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Major article

Surveillance for respiratory health care–associated infections among inpatients in 3 Kenyan hospitals, 2010-2012

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Background: Although health care–associated infections are an important cause of morbidity and mortality worldwide, the epidemiology and etiology of respiratory health care–associated infections (rHAIs) have not been documented in Kenya. In 2010, the Ministry of Health, Kenya Medical Research Institute, and Centers for Disease Control and Prevention initiated surveillance for rHAIs at 3 hospitals.
Methods: At each hospital, we surveyed intensive care units (ICUs), pediatric wards, and medical wards to identify patients with rHAIs, defined as any hospital-onset (≥3 days after admission) fever (≥38°C) or hypothermia (<35°C) with concurrent signs or symptoms of acute respiratory infection. Nasopharyngeal and oropharyngeal specimens were collected from these patients and tested by real-time reverse transcription polymerase chain reaction for influenza and 7 other viruses.
Results: From April 2010-September 2012, of the 379 rHAI cases, 60.7% were men and 57.3% were children <18 years old. The overall incidence of rHAIs was 9.2 per 10,000 patient days, with the highest incidence in the ICUs. Of all specimens analyzed, 45.7% had at least 1 respiratory virus detected; 92.2% of all positive viral specimens were identified in patients <18 years old.
Conclusion: We identified rHAIs in all ward types under surveillance in Kenyan hospitals. Viruses may have a substantial role in these infections, particularly among pediatric populations. Further research is needed to refine case definitions and understand rHAIs in ICUs.

Health care–associated infections (HAIs) cause substantial morbidity and mortality worldwide,[1] with prevalence varying from 4%-34% in a variety of patient populations and clinical settings.[2-6] Although HAI prevalence, incidence, and burden have been characterized by established surveillance systems in several developed countries, data on HAIs in developing countries are sparse, especially in Africa.[7,8] Based on a recent review of published studies of HAI in developing countries, an estimated 15% of hospitalizations resulted in an HAI, which is much higher than estimated rates (4%-10%) in developed countries.[2,5] In developing countries, resource

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limitations make it more challenging to optimize infection control measures (eg, hand hygiene, proper disinfection of medical equipment and surfaces, injection safety, waste management).[1,8] In addition, some factors that are more common in the developing world (eg, overcrowding of hospital wards, lack of training, fewer programs on prevention of nosocomial infections) can increase the likelihood of transmission of respiratory pathogens in health care settings.[9]

In Kenya, community-acquired acute respiratory illnesses, including pneumonia, are common and may account for up to half of all hospital admissions in medical and pediatric wards.[10-15] However, no data are available on respiratory HAIs (rHAIs) in Kenya. In an effort to understand rHAIs in Kenyan hospitals, in 2009, the Kenya Medical Research Institute (KEMRI), Centers for Disease Control and Prevention-Kenya (CDC-Kenya), and Kenya Ministry of Health established a pilot system for tracking rHAIs in 3 hospitals. Laboratory resources and protocols that have been used for surveillance of community-onset influenza-like illness (ILI) were available for testing a subset of rHAI cases with ILI symptoms. In this study we summarize findings from this pilot surveillance system. Specifically, our objectives were to characterize the epidemiology and etiology of rHAIs stratified by patient and ward characteristics and to identify viral pathogens associated with rHAI in a subset of patients with ILI symptoms.

METHODS

Setting

Three facilities were chosen based on proximity to the KEMRI or CDC-Kenya Laboratories in Nairobi and Kisumu and to ensure sites represented were of varying size and resources. These criteria resulted in the selection of 1 national and 1 district hospital in Nairobi and a provincial (ie, regional referral) hospital in Kisumu. Kenyatta National Hospital (KNH), the largest public hospital in the country, is a university-affiliated national referral hospital with 1,800 beds that receives 89,000 admissions per year. Mbagathi District Hospital (MDH) is a 200-bed hospital with annual admissions of approximately 13,000, which serves the local population but provides no specialty services or intensive care. KNH and MDH are both based in Nairobi, the capital of Kenya, which has a population of about 3 million people. The provincial hospital, New Nyanza Provincial General Hospital (NNPGH), is a 300-bed facility located in western Kenya; it receives approximately 18,000 admissions per year and serves as a regional referral hospital. We targeted medical wards, pediatric wards (which typically admit children $<$13 years old), and intensive care units (ICUs) for the prospective rHAI surveillance. As a result, there were 394 total patient beds under surveillance: 212 beds in medical wards (51 at KNH, 101 at NNPGH, 60 at MDH), 186 beds in pediatrics wards (61 at KNH, 80 at NNPGH, 45 at MDH), and 26 beds in general ICUs (21 at KNH, 5 at NNPGH).

