

## CONCISE COMMUNICATION

## Incidence Rates of Healthcare-Associated Infection in a Pediatric Home Healthcare Service

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We describe the incidence rates of home healthcare-associated infections (HHAIs) in a pediatric home healthcare service (PHHCS). The overall incidence density of HHAs was 11.1 infections per 1,000 patient-days. Average incidence density of ventilator-associated pneumonia (VAP) was 6.8 per 1,000 ventilator-days. Strategies for control of VAP should be prioritized in PHHCSs.

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An estimated 1,459,900 patients received home healthcare assistance per day in the United States in 2007.<sup>1</sup> Although estimates for the pediatric population are lower than for adults, the number of children in home healthcare services (HHCS) is increasing worldwide.<sup>2,3</sup> The incidence density rates of home healthcare-associated infections (HHAs) in children are not known, but some data are available.<sup>4,5</sup> Araujo da Silva and colleagues previously reported that pneumonia is the principal cause of hospital readmission in children attended by a pediatric home healthcare service (PHHCS).<sup>4</sup> In this article, we describe the incidence density of infections related to a PHHCS and their identified causative agents.

### METHODS

We studied all patients (0–21 years) assisted for more than 24 hours between January 2008 and June 2009 by the PHHCS of Prontobaby Children's Hospital, a private pediatric hospital in Rio de Janeiro, Brazil. The healthcare assistance was performed at least 12 hours per day by a nurse and a weekly visit by a physician in the patient's home. Other healthcare specialists (physiotherapists or speech specialists) visited patients when necessary. All parents gave written consent for their children to participate in the study, which was approved by local institutional review board. The Infection Control Committee reviewed all PHHCS infection control protocols and gave periodic infection control training to physicians and nurses.

Surveillance of HHAI was performed by an infection control practitioner who performed weekly analysis of patient data collected daily by a nurse using an adaptation of the National Healthcare Safety Network's (NHSN) methodology.<sup>6</sup>

The adaptation concerned weekly, rather than daily, analysis of patients' medical records. The HHAI criteria were those recommended by APIC-HICPAC for home healthcare,<sup>7</sup> with the inclusion of the following criteria for tachypnea: respiratory frequency higher than 50 breaths per minute for children aged 2–12 months and higher than 40 breaths per minute for children aged 1–5 years.

Multidrug-resistant bacteria were identified according to published criteria.<sup>8</sup> Routine screening for multidrug-resistant bacteria colonization was not performed in the PHHCS. Multidrug-resistant bacteria were investigated through clinical samples and rectal swabs when required by physicians in PHHCS or were systematically collected during readmissions to Prontobaby Hospital.<sup>4</sup>

Demographic variables were analyzed by descriptive statistics using EPI INFO (ver. 6.04; Centers for Disease Control and Prevention). Satterthwaite and  $\chi^2$  tests were used to compare means and proportions. A 2-sided *P* value of .05 or less was considered statistically significant.

### RESULTS

Thirty-one patients (16 males) were studied; average age at admission was 55 months (range, 4–231 months; median, 39 months). Cerebral palsy and bronchopulmonary dysplasia were principal causes of admission to PHHCS.<sup>4</sup> Mechanical ventilation was required in 9 patients (29%), whereas other invasive devices were never required.

The average incidence density of HHAI was 14.4 infections per 1,000 patient-days from September through December 2008, whereas it was 10.6 infections (*P* = .03) and 9.8 per 1,000 patient-days (*P* = .009) during January through August 2008 and 2009, respectively (Figure 1). Respiratory infections were the main causes of infections (74/129 [57%]), even in the period of higher HHAI rates (September–December 2008).

We observed 23 cases of ventilator-associated pneumonia (VAP), with 3,394 invasive ventilator-days, an average ventilator utilization ratio of 29% (range, 23%–39%), and an average incidence density of 6.8 VAP cases per 1,000 ventilator-days. There was no statistically significant difference (*P* = .66) in the incidence density of VAP between 2008 and 2009 (7.1 and 6 VAP cases/1,000 ventilator-days, respectively), although the average ventilator utilization ratios were 31% in 2008 and 26% in 2009 (*P* = .08).

The etiologies of HHAI were identified in 11% (14/129) of infections (Table 1). None of the gram-negative bacteria had a multidrug-resistant profile, but 10% (3/31) of patients had multidrug-resistant bacterial colonization probably acquired during their PHHCS stays.<sup>4</sup>

