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## Inside



# Incidence and viral aetiology of hospital-acquired respiratory infections at three tertiary care hospitals in Bangladesh, 2008-2011

Since May 2008, surveillance for hospital-acquired respiratory infections has been conducted in adult and paediatric medicine wards at three tertiary care hospitals to understand the epidemiology of hospital-acquired respiratory infections (HARI) in Bangladesh. The objectives of this analysis were to determine the incidence, seasonality, and viral etiology of HARI in these hospitals from 2008-2011. Surveillance physicians on each study ward identified patients who developed new onset of fever, cough, runny nose, or difficulty breathing after being hospitalized for >72 hours and then collected demographic and clinical information and nasopharyngeal and throat swabs. The swabs were tested for common respiratory viruses using real-time RT-PCR. During May 2008-April 2011, 25,319 patients were hospitalized for >72 hours on study wards, contributing 80,425 patient-days at risk. Overall, 678 cases of HARI were identified; respiratory viruses were detected in swabs from 142 (21%) cases. The incidence of HARI was 8.4 cases/1,000 patient-days at risk and the incidence of virus-associated HARI

icddr,b

**was 1.7 cases/1,000 patient-days at risk. The rate was higher among paediatric patients than adult patients. Virus-associated HARI was observed during most months in the study period. The virus most commonly associated with HARI was influenza.**

In Bangladesh, hospitals are likely sites of transmission of respiratory infections. Wards are overcrowded with patients as well as with community members, who provide the majority of care to patients (1,2). Wards have a limited supply of running water and soap, patients have poor respiratory hygiene practices, and hospitals lack adequate routine infection control activities (2). In 2007, a pilot study in three tertiary care hospitals in Bangladesh estimated the incidence of hospital-acquired respiratory infections (HARI) to be six cases per 1,000 patient-days, but the aetiology of those infections was not investigated (3). In high-income countries, respiratory viruses, including influenza, respiratory syncytial virus (RSV), parainfluenza virus (HPIV) and human metapneumovirus (HMPV) have been associated with cases and outbreaks of HARI (4-8). Respiratory viruses could be important causes of HARI in Bangladesh as well because these viruses circulate widely in the Bangladeshi community (9). Respiratory virus-associated HARI can cause additional medical complications and increase the risk of death in severely ill patients, particularly those with strokes and other cardiovascular diseases (7,10,11). icddr,b in collaboration with the Bangladesh Ministry of Health and Family Welfare's Institute of Epidemiology, Disease Control and Research (IEDCR) have been conducting surveillance for HARI in adult and paediatric medicine wards at three tertiary care hospitals since 2008 to determine the epidemiology of HARI in Bangladesh. This report describes the incidence, seasonality, and viral aetiology of HARI in these three hospitals during 2008-2011.

In May 2008, surveillance for HARI was begun in one adult male medicine ward, one adult female medicine ward and one paediatric medicine ward in three hospitals: Faridpur Medical College Hospital, Rajshahi Medical College Hospital, and Khulna Medical College Hospital. HARI was defined as new onset of cough, fever, difficulty breathing or runny nose with onset >72 hours following admission. On each study ward, one surveillance physician was recruited from among the physicians at the hospital to conduct the surveillance activities. Surveillance physicians were supported by one full-time field assistant from icddr,b at each of the hospitals. Surveillance physicians identified patients who met the HARI case definition, collected demographic and medical information and nasopharyngeal and throat swabs. Field assistants stored specimens in liquid nitrogen and transported them to the icddr,b virology laboratory twice monthly. Virologists at icddr,b tested the swabs for a panel of four respiratory viruses including influenza A (and subtypes of influenza A), influenza B, HPIV types 1, 2 & 3, RSV and HMPV by real-time reverse transcription-polymerase chain

reaction assay (12) using primers and probes supplied by the US Centers for Disease Control and Prevention (13). Data were analyzed to describe the demographics of case-patients, distribution of hospital outcomes and mean duration of hospital stays. Three days were subtracted from the total days of hospitalization for each patient who was hospitalized for >72 hours to estimate patient-days at risk (PDR). The incidence rate of HARI per 1,000 PDR was calculated using Equation 1 and the virus-specific incidence rate of HARI was calculated using Equation 2. The 95% confidence interval (CI) for the incidence was estimated using a Poisson model.