Surveillance protocol and case definitions

We trained 4 clinicians (1 nurse, 3 clinical officers) to be HAI surveillance officers (SOs) and assigned them to the 3 hospitals (1 in MDH, 1 in NNPGH, 2 in KNH) where they worked closely with the health care personnel and hospital administrators to implement the surveillance protocol. SOs were instructed to survey each ward under surveillance at least 2 days per week. They reviewed all patients' medical records in the selected wards to identify patients with new documented axilla fever ($\geq$38°C) or hypothermia ($<$35°C) with onset at least 3 days after admission to the hospital. SOs relied on temperatures taken as part of routine clinical care and documented in charts. To encourage and enhance consistency of temperature taking, surveillance wards were provided with Omron digital thermometers (Omron, Pudong, China) for axilla temperature taking (thermometer placed in the central position while adducting the arm close to the chest wall). Because temperature taking was found to be inconsistent in the prepilot phase, SOs also took axilla temperatures of all the patients during ward visits to enhance sensitivity of temperature-based surveillance.

Surveillance began on April 1, 2010, and continued through September 30, 2012, which composes the 30-month study period reported here. If new-onset axilla fever or hypothermia were identified in a patient who had been afebrile for at least 3 days, the SOs filled out a suspected HAI form. The form included information on basic demographic characteristics, dates of admission, admitting diagnosis, date of new onset of axilla fever, clinical symptoms occurring from 1 day before to 3 days after the onset of fever or hypothermia, and information about routine laboratory tests ordered, laboratory results obtained, antibiotic use, and details of patient management. SOs also asked patients and patient's family members about clinical symptoms. All patients with a suspected HAI were followed for their ultimate outcome, including patient discharge, transfer, or death.

Based on clinical information collected on suspected HAI cases, respiratory HAIs were characterized by 2 case definitions. The first was a broad definition of rHAIs that incorporated a wide range of respiratory signs and symptoms; the second was a narrower definition for hospital-associated ILI. Specifically, a case of an rHAI was defined as a patient with new-onset fever or hypothermia and concurrent (1 day before to 3 days after) documentation in the medical chart of any of the following indications of respiratory infection: crackles, rhonchi, decreased breath sounds, crepitus, need for supplemental oxygen in nonventilated patients, clinician documentation of upper respiratory infection, clinician request for sputum culture, and oxygen saturation (by pulse oximetry) $<$90% in ventilated patients or concurrent patient or family report of cough or sore throat. A case of hospital-associated ILI was defined as new-onset fever or hypothermia with concurrent patient or family report of cough or sore throat. Therefore, the hospital-associated ILI cases represented a subset of the rHAI cases (Table 1).

Laboratory testing

Because of laboratory resource constraints, SOs were instructed to collect specimens from patients who met the case definition for hospital-associated ILI only. SOs also collected specimens from a convenience sample of patients who met the rHAI case definition but did not meet the ILI case definition. SOs collected oropharyngeal and nasopharyngeal specimens from eligible patients according to standard procedures that have been previously described.[14] For intubated patients in the ICU in KNH and NNPGH, endotracheal aspirates were collected.

