (90)	27 (21)	30 (23)
Other (n=62)	40 (65)	10 (16)	10 (16)
TOTAL (n=569)	426 (75)	177 (31)	174 (31)

h. Medication Use 72 Hours Prior to ViCo Enrollment (N=3,044) (Figure 8)

	Young Children (<5 y) (n=2,113)	**Older Children (5-15 y)** (n=400)	**Adults (>15 y)** (n=531)	***Younger to Older Children comparison***	***Children to Adults comparison***
	n (%)	***n (%)***	***n (%)***	***χ^2 (p-value)***	***χ^2 (p-value)***
Antibiotics	296 (14)	39 (10)	46 (9)	8.40 (0.02)	17.48 (<0.001)
Other meds	485 (23)	118 (30)	183 (34)		
Did not take meds	1,332 (63)	243 (61)	302 (57)		
ORS	669 (32)	--	--	--	--

5. Results: Oral Rehydration Therapy Utilization in Children Less Than Five Years of Age

a. Description of Study Sample Demographics by Department for Children Less than Five Years of Age

	Santa Rosa (N=1,559) 10/1/07-2/28/10	**Quetzaltenango** (N=309) 2/8/09-2/28/10	**TOTAL** (N=1,868)	**Study Site Comparison**
	n (%)	**n (%)**	**N (%)**	**χ^2 (p-value)**
Facility				16.73 (<0.0001)
Hospital	434 (28)	122 (39)	556 (30)	
Ambulatory Clinic	1,125 (72)	187 (61)	1,312 (70)	
Age				14.54 (<0.01)
Less than one year	557 (36)	114 (37)	671 (36)	
1 year	577 (37)	131 (43)	708 (38)	
2 years	213 (14)	37 (12)	250 (13)	
3 years	137 (9)	9 (3)	146 (8)	
4 years	75 (5)	18 (6)	93 (5)	
Gender				0.10 (0.75)
Female	722 (46)	140 (45)	862 (46)	
Male	837 (54)	169 (55)	1,006 (54)	
Ethnicity**				1,211.48 (<0.0001)
Ladino	1,527 (98)	65 (21)	1,592 (85)	
Indigenous	32 (2)	244 (79)	276 (15)	
Education*				146.55 (<0.0001)
none	646 (41)	53 (17)	699 (37)	
Some primary	514 (33)	93 (30)	607 (32)	
Primary completed	309 (20)	91 (29)	400 (21)	
Básico completed	45 (3)	29 (9)	74 (4)	
Secondary	45 (3)	43 (14)	88 (5)	

*if patient <18 years of age, education = level of the parent

**Indigenous Xinca ethnic group was excluded from the analysis

b. Univariate Logit Models Relating Individual Variables to ORS Non-Use: Pooled Study Sites (N=1,868)

Variables	β	se (β)	OR	95% CI (OR)	-2LogL	G*	p**
Const.					2421.57		
Study Site (Quetz to SR)	0.29	0.14	1.34	1.03, 1.74	2416.83	4.74	0.03
Facility (Amb to Hosp)	1.85	0.11	6.38	5.14, 7.93	2118.98	302.59	<0.0001
Age	0.04	0.11	1.04	0.84, 1.29	2391.78	29.79	<0.0001
(1 to 0)	0.54	0.16	1.72	1.25, 2.34			
(2 to 0)	0.71	0.21	2.03	1.35, 3.06			
(3 to 0)	0.79	0.26	2.20	1.32, 3.66			
(4 to 0)							
Gender (F to M)	0.24	0.10	1.28	1.05, 1.55	2415.31	6.27	0.01
Ethnicity (Indig to *ladino*)	0.54	0.15	1.71	1.28, 2.29	2407.44	14.13	<0.001
Education	0.03	0.12	1.04	0.82, 1.30	2416.99	4.58	0.33
(pini to none)	-0.15	0.13	0.86	0.67, 1.11			
(pcomp to none)	-0.22	0.25	0.80	0.49, 1.31			
(bini to none)	-0.34	0.23	0.71	0.45, 1.12			
(seccomp to none)							
Monthly income	0.31	0.49	1.37	0.53, 3.54	2416.47	5.10	0.16
(>Q3 v <Q1)	-0.05	0.11	0.95	0.76, 1.18			
(Q1-3 v <Q1)	0.57	0.29	1.77	1.00, 3.14			
(NR v <Q1)							
Roof	-0.53	0.21	0.59	0.39, 0.87	2414.54	7.04	0.03
(lamina v shingles)	-0.52	0.27	0.58	0.34, 0.98			
(palm/oth v shingles)							
Floors	0.21	0.11	1.23	0.99, 1.53	2405.92	15.65	<0.001
(dirt to cement)	-0.50	0.17	0.61	0.34, 0.84			
(rock/oth to cement)							
People/room	0.09	0.03	1.10	1.04, 1.17	2411.86	9.71	<0.01
Electricity (yes to no)	-0.34	0.16	0.71	0.52, 0.98	2416.99	4.58	0.03
Dur. Asset Score	-0.11	0.03	0.90	0.84, 0.95	2408.61	12.96	<0.001
Season (M-S to O-F)	0.28	0.10	1.33	1.10, 1.61	2413.17	8.41	<0.01
Blood (Y to N)	0.12	0.20	1.13	0.77, 1.66	2421.18	0.40	0.53
Mucus (Y to N)	-0.24	0.10	0.79	0.65, 0.96	2415.83	5.74	0.02
Resp dx (Y to N)	0.22	0.19	1.25	0.87, 1.81	2420.12	1.45	0.23
Severity	-1.14	0.13	0.32	0.25, 0.41	2250.73	170.84	<0.0001
(Mod to Mild)	-2.31	0.20	0.10	0.07, 0.15			
(Severe to Mild)							
Med Use	-1.04	0.14	0.35	0.27, 0.46	2145.69	67.18	<0.0001
(antibiotics to none)	-0.14	0.12	1.15	0.90, 1.46			
(other to none)							
Prior Care Seeking	-1.40	0.73	0.25	0.06, 1.04	2267.79	153.78	<0.0001
(Hosp to none)	-1.88	0.20	0.15	0.10, 0.23			
(Amb to none)	-1.51	0.22	0.22	0.15, 0.34			
(Pvt to none)	-0.85	0.28	0.43	0.25, 0.74			
(Pharm to none)	0.25	0.28	1.28	0.74, 2.20			
(*Tienda* to none)	-0.43	0.30	0.65	0.36, 1.17			
(other to none)							