Equation 1: Incidence rate of HARI

$$I = \frac{N_{hospital} \times 1{,}000}{PDR}$$

I= Incidence of HARI

$N_{hospital}$ = Total number of case-patients

PDR = Total patient-days at risk

Equation 2: Incidence rate of virus-associated HARI

$$I_v = \frac{N_v \times 1{,}000}{PDR}$$

$I_v$= Incidence of virus-associated HARI

$N_v$ = Number of HARI cases with laboratory confirmation for a virus

PDR = Total patient-days at risk

During May 2008-April 2011, 119,809 patients were admitted to the study wards. Among them, 25,319 (21%) were hospitalized for >72 hours and contributed 80,425 PDR. The average bed occupancy rate was 159%, meaning that on average, 159 patients were hospitalized each day for every 100 available beds; the rate was significantly higher on adult medicine wards than on paediatric wards (170% vs. 137%, p=<0.001). A total of 678 HARI case-patients were identified; 330 in paediatric and 348 in adult wards (Table 1). Demographic and clinical information of HARI cases are presented in Table 2. The incidence of HARI was 8.4 cases (95% CI: 7.8-9.0) per 1,000 PDR. Of 678 HARI case-patients, 142 (21%) had detectable RNA (note that all viruses for which testing was conducted were RNA viruses) in their respiratory swabs for any respiratory virus in the panel; 53 (37%) had RNA for influenza virus, 37 (26%) for HPIV, and 26 (18%) each for RSV and HMPV. Among the 142 case-patients with virus-associated HARI , three died, and all were adults; one was infected with influenza A/H3, one with influenza B and one with HPIV type 3. The incidence of virus-associated HARI was 1.7 (95% CI: 1.4-2.0)/1,000 PDR for all, 3.0 (2.4-3.7) for paediatric, and 1.1 (0.8-1.4) for adult patients admitted to study wards (Table 1). We observed virus-

associated HARI in most months during the study period (Figure). Influenza-associated HARI and HPIV-associated HARI were observed in each year, RSV-associated HARI was observed in 2008 and 2010, and HMPV-associated HARI was observed in 2009 and 2011. Influenza-associated HARI was most commonly observed during June - September in 2008, 2009, and 2010. The first HARI case with 2009 pandemic influenza strain, influenza A(H1N1) pdm 09, was identified in September 2009.

*Table 1: Patient admissions, numbers and percentages of hospital-acquired respiratory infections (HARI), patient-days at risk and incidence of HARI and virus-associated HARI in adult and paediatric medicine wards at three tertiary care hospitals in Bangladesh, by hospital ward, 2008-2011*

| Characteristics | Faridpur hospital | | Rajshahi Hospital | | Khulna Hospital | | Total |
|---|---|---|---|---|---|---|---|
| | Adult | Paedi-atric | Adult | Paedi-atric | Adult | Paedi-atric | |
| Total number of admitted patients | 27,815 | 10,506 | 38,664 | 18,606 | 16,592 | 7,626 | 119,809 |
| **Patients hospitalized for >72 hours** | | | | | | | |
| Total number of patients | 7,535 | 1,975 | 3,864 | 2,614 | 5,724 | 3,607 | 25,319 |
| Number (%) of patients with HARI | 167 (2) | 73 (4) | 106 (3) | 111 (4) | 75 (1) | 146 (4) | 678 (3) |
| Number (%) of patients with virus- associated HARI | 25 (15) | 17 (23) | 22 (21) | 25 (26) | 11 (15) | 42 (29) | 142 (21) |
| Total patient-days at risk (PDR) | 20,963 | 4,619 | 11,489 | 9,846 | 19,710 | 13,798 | 80,425 |
| Incidence of HARI*, 95% CI | 7.9 (6.8-9.2) | 16 (12-20) | 9.2 (7.5-11) | 11 (9.2-13) | 3.8 (2.9-4.7) | 11 (8.9-12) | 8.4 (7.8-9.0) |
| Incidence of virus-associated HARI*, 95% CI | 1.2 (0.8-1.7) | 3.7 (2.1-5.9) | 1.9 (1.2-2.9) | 2.5 (1.6-3.7) | 0.6 (0.3-1.0) | 3.0 (2.2-4.1) | 1.7 (1.4-2.0) |

*Incidences are calculated per 1,000 PDR

Reported by: Centre for Communicable Diseases, icddr,b

Supported by: Centers for Disease Control and Prevention, Atlanta, USA

### *Comments*

Overall, three out of every 100 patients hospitalized for >72 hours developed HARI in study wards, giving an incidence of eight cases per 1,000 patient-days, comparable to rates observed at three tertiary care hospitals in Bangladesh, including two of the three participating hospitals in this study, during 2007-2008 (3). One in five HARI cases were associated with respiratory viruses, and the rates were almost three times higher for children than for adults admitted to the study wards. These data suggest

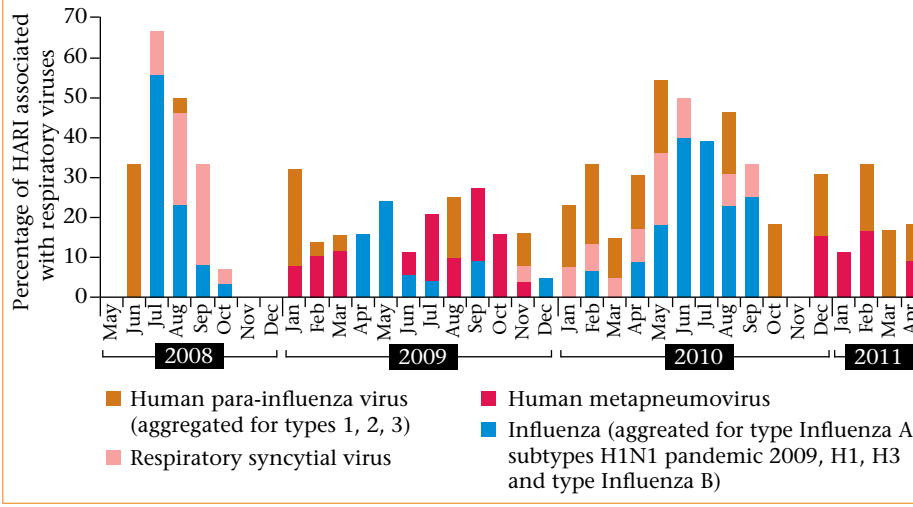
*Table 2: Characteristics of hospital-acquired respiratory infection case-patients among paediatric and adult medicine patients at three tertiary care hospitals in Bangladesh, 2008-2011*