At the KEMRI/CDC-Kenya Laboratory in Nairobi, specimens were tested by real-time reverse transcription (rRT) polymerase chain reaction (PCR) for the following pathogens: influenza viruses A and B; respiratory syncytial virus (RSV); adenovirus; parainfluenza virus types 1, 2, and 3; and human metapneumovirus. We followed the same testing protocol as previously described for population-based acute respiratory illness surveillance in Kenya.[15] For rRT-PCR, total RNA was extracted from 100-μL aliquots of each specimen using QIAamp Viral RNA Mini Kit (Qiagen Inc, Hilden, Germany) according to manufacturer's instructions. One-step rRT-PCR was carried out using the AgPath-ID One-Step RT-PCR Kit (Applied Biosystems, Carlsbad, CA). Pathogen-specific primers were used. Following the reverse

Table 1
Demographics and clinical characteristics for cases of suspected HAI, respiratory HAI, and hospital-associated ILI, Kenya, 2010-2012

Variable	Suspected HAI* (n = 1,255)	Respiratory HAI† (n = 379)	Hospital-associated ILI‡ (n = 147)
Sex			
Male	694 (55.3)	230 (60.7)	85 (57.8)
Female	561 (44.7)	149 (39.3)	62 (42.2)
Age group, years			
<1	206 (16.4)	70 (18.5)	30 (20.4)
1-17	555 (44.2)	147 (38.8)	70 (47.6)
18-49	372 (19.6)	123 (32.5)	40 (27.2)
50-64	80 (6.4)	22 (5.8)	6 (4.1)
≥65	42 (3.4)	17 (4.5)	1 (0.7)
Hospital			
KNH	190 (15.1)	103 (27.2)	58 (39.5)
NNPGH	933 (74.3)	220 (58.1)	43 (29.3)
MDH	132 (10.5)	56 (14.8)	46 (31.3)
Ward type			
Pediatrics	690 (55.0)	189 (49.9)	99 (67.4)
Medical	477 (38.0)	116 (30.6)	43 (29.3)
ICU	88 (7.0)	74 (19.5)	5 (3.4)
Length of stay (days) in the ward, median (minimum-maximum)	24 (4-657)	25 (4-288)	29 (6-288)

NOTE. Values are n (%) or as otherwise indicated.
HAI, hospital-associated infection; *ICU*, intensive care unit; *ILI*, influenza-like illness; *KNH*, Kenyatta National Hospital; *MDH*, Mbagathi District Hospital; *NNPGH*, New Nyanza Provincial General.
*Suspected HAI refers to patients with new documented fever or hypothermia with onset at least 3 days after admission to the hospital.
†Respiratory HAI refers to patients with suspected HAI and with concurrent documentation in the medical chart of indication of respiratory infection.
‡Hospital-associated ILI refers to patients with respiratory HAI with concurrent onset of cough or sore throat.

transcription step, a typical 45-cycle PCR was run, and fluorescence was read at the annealing and extension step. Appropriate negative and positive control specimens were run alongside each reaction. The results were recorded as crossover threshold (C_T) values. Any pathogen C_T value ≤39.9 was recorded as positive. Specimens with C_T values >40.0 were considered negative, and those without a C_T reading were recorded as negative.

Data analysis

Incidence was calculated by dividing the number of rHAIs and hospital-associated ILI cases identified by the number of patient days under surveillance; the patient-day denominator was determined from monthly ward-specific bed occupancy data provided by each hospital. We used all patient days rather than patient days at risk (ie, eliminating patient days for those discharged from the hospital after a stay <3 days) because using overall patient days has become standard protocol where most patient days are contributed by patients with lengths of stay >3 days.[16] Incidence rates for rHAIs and ILIs were calculated overall and by hospital and ward type. Stratified incidence rates were compared using a Poisson regression (Table 2). Median length of stay was calculated by ward type and differences compared using Wilcoxon rank-sum tests. Longitudinal trends were plotted quarterly by hospital. Viral pathogen test results were summarized for patients with hospital-associated ILI and rHAI.

We analyzed outcomes related to patient discharge status for those with rHAI. Because patients could have ≥1 HAI during the study time period, outcomes were analyzed at the patient level. Death within 7 days of rHAI onset was used as a proxy for death attributable to an HAI.[17] For patients with multiple rHAIs, the time from rHAI onset to death was based on the onset of their last rHAI. Characteristics of patients who died within 7 days of onset of rHAI were compared with patients who died after 7 days and patients who did not die using χ^2 tests for independence.