*change in deviance (LRT statistic) compared to null

**p-value is for LRT (G)

c. Univariate Logit Models Relating Individual Variables to Improper ORS Use: Pooled Study Sites (N=200)

Variables	β	se (β)	OR	95% CI (OR)	-2LogL	G*	p**
Const.					266.58		
Study Site (Quetz to SR)	-0.03	0.38	0.97	0.46, 2.02	224.65	0.01	0.93
Facility (Amb to Hosp)	0.95	0.30	2.59	1.44, 4.65	255.19	10.39	<0.01
Age	-0.85	0.35	0.43	0.22, 0.85	256.18	10.41	0.03
(1 to 0)	0.09	0.41	1.10	0.49, 2.46			
(2 to 0)	0.20	0.75	1.23	0.28, 5.30			
(3 to 0)	0.90	0.90	2.45	0.42, 14.28			
(4 to 0)							
Gender (F to M)	0.43	0.29	1.53	0.87, 2.72	264.43	2.15	0.14
Ethnicity (Indig to *ladino*)	-0.14	0.42	0.87	0.38, 2.00	266.48	0.1076	0.72
Education	-0.45	0.44	0.64	0.27, 1.53	257.97	8.61	0.07
(pini to none)	-0.28	0.44	0.76	0.32, 1.80			
(pcomp to none)	1.65	0.87	5.23	0.95, 28.91			
(bini to none)	-0.24	0.63	0.79	0.23, 2.72			
(second to none)							
Monthly income	0.71	1.43	2.04	0.13, 33.38	258.20	8.39	0.04
(>Q3 v <Q1)	0.71	0.33	2.04	1.06, 3.93			
(Q1-3 v <Q1)	2.10	1.13	8.17	0.89, 75.14			
(NR v <Q1)							
Roof	-0.49	0.72	0.62	0.15, 2.54	266.13	0.46	0.80
(*lamina* v shingles)	-0.51	0.88	0.60	0.11, 3.34			
(palm/oth v shingles)							
Floors	-0.02	0.34	0.98	0.50, 1.92	266.46	0.12	0.94
(dirt to cement)	0.14	0.42	1.15	0.50, 2.62			
(rock/oth to cement)							
Electricity	-0.63	0.45	0.53	0.22, 1.27	264.58	2.00	0.16
People/room	0.10	0.09	1.10	0.93, 1.31	265.35	1.24	0.27
Dur. Asset Score	-0.06	0.09	0.94	0.79, 1.13	266.18	0.40	0.52
Season (M-S to O-F)	0.96	0.30	2.62	1.46, 4.70	255.96	10.62	<0.01
Blood (Y to N)	1.22	0.72	3.38	0.82, 13.94	263.53	3.06	0.08
Mucus (Y to N)	-0.21	0.30	0.81	0.45, 1.45	266.09	0.49	0.48
Resp dx (Y to N)	-0.78	0.59	0.46	0.15, 1.48	264.71	1.87	0.17
Severity	-0.41	0.41	0.66	0.30, 1.49	264.68	1.91	0.39
(Mod to Mild)	-1.71	0.52	0.49	0.18, 1.36			
(Severe to Mild)							
Med Use	-0.24	0.38	0.79	0.38, 1.66	253.53	4.06	0.13
(antibiotics to none)	0.55	0.35	1.74	0.87, 3.45			
(other to none)							
WhereObtained	-0.41	0.81	0.67	0.14, 3.24	224.65	41.93	<0.0001
(house to amb)	2.07	0.42	7.90	3.49, 17.86			
(pharm to amb)	0.83	0.47	9.78	3.40, 28.08			
(tienda to amb)	2.28	0.54	2.29	0.91, 5.78			
(other to amb)							

*change in deviance (LRT statistic) compared to null

**p-value for LRT (G)