| Characteristics | Value (N=678) |
|---|---|
| **Age group, years** | |
| <5 | 176 (26) |
| 5-13 | 159 (23) |
| 14-34 | 110 (16) |
| 35-59 | 148 (22) |
| ≥60 | 85 (13) |
| Days from admission to new onset of respiratory illness, median (IQR) | 5 (4-8) |
| **Symptoms associated with respiratory illness*** | |
| Fever | 358 (53) |
| Runny nose | 132 (19) |
| Difficulty breathing | 39 (6) |
| More than one symptom | 215 (32) |
| Days from new onset of illness to hospital outcome, median (interquartile range) | 3 (2-6) |
| **Hospital outcome** | |
| Discharged | 623 (92) |
| Left against medical advice | 27 (4) |
| Referred | 15 (2) |
| Death | 13 (2) |

Note: Data are no. (%) of patients, unless otherwise indicated
* The sum of percentages is more than 100% as some patients had more than one symptom/sign

that children are at higher risk than adults for virus-associated HARI in these tertiary care hospitals. HARI rates from this study are not readily comparable to those found in other high-income settings where ventilator-associated pneumonia is more common (14-16). The rate of HARI in Bangladeshi hospitals is low compared to other low- and middle-income countries like Argentina (11%) (17), Albania (13%) (18) and Tunisia (4%) (19), although conditions in hospitals in Bangladesh (such as crowding, as evidenced by the high bed occupancy rates) may facilitate transmission of respiratory viruses. Some HARI cases may not have been detected in this study. However, it is unlikely that many cases would have gone undetected because surveillance physicians and field assistants closely monitored enrolled patients several times a day. Patient care is primarily provided by family members in hospitals in Bangladesh(1). Relatively limited physical contact between healthcare staff and patients may be an important factor explaining the low rate of HARI in this study.

***Figure: Percentage of hospital-acquired respiratory infection cases associated with four respiratory viruses among patients admitted to paediatric and adult medicine wards at three tertiary care hospitals in Bangladesh, by month, 2008-2011***




Influenza was the most common virus associated with HARI in this study. Most influenza-associated HARI cases were identified between June and September when influenza activity is higher in Bangladesh (20,21). HMPV-associated HARI and RSV-associated HARI were identified in alternate years, HMPV in 2009 and 2011 and RSV in 2008 and 2010, reflecting the pattern of circulation of these viruses observed in an urban community in Bangladesh during these years (9).

Data from this study confirm hospital transmission of the newly emergent respiratory virus, influenza A(H1N1)pdm09, in tertiary care hospitals during September 2009 when the virus was first identified in the Bangladeshi community and patients were hospitalized with the virus (Unpublished data from Bangladesh's national hospital-based influenza surveillance system). This is concerning because this indicates that these hospitals and others in low-income settings with limited routine infection control programs could be potential sites of transmission for other novel viruses, including, the Middle East Respiratory Syndrome Coronavirus, and the Nipah virus, which have previously caused nosocomial outbreaks of respiratory infections (22,23).

There are some limitations to this study. The majority of patients (79%) in our study wards were discharged within 72 hours of hospitalization and were not followed up. Thus, some HARI cases might have been missed, which would have led to an underestimation of HARI incidence

as well. Additionally, because of limited funds, testing for some common viral respiratory pathogens such as adenoviruses or rhinoviruses was not performed, which might have resulted in an underestimation of virus-associated HARI incidence. Lastly, this study only included three hospitals, and only those admitted to the adult and paediatric medicine wards, and so the estimated rates of HARI and virus-associated HARI from this study may not be generalizable to other hospitals in other low-resource countries or in Bangladesh. However, as the rates were similar across the three tertiary care hospitals, it is likely that these findings apply to other tertiary care hospitals in Bangladesh.

Surveillance for HARI at the three participating hospitals provides important data on the incidence of HARI and viral etiologies of HARI in tertiary care hospitals in Bangladesh. Viral pathogens were not detected in more than three-fourths of HARI cases; many of the cases could be caused by bacteria or by other viruses for which specific testing was not conducted. Surveillance for HARI at the study hospitals required external funding. Continued support for this activity will be critical. Further studies to identify viral and bacterial causes of HARI cases would inform the development of an evidence-based infection control program to prevent the spread of respiratory viruses in hospitals in Bangladesh.