SOs collected all data on paper-based forms until November 30, 2011, at which point they switched to electronic collection of data on tablets. Data were manually entered into Microsoft Access 2007 (Microsoft Inc, Redmond, WA) prior to December 2011, after which data were downloaded directly into Microsoft Access from tablets. Statistical analysis was performed using SAS software version 9.1 (SAS Institute, Cary, NC). The surveillance protocol was approved by both the Institutional Review Board of CDC-Atlanta and the Ethical Review Committee of KEMRI.

RESULTS

The surveillance period (April 2010-September 2012) included a total of 410,182 patient days at the 3 hospitals: 162,394 on medical wards, 225,354 on pediatric wards, and 22,434 in ICUs. During this time, SOs identified 1,255 cases of suspected HAIs; 379 (30.2%, including 18 patients with >1 case) met the definition for rHAI, and 147 (11.7%, including 1 patient with 2 cases) cases met the definition for hospital-associated ILI. Of the 379 rHAI cases identified, 60.7% were men, and 57.3% were <18 years of age. Of the 147 ILI cases identified, 57.8% were men, and 68.0% were <18 years of age; 20.4% were <1 year of age (Table 1). Of the 379 rHAI cases identified, 49.9% were in pediatrics wards, 30.6% were in medical wards, and 19.5% were in the ICUs. The median length of stay in the hospital for rHAI patients was 25 days (range, 4-288); there was no statistically significant variation by ward type.

The overall incidence of rHAI was 9.2 infections per 10,000 patient days under surveillance (Table 2). The incidence of rHAIs in the ICUs was 33.0 per 10,000 patient days, which was significantly higher than the incidence in pediatric wards (8.4 per 10,000 patient days, $P < .0001$) and medical wards (7.1 per 10,000 patient days, $P < .0001$). There was no statistically significant difference in the incidence of rHAI in the pediatrics wards compared with the medical wards. The incidence of rHAI differed significantly by hospital; it was 18.1 per 10,000 patient days at the NNPGH, 8.4 at the KNH, and 3.4 at the MDH ($P < .0001$ for all comparisons).

The overall incidence of hospital-associated ILI was 3.6 per 10,000 patient days (Table 2). By ward type, the incidence was higher in the pediatrics wards at 4.4 per 10,000 patient days than the medical wards (2.6, $P < .0001$) and ICUs (2.2, $P = .13$). By hospitals, the incidence of hospital-associated ILI was highest at the KNH at 4.7 per 10,000 patient days. KNH incidence was higher than the MDH (2.8, $P = .007$) and NNPGH (3.5, $P = .15$); however, the latter comparison did not reach statistical significance.

HAIs were detected throughout the year without any clear seasonal trends. A notable drop in case identification occurred in the last quarter of 2011, and a notable increase in rHAI rates occurred between March and November 2011 at the NNPGH (Fig 1).

Specimens were collected and tested for 112 of the 147 suspected hospital-associated ILI cases (76.2%). When we compared patients from whom specimens were collected with patients from whom specimens were not collected, there were no significant differences in age, sex, ward type, or hospital. Reasons for not collecting specimens included refusal by patient or their guardian or inability to obtain a specimen (eg, because of oxygen mask use, severe difficulty breathing). Among hospital-associated ILI cases, 54 (48% of specimens tested) were positive for at least 1 viral pathogen (Table 3). The most common viruses identified among specimens tested were adenovirus (n = 19, 18.5%), RSV (n = 17, 16.5%), parainfluenza virus type 3 (n = 16, 15.3%), and influenza virus A (n = 9, 8.7%). Multiple viruses were isolated for 17 (16.5%) ILI specimens.

Table 2
Incidence of respiratory HAI and hospital-associated ILI per 10,000 patient days by ward type and hospital, Kenya, 2010-2012

	KNH		NNPGH		MDH		Overall	
Ward type	Respiratory HAI	Hospital-associated ILI	Respiratory HAI	Hospital-associated ILI	Respiratory HAI	Hospital-associated ILI	Respiratory HAI	Hospital-associated ILI
Medical	4.4	4.2	11.5	1.4	4.0	3.2	7.1	2.6
Pediatrics	6.5	5.6	21.5	6.5	3.0	2.6	8.4	4.4
ICU	21.9	2.5	111.6	0.0	NA*	NA	33.0	2.2
Overall	8.4	4.7	13.3	2.6	4.6	3.8	9.2	3.6

HAI, hospital-associated infection; *ICU*, intensive care unit; *ILI*, influenza-like illness; *KNH*, Kenyatta National Hospital; *MDH*, Mbagathi District Hospital; *NA*, not applicable; *NNPGH*, New Nyanza Provincial General.
*MDH has no ICU.