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*Alert for Healthcare Providers*

# Ebola virus disease (EVD) and travelers coming to Bangladesh from countries with EVD cases

In March 2014, an outbreak of Ebola Viral Disease (EVD), was reported in West Africa. EVD, formerly known as Ebola haemorrhagic fever, is a severe, often fatal illness in humans that is transmitted to people from wild animals and spreads in the human population through human-to-human transmission. On August 8, 2014, the World Health Organization (WHO) declared that the current Ebola outbreak to be a Public Health Emergency of International Concern (PHEIC). Most of the cases have been reported in three West African countries: Guinea, Liberia, and Sierra Leone. A small number of cases have also been reported in Nigeria. As of September 25, 2014, there have been a total of 6263 cases of EVD and 2917 deaths reported. Additional information and updates on the EVD situation are available at the World Health Organization (WHO) EVD site: www.who.int/csr/disease/ebola/en/ and at the US Centers for Disease Control and Prevention (CDC) EVD site: http://www.cdc.gov/vhf/ebola/.

Although the risk of an Ebola outbreak in Bangladesh is very low, the Bangladesh Ministry of Health and Family Welfare, icddr,b and partners are taking precautions to prevent this from happening. Ebola virus is spread through direct contact with the blood or body fluids (including but not limited to feces, saliva, urine, and vomit) of a person who is sick with EVD. Healthcare workers caring for EVD patients and the family and friends in close contact with EVD patients are at the highest risk of getting sick because they may come in contact with the blood or body fluids of sick patients. Early recognition of possible cases and protection of healthcare providers are critical. Healthcare providers should be alert for patients presenting with febrile illness within three weeks of returning from affected countries in West Africa. Please call the Institute of Epidemiology Disease Control and Research (IEDCR) at 01937110011 or 01937000011 for diagnostic support and clinical advice if you encounter a patient with recent travel to West Africa.

Healthcare workers caring for patients with suspected EVD should isolate patients with Ebola from other patients and follow infection control precautions, including wearing protective clothing (masks, gloves, gowns, and eye protection) to prevent the spread of Ebola.

# Is an automated batch chlorinator an effective and acceptable means of water treatment in urban Bangladesh?

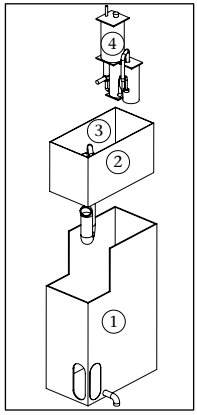
**Point-of-use water treatment with chlorine is underutilized in low-income households. From February to April 2012, we selected 11 compounds with 9-30 households each, from an urban slum in Dhaka. Fieldworkers tested water turbidity and free chlorine and they collected water samples from control and treatment households to assess levels of *Eschericia coli* contamination at baseline and during follow-up visits. They conducted interviews with a sub-set of participants to understand their experiences using the Zimba device. Eighty percent of stored water samples among treatment households were determined to be safe for drinking compared to 29% from control compounds (p<0.001). Concentrations of *E. coli* in stored water were lower in treatment households than in control households (mean difference=0.4 log colony-forming units/100ml, p=0.004). Nine (53%) of 17 mothers interviewed thought the Zimba was easy to use and 76% were satisfied with the taste of water treated with Zimba. Nine (75%) of 12 mothers who participated in-in depth interviews mentioned that collecting water from Zimba took more time and created a long queue at the handpump. Zimba may be a good alternative for point-of use water treatment in areas where queuing for water is uncommon.**

Unsafe drinking water is a leading cause of diarrhea (1). Evidence from randomized controlled trials suggests that point-of-use (POU) water treatment with chlorine reduces the incidence of reported diarrheal disease (2-4), but that treatment techniques have been poorly adopted and inconsistently used among low-income households (5).

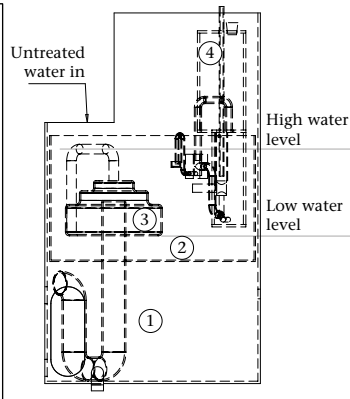
Current POU water treatment requires the use of a specified volume container (6,7) to add a chlorination tablet or specific dose of liquid chlorine for correct dosage. Community members may not know how to estimate the dose of chlorine for containers of different volumes which may lead to incorrect dosing. There are limited options for low-cost community-level water treatment for quantities of water >10 L. In addition, it is difficult to estimate the correct dose of chlorine for small amounts of water such as one glass or small jug (<3 L). One reason for low adoption of POU water treatment at the household level might be the requirement of adding chlorine each time drinking water is collected -- this requires knowledge, behavior change and personal motivation. If these criteria are not met, inconsistent and inaccurate chlorine dosage could result.

The Zimba automated batch chlorinator was invented to reduce or eliminate barriers to POU water treatment at the household level (8). Zimba attaches to a handpump and dispenses 3 ml of sodium hypochlorite (NaOCl) solution into a dosing chamber for every 10 L of water that is pumped. The treated water is then flushed by an automatic siphon into a storage reservoir and then dispensed via a tap (Figure 1). We conducted a small-scale trial in low-income urban neighborhoods in Dhaka to assess the accuracy and consistency of Zimba's chlorine dosing, the microbial quality of water chlorinated by the Zimba device and the acceptability of Zimba among users.

***Figure 1: Line drawings of Zimba automated chlorine dispenser***




Explored view of ZIMBA




ZIMBA sketch showing different parts


ZIMBA installed in a community handpump

Figures show: 1. Outer box; 2. Dosing chamber; 3. Siphon and 4. Chlorine dispenser

From February to April 2012, we purposively enrolled 11 (5 control and 6 treatment) compounds, each containing 9-30 households in Mirpur, an urban slum where residents collect water using handpumps connected to a municipal piped water supply that was not being chlorinated during the study period. From each compound, five households with at least one child <5 years were purposively selected to participate in a household survey. We collected information on the demographics of the households, their perceptions of the quality of their drinking water, their water collection, storage, and treatment practices, and satisfaction with their water supply.

Before installing Zimba, fieldworkers tested water turbidity and free chlorine concentrations using a digital colorimeter. They also collected stored drinking water from all selected households to assess levels of *Escherichia coli* contamination using membrane filtration (9). After this baseline assessment, Zimba devices were installed on six handpumps.

During biweekly follow-up visits and one end-line visit, fieldworkers

collected water samples from the selected handpumps with and without Zimba chlorinators and stored drinking water from control and treatment households. At the end of the three-month intervention, fieldworkers conducted an end-line quantitative survey of all households to assess satisfaction with their water systems and their perceptions of water taste, smell, and quality. In treatment households, fieldworkers also conducted qualitative in-depth interviews to assess acceptability and satisfaction with the chlorinated water and with the Zimba. Fieldworkers used a written guideline to conduct in-depth interviews focusing on consistency of using the chlorinated water treated by the Zimba, perceptions (likes/dislikes and advantages/disadvantages) of chlorinated water and the Zimba chlorinator, and any changes in taste and smell of chlorinated water over the study period.

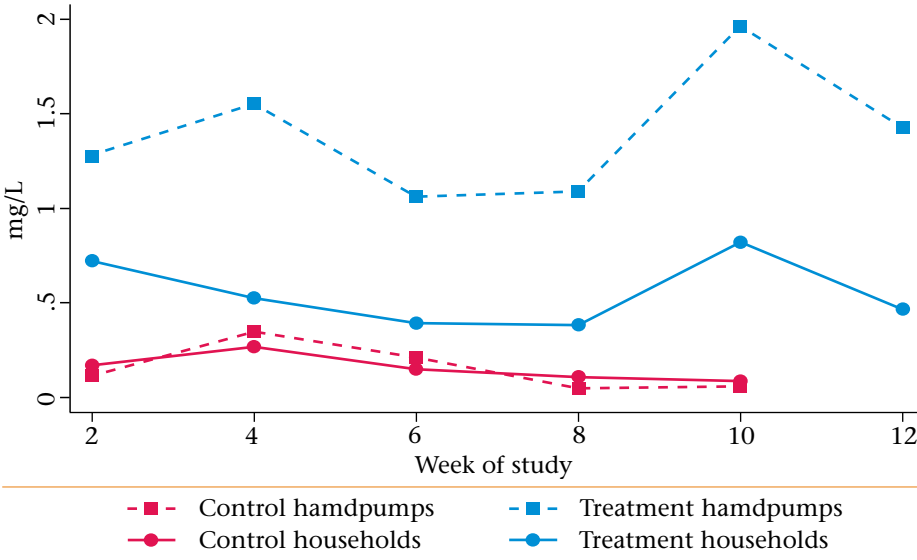
We categorized water turbidity as: ≤5 Nephelometric Turbidity Units (NTU) and >5 NTU (10). Free chlorine was categorized based on WHO guidelines as: <0.2 mg/L (unsafe), 0.2-2.0 mg/L (safe), and >2 mg/L (safe) (10). Microbial water quality was categorized as: low risk (0-10 colony-forming unit [cfu]/100ml) and intermediate to high risk (>10 cfu/100ml) (10). To compare the mean difference between the groups, water samples under the detection limit were assigned the value of 0.5 cfu/100ml and samples above the detection limit were assigned the value of 500 cfu/100ml. To compare the mean differences within groups and between control and treatment groups, we converted bacterial counts into $\log_{10}$ scale and performed two-sided t-tests.

Two compounds (comprising 10 households) in the treatment group withdrew from the study after installation of the Zimba and were not included in the analysis; one withdrew because the additional time required to pump the water into the siphon tank was inconvenient and the other because the amount of space that the device occupied around the handpump interfered with cleaning utensils and washing clothes. Three households in treatment compounds moved during the study period and were not included in the analysis. At baseline, 24 control households (one household decided not to participate following enrollment) and 30 treatment households were interviewed. At end-line, the fieldworkers surveyed all 24 control households and the 17 treatment households that completed the study. Fieldworkers collected 71 water samples at baseline and 248 water samples during follow-up and end-line surveys.

At baseline, mean levels of turbidity, free chlorine and *E. coli* contamination were the same (1.5 NTU in each, 0.1 mg/L in each and 0.67 log cfu/100ml in each respectively). Only 28% of baseline handpump water samples from treatment compounds and 39% of handpump samples from control compounds contained safe chlorine levels.