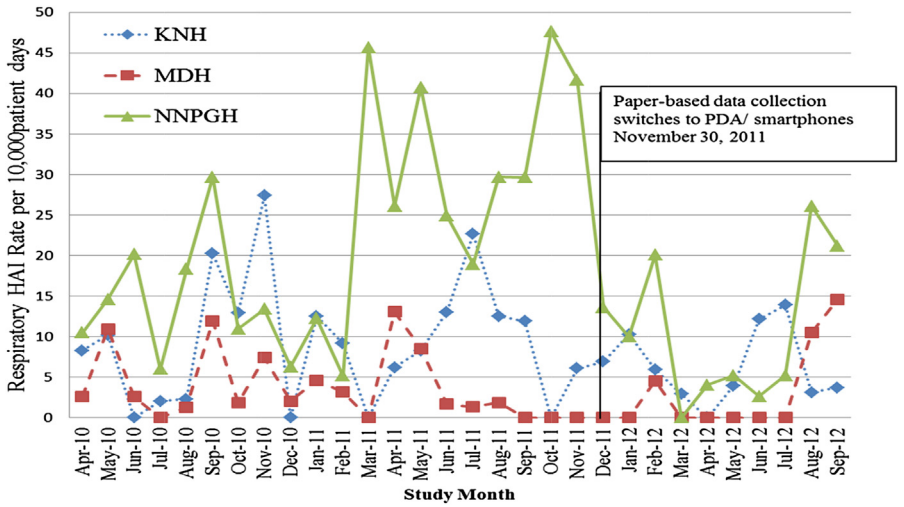

Fig 1. Overall respiratory HAI incidence reported per 10,000 patient days by hospital, Kenya, 2010-2012. *HAI*, health care–associated infection; *KNH*, Kenyatta National Hospital; *MDH*, Mbagathi District Hospital; *NNPGH*, New Nyanza Provincial General; *PDA*, personal digital assistant.

Table 3
Viral pathogens detected among patients with respiratory HAI, Kenya, 2010-2012

Variable	Total respiratory HAI (n = 379)	Respiratory HAI with hospital-associated ILI* (n = 147) n (%)
Samples collected for viral testing†	153 (40.4)	112 (76.2)
Sample results available†	140 (36.9)	103 (70.0)
Any virus*	64 (45.7)	54 (52.4)
Influenza virus A*	13 (9.3)	9 (8.7)
Influenza virus B*	10 (7.1)	8 (7.7)
Adenovirus*	22 (15.7)	19 (18.5)
Respiratory syncytial virus*	17 (12.1)	17 (16.5)
Human metapneumovirus*	6 (4.3)	4 (3.9)
Parainfluenza virus type 1*	4 (2.9)	3 (2.9)
Parainfluenza virus type 2*	2 (1.4)	2 (1.9)
Parainfluenza virus type 3*	18 (12.9)	16 (15.3)
Multiple viruses detected	20 (14.2)	17 (16.5)

NOTE. Values are n (%).
HAI, hospital-associated infection; *ILI*, influenza-like illness.
*Denominator for the percentage reported is the number of cases that were swabbed with results available.
†Denominator for the percentage reported is the number of cases meeting the case definition.

Among the 54 ILI cases with any virus identified, 53 (98.2%) were <18 years old, and 20 (37.0%) were <1 year old.

From the 232 rHAI cases that did not meet the definition for hospital-associated ILI, we collected a convenience sample of 37 specimens of which 10 (27%) were positive for at least 1 viral pathogen. Of these, 6 specimens were identified from the 69 non-ILI rHAI cases in the ICUs. The remaining 4 specimens were identified from the 90 non-ILI rHAI cases in the pediatric wards. Overall, 92.2% of all positive specimens were from patients <18 years old.