All of the water samples collected from the Zimba devices contained safe chlorine levels (between 0.2-2 mg/L). In stored drinking water samples, 80% of treatment households had safe chlorine levels compared to 28% of control households (p<0.001). Free chlorine levels in stored water were significantly higher in treatment compared to control households (mean difference=0.33 mg/L, p<0.001) (Table). Mean free chlorine levels were also consistently above 0.2 mg/L in stored water from treatment households throughout the study period (Figure 2).

***Figure 2: Mean free chlorine level in control (N=24) and treatment (N=23) handpumps, and in stored water at control (N=83) and treatment (N= 96) households over time during follow-up visits, in Mirpur, Dhaka, 2012***




Only 4% of samples collected from handpumps and 8% of stored water stored in treatment households contained >10 cfu/100 ml *E. coli*. In comparison, 26% of handpump water samples and 28% of stored water samples from control households had >10 cfu/100ml *E. coli*. The concentrations of *E. coli* in handpump water (log-mean cfu=-0.16) and in stored water (log-mean cfu=0.11) in treatment households were low. The concentration of *E. coli* in stored water was significantly lower in treatment households (log-mean cfu=0.11) compared to control households (log-mean cfu=0.54, mean difference=0.4 cfu/100ml, p=0.004) (Table).

Five (29%) of the 17 respondents from treatment households who completed the end-line survey reported a bad (chlorine) smell in their drinking water at end-line. Only half (53%) of the 17 mothers thought the device was easy to

use, however 15 (88%) were satisfied with the device, 13 (76%) were satisfied with the water taste and 12 (71%) were satisfied with the smell. Fourteen (85%) mothers believed that drinking Zimba-chlorinated water was healthier for their families and almost half (47%) stated that their household would be willing to pay 10 taka (USD 0.13) per week for chlorine refills and would continue to use the Zimba device.

***Table: Turbidity, free chlorine, and fecal indicator bacteria concentrations in water samples collected from control and treatment compounds during bi-weekly follow-up household visits, Mirpur, 2012***

| Water quality | Control group n (%) | | Treatment group n (%) | | | Mean difference between control vs. treatment compounds (p-value) | |
|---|---|---|---|---|---|---|---|
| | Source water (N=23) | Stored water (N=96) | Source water (N=24) | Zimba water (N=23) | Zimba stored water (N=82) | Un-treated source water | Stored water |
| **Turbidity (NTU*)** | | | | | | | |
| <5 | 23 (100) | 96 (100) | 24 (100) | 23 (100) | 82 (100) | | |
| Mean (SD‡) | 1 (0.52) | 0.72 (0.47) | 0.73 (0.39) | 1 (0.33) | 0.73 (0.34) | -0.30 (0.006) | 0.02 (0.724) |
| **Free chlorine (mg/L)** | | | | | | | |
| <0.2 | 14 (61) | 69 (72) | 21 (88) | 0 | 16 (20) | | |
| 0.2-2 | 9 (39) | 27 (28) | 3 (12) | 23 (100) | 66 (80) | | |
| Mean (SD) | 0.18 (0.17) | 0.17 (0.12) | 0.12 (0.08) | 1.3 (0.54) | 0.5 (0.5) | -0.06 (0.054) | 0.33 (0.001) |
| Log-mean *E. coli* CFU† (SD) | 0.45 (1) | 0.54 (1.1) | 0.4 (1) | -0.16 (0.4) | 0.11 (0.84) | -0.05 (0.773) | -0.43 (0.004) |
| Log-mean total coliforms CFU (SD) | 1.3 (1) | 1.6 (1.1) | 1.2 (1) | 0.5 (0.9) | 1 (1.2) | -0.09 (0.029) | -0.61 (<0.001) |

*Nephelometric Turbidity Units; †Colony Forming Unit; ‡Standard Deviation

In-depth interviews with mothers in treatment households suggested that most users (9 of 12) liked the Zimba device but stated that collecting water from handpumps with Zimba took more time and often resulted in a long queue at the handpump.

The Zimba was designed for batch chlorination of 10 L of water at a time and the additional time needed to collect water was an issue for the users particularly when they wanted to collect small volumes of water. Three respondents mentioned that the approximately 12 inches in increased

height of handpumps needed to accommodate the Zimba device made it difficult to pump out water, particularly for children (Figure 1). Eleven of 12 mothers who participated in in-depth interviews mentioned they would not be able to refill the Zimba chlorine dispenser after the project ended because of lack of knowledge about how to refill them.

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### *Comments*

All the water collected from the handpumps with the Zimba device was safe to drink. Our results suggest that the microbial quality of stored household water in treatment households was better than that in control households. Although all water samples from handpumps with the Zimba device had chlorine concentrations in the recommended range, 20% of stored water samples from treatment households did not have chlorine in the recommended level and 10% of these samples had unsafe *E. coli* levels. Although not ideal, drinking stored water that was treated by the Zimba device may still have a health impact because the water was disinfected before it was stored. In addition, chlorine concentrations were significantly higher in stored water samples from treatment households than control households and the proportion of stored water samples with unsafe *E. coli* levels were substantially lower in treatment households.

Current Zimba dispensers require at least 10 L of water to function, so users must wait until the 10 L tank is filled before withdrawing water. Pumping 10 L of water from handpumps takes an average of 60 (range=20-117) seconds if pumped continuously (Yoshika Crider, personal communication). Since urban slums in Dhaka and elsewhere are typically densely populated, extra wait times for water due to the use of the Zimba device could prolong overall water collection times and cause queues at peak usage times. Future advances in the Zimba technology could result in more compact devices with improved flow rates that will be accessible to all users and reduce the likelihood of queues at shared water collection points. Findings from this study indicate that the current Zimba device might be a more appropriate technology for rural communities where the space around handpumps is not a constraint and there is less queuing for water.

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# Surveillance updates

With each issue of HSB, updates of surveillance data described in earlier issues are provided. These updated tables and figures represent the most recent observation period available at the time of publication. We hope these updates will be helpful to health professionals who are interested in current patterns of disease and drug resistance in Bangladesh.

***Proportion of diarrhoeal pathogens susceptible to antimicrobial drugs: September 2013-August 2014***

| Antimicrobial agents | *Shigella* N=63 | *V. cholerae* O1 N=281 |
|---|---|---|
| Mecillinam | 89.8 | Not tested |
| Ampicillin | 59.7 | Not tested |
| TMP-SMX | 36.2 | 0.0 |
| Ciprofloxacin | 41.9 | 100.0 |
| Tetracycline | Not tested | 0.7 |
| Azithromycin | 76.2 | 100.0 |
| Ceftrioxone | 100.0 | Not tested |

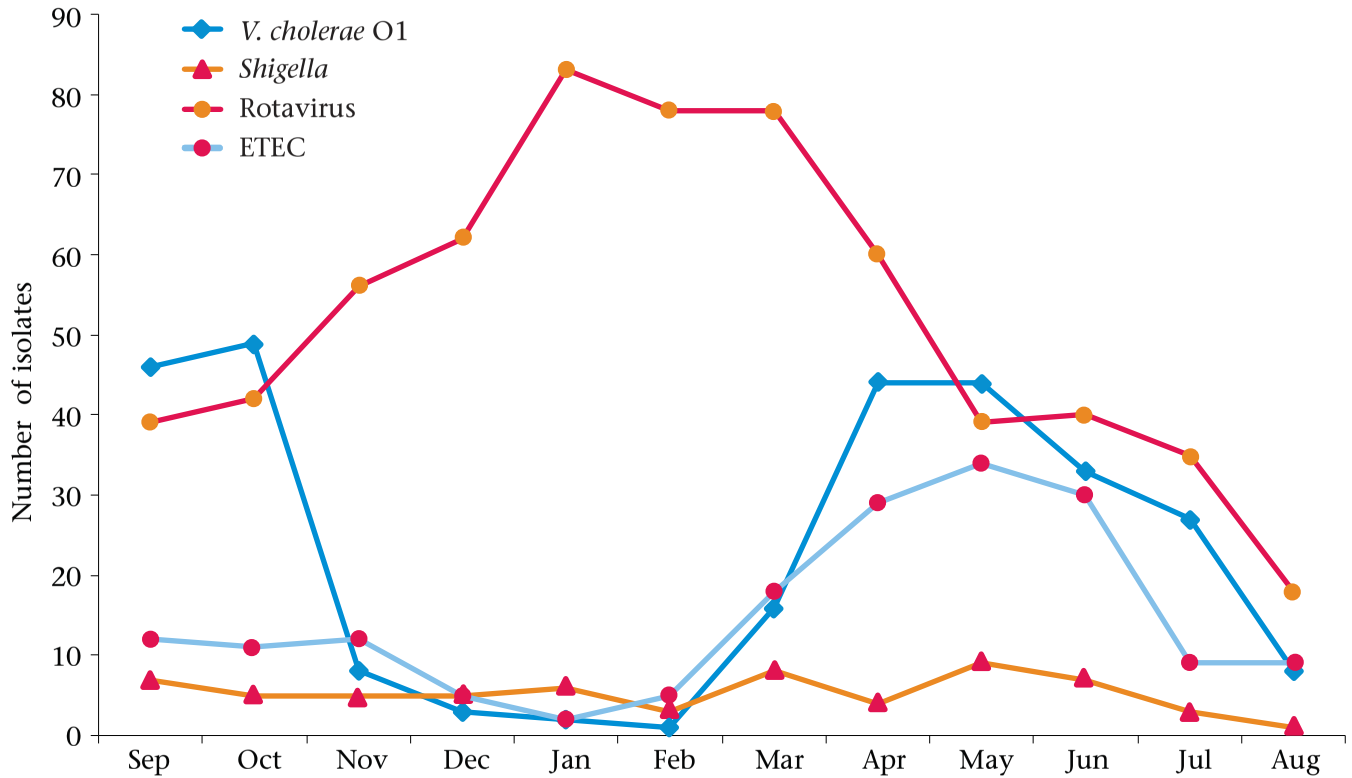
*Source: Hospital Surveillance, Dhaka Hospital, icddr,b*