Of the 351 patients with at least 1 case of rHAI, 207 (59.0%) were discharged from the hospital, 78 (22.2%) died, 36 (10.3%) transferred, 16 (4.6%) absconded, and 14 (4.0%) were still in the hospital at the final date of data collection. Of the 78 patients who died, 41 (52.6%) of the deaths occurred within 7 days of a new rHAI case (Table 4). Overall, 10 (58.8%) of the rHAI patients >65 years old died in the hospital; of those, 6 died within 7 days of having an rHAI. The proportion of death within 7 days among patients with at least 1 case of rHAI was highest in the ICUs and lowest in pediatric settings (16.4% vs 9.6%, $P = .0001$). Fewer patients who had an identified virus died within 7 days (4.9%) compared with patients who did not have any virus identified (9.9%, $P = .007$). Among rHAI patients, having a hospital-associated ILI was not significantly associated with death (Table 4).

DISCUSSION

In this study we report the first, to our knowledge, systematically collected surveillance data in East Africa to estimate the incidence and viral etiology of rHAI illness. At 3 hospitals in Kenya, over half of the rHAIs and two thirds of the hospital-associated ILI cases were identified in pediatric wards. Incidence of rHAI was highest in ICUs, whereas incidence of hospital-associated ILI was highest in pediatric wards. Nearly all of the virus-positive hospital-associated ILI cases occurred in patients <18 years of age, suggesting that virus transmission among infant and child patients is

Table 4
Characteristics of patients that died within 7 days of respiratory health care–associated infection and patients who died after 7 days among 337 patients with at least 1 respiratory health care–associated infection case with outcome information available (ie, not in hospital at time of final data collection)

Variable	Total (n = 337)	Died <7 days (n = 41, 12.2%)	Died ≥7 days (n = 37, 11.0%)	Died all (n = 78, 23.1%)
Sex				
Male	203	23 (11.3)	19 (9.4)	42 (20.7)
Female	134	18 (13.4)	18 (13.4)	36 (26.9)
Age, years				
<1	59	7 (11.9)	4 (6.8)	11 (18.6)
1-17	128	11 (8.6)	9 (7.0)	20 (15.6)
18-49	113	14 (12.4)	17 (15.0)	31 (27.4)
50-64	20	3 (15.0)	3 (15.0)	6 (30.0)
≥65	17	6 (35.3)	4 (23.5)	10 (58.8)
Ward type				
ICU	61	10 (16.4)	14 (23.0)	24 (39.3)
Medical	109	15 (13.8)	15 (13.8)	30 (27.5)
Pediatrics	167	16 (9.6)	8 (4.8)	24 (14.4)
Any influenza-like illness				
Yes	138	13 (9.4)	15 (10.9)	28 (20.3)
No	186	26 (14.0)	21 (11.3)	47 (25.3)
Any virus identified*,†				
Yes	61	3 (4.9)	6 (9.8)	9 (14.8)
No	71	7 (9.9)	18 (25.4)	25 (35.2)
Length of stay, days				
Median (minimum-maximum)		11 (5-67)	38 (12-244)	NA

NOTE. Values are n (%) or as otherwise indicated.
NA, not applicable.
*Total here is the number of patients who were sampled with results available.
†Viruses were much more commonly detected in the pediatric population.

an important infection control priority. Although virus positivity among rHAI patients in ICUs was lower, the high overall incidence of rHAI in ICUs suggests that both the specificity of the rHAI case definition and the possibility of bacterial rHAI be further evaluated in ICU patients.

At the 3 surveillance hospitals in Kenya, the overall rHAI rate was 9.2 per 10,000 patient days. Although there are few comparable studies documenting incidence rates of rHAIs in these settings, our estimates of an incidence of 8.4 infections per 10,000 patient days in pediatric wards in Kenya are consistent with a study from Canada that reported an incidence of 2.9-15.0 rHAIs per 10,000 patient days[18] in the pediatric population. Our findings are also similar to rHAI incidence rates of 7.9 per 10,000 patient days reported in Germany in 2004 for children <3 years old.[19] One primary risk factor for rHAI was the use of respirators, which were present in the hospitals where both the Canadian and German studies were conducted; respirators were uncommon in our 3 study sites. Although this difference complicates the comparison of our findings with these 2 studies, our findings still provide baseline estimates that have some consistency with rHAI rates observed elsewhere.