***Antimicrobial susceptibility pattern of* S. typhi *among children <5 years during July to September 2014***

| Antimicrobial agent | Total tested (N) | Susceptible n (%) | Reduced susceptibility n (%) | Resistant n (%) |
|---|---|---|---|---|
| Ampicillin | 30 | 25 (83) | 0 (0) | 5 (17) |
| Cotrimoxazole | 29 | 25 (86) | 0 (0) | 4 (14) |
| Chloramphenicol | 30 | 25 (83) | 0 (0) | 5 (17) |
| Ceftriaxone | 30 | 30 (100) | 0 (0) | 0 (0) |
| Ciprofloxacin | 30 | 0 (0) | 30 (100) | 0 (0) |
| Nalidixic Acid | 30 | 2 (7) | 0 (0) | 28 (93) |

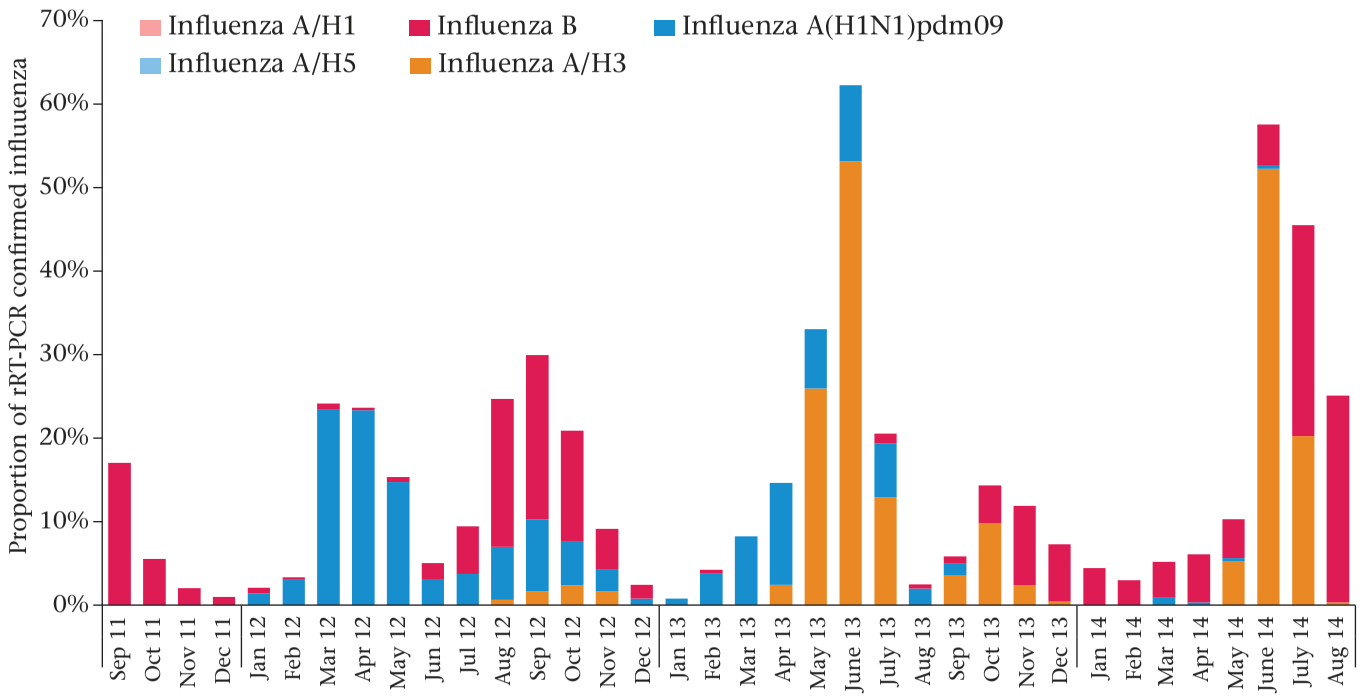
*Source: Kamalapur Urban Surveillance, icddr,b*

## *Monthly isolation of* V. cholerae *O1,* Shigella, *Rotavirus and ETEC: September 2013-August 2014*




*Source: Hospital Surveillance, Dhaka Hospital, icddr,b*

## *Proportion of laboratory-confirmed influenza among hospitalized severe acute respiratory illness (SARI) and outpatient influenza like illness (ILI) cases between September 2011 and August 2014*




Source: Patients participating in hospital-based influenza surveillance in Dhaka National Medical College Hospital, Community-based Medical College Hospital (Mymensingh), Jahurul Islam Medical College Hospital (Kishoregonj), Rajshahi Medical College Hospital, Shaheed Ziaur Rahman Medical College Hospital (Bogra), LAMB Hospital (Dinajpur), Bangabandhu Memorial Hospital (Chittagong), Comilla Medical College Hospital, Khulna Medical College Hospital, Jessore General Hospital, Jalalabad Ragib-Rabeya Medical College Hospital (Sylhet), Sher-e-Bangla Medical College Hospital (Barisal), Chittagong Medical College Hospital* and Dinajpur Medical College Hospital* (*since April 2014)


*Pumping water into the ZIMBA device installed in an urban slum*

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