There are also some notable differences between our findings and other published studies on rHAIs. A study conducted in Bangladesh in 2011 found the incidence of rHAI to be 5-fold higher than what we have documented in Kenya.[3] This difference could be caused by differences in data collection strategies; in Bangladesh, staff gathered data on all rHAIs by visiting wards daily, whereas in Kenya we gathered data on all rHAIs by visiting the wards twice per week. It is also possible that rates of HAI are significantly higher in Bangladesh than in Kenya because of hospital crowding or possibly because of differences in infection control practices. During the surveillance period we introduced health education sessions to health care providers at the 3 study hospitals to improve infection control practices (eg, hand hygiene). Although the impact of these health education sessions has not been evaluated formally, it is possible that the education sessions led to improvements in infection control in the 3 hospitals, which could also explain why our reported rHAI rates are lower than those reported in Bangladesh.

The percentage of virus-positive samples and the main viruses we identified were similar to findings from recent reports of general acute respiratory illness surveillance in Kenya; a recent study of acute respiratory illness in older children and adults in rural western Kenya showed similar percent-positive results for inpatients in regard to any virus identified (58% compared with 46% presented here), influenza virus A (10% compared with 9% presented here), and RSV (12% compared with 12% presented here).[20] Another study reported similar rates of viral pathogens among infants and children at a rural Kenyan hospital (56% positive for at least 1 virus), a slightly lower percentage of specimens positive for influenza virus A (5.8%), and a higher percentage of RSV-positive samples (5.8%).[21]

In the 30 months of HAI surveillance presented in this study, nearly a quarter of patients with rHAI died while they were in the hospital, and over half of those deaths were within 7 days of being diagnosed with an rHAI. Although this study did not measure death attributable to rHAI, death within 7 days of diagnosis may serve as a proxy indicator.[17] The proportion of rHAI cases with an outcome of death is higher than reported in similar studies. In a Canadian study, 9% of febrile rHAI cases died; in a study from Bangladesh, 2% of rHAI patients died.[3,6] These differences suggest the possibility that our surveillance may have not detected milder cases of HAI; if so, this may also help to explain the differences in rates of rHAI.

Our data have several limitations that reflect the challenges of sustaining surveillance in low resource settings. Data reported here may be an underestimation of rHAI for 2 reasons. First, SOs only visited wards at the most 2 days per week; therefore, they relied on chart documentation to measure patient temperatures when they were not at the ward. Wards were understaffed, and thermometers were scarce; as a result, temperatures were measured and recorded inconsistently in hospital charts. Therefore, rHAI cases were likely missed. To address some of these issues, we supplied the surveillance wards with digital thermometers and encouraged the ward nurses to record temperatures. In addition, we likely missed a number of etiologies of rHAIs because we only tested for some viruses and did not test for bacteria. Further, we did not follow-up on any patients following discharge from the wards who may have

developed symptoms from new infections after discharge from the hospital. Finally, although we chose 3 different kinds of hospitals (national, provincial, district), our results may not be representative of all hospitals in Kenya.

To draw on these limitations, lessons learned from the establishment of this surveillance suggest that future routine HAI surveillance will require more consistent temperature monitoring by the ward staff and improved documentation of fever on patient charts. Also, none of the 3 hospitals had any dedicated infection control nurses. Dedicated infection control staff who have continual support from the hospital administration and ward staff can promote HAI awareness and support HAI surveillance efforts.

In conclusion, a new surveillance system for rHAI in 3 hospitals in Kenya showed that rHAI occurred consistently during a 30-month period in the pediatric and medical wards and ICUs of 3 hospitals in rates similar to those described in other developing countries. Most ILI cases tested were positive for at least 1 viral pathogen. Infection control measures should be strengthened in Kenyan hospitals, and continued HAI surveillance will be important to monitor the burden of HAIs and the impact of future infection control interventions.

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