Causes of death, which gives us the overall mortality rate

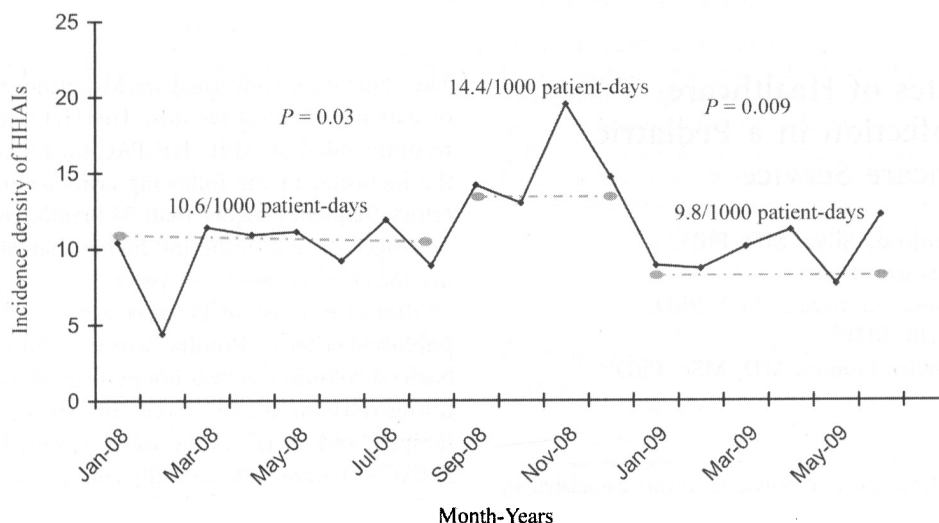


FIGURE 1. Incidence density (per 1,000 patient-days) of home healthcare-associated infections (HHAI), pediatric home healthcare service of Prontobaby Children's Hospital, Rio de Janeiro, between January 2008 and June 2009. The solid lines show the average incidence rates of HHAI for the periods. *P* values for the difference among periods of higher and lower HHA rates are shown.

of 9.7% and the HHA-attributable mortality rate of 6.5%, were previous described (Table 1).<sup>4</sup>

## DISCUSSION

Criteria and preventive measures for HHA come from definitions or recommendations designed for hospitals, and these are frequently not useful for HHCS.<sup>7</sup> This is especially important in view of the unusual nature of this medical care, in which clinical staff fully interact and participate in the routine of family life, which does not occur in hospitals. Another poorly recognized aspect of home healthcare assistance is the risk of transference of microorganisms from hospital to the community through, for example, medical equipment or healthcare professionals serving as carriers. The patients themselves are probably the main reservoir of microorganisms, and despite their transference from hospital to home they are still dependent on invasive devices.

To the best of our knowledge, this is the first study that seeks to qualify and quantify HHA in a PHHCS. Pneumonia and influenza-like illnesses accounted for more than 50% of all HHAI, and VAP was the only cause of device-associated infections, because other devices were not required in our studied population. The anatomic changes of the thorax (scoliosis, kyphosis, and kyphoscoliosis) and chronic bedridden conditions may have contributed to their acquisition of respiratory infections. VAP rates were higher than those tabulated by NHSN for pediatric critical units<sup>5</sup> and for adults in HHCS, although the attributable mortality rates were similar.<sup>8</sup> This result is in itself surprising, indicating a high risk for VAP in PHHCS. Despite using a different population and methodology for surveillance and diagnosis of VAP, the comparison with the NHSN rates, although not adequate, may

serve as initial reference to emphasize the importance of establishing measures for VAP prevention in PHHCSs.

HHCSs have been considered cost-effective alternatives for patients with chronic diseases and those dependent on invasive devices in hospitals.<sup>9</sup> However, analysis of overall incidence density of HHA in our study showed rates of VAP comparable to nosocomial rates. Therefore, patients assisted in home healthcare require specific conduct standards: quality control of equipment and devices, cleanliness of the home, training in infection control for parents or caregivers,<sup>10</sup> and standards for circulating healthcare professionals, who most often also work at hospitals. HHA rates declining in 2009 was probably due to initial intervention after preliminary findings with hiring an administrative employee and standardization of procedures.

In this real-life study, the etiological agents were identified in only 11% of HHAI, and gram-negative bacteria were the most identified cause of infections. The criteria for HHA on the basis of clinical findings only, without complementary examinations, were insufficient for the diagnosis of infections. Microbiological and imaging examinations are difficult to perform in home settings, but they are nonetheless important and should be included. Additionally, although the infection criteria defined by the Association for Professionals in Infection Control and Epidemiology on the basis of clinical diagnoses of infections have practical advantages, it is also necessary to include other clinical parameters as we did for pneumonia. Another point is the difficulty to differentiate community infections from HHA (all were considered as HHA in our study). Moreover, besides the small sample size, HHA surveillance was performed by the infection control practitioner weekly in patients' homes, although data were

TABLE 1. Incidence Density and Etiology of HHAI in 31 Patients, Pediatric Home Healthcare Service of Prontobaby Children's Hospital, between January 2008 and June 2009

Types of infections	HHAI	Incidence density of HHAI per 1,000 patient-days <sup>a</sup>	Identified agents of HHAI (no. of cases)
Non-VAP	32 (24.8) <sup>b</sup>	2.7	...
VAP	23 (17.8)	6.8 <sup>c</sup>	<i>Pseudomonas</i> sp. (1) <sup>d</sup> <i>Proteus</i> sp. (1) <sup>d</sup> <i>Enterobacter</i> sp. (1) <sup>d</sup>
Influenza-like illnesses	19 (14.7)	1.6	...
Cutaneous infections	18 (14.0)	1.6	<i>Candida</i> spp. (2)
Urinary tract infections	15 (11.6) <sup>b</sup>	1.3	<i>Klebsiella pneumoniae</i> (3) <i>Escherichia coli</i> (2) <i>Morganella morganii</i> (2)
Conjunctivitis	9 (7.0)	0.8	...
Other infections	13 (10.1)	1.1 <sup>b</sup>	
Bloodstream infections	1	0.08	Coagulase-negative staphylococci (1)
Gastroenteritis	4	0.3	Rotavirus (1)
Oral infections	4	0.3	...
Otitis	4	0.3	...
Total	129 (100)	11.1	...

Note. Data are no. (%) of participants, unless otherwise noted. HHAI, home healthcare-associated infections; VAP, ventilator associated pneumonia.

<sup>a</sup> During readmissions to the hospital, patients were excluded for the calculation of number of patient-days.

<sup>b</sup> One case of death related to this type of infection.

<sup>c</sup> Per 1,000 ventilator-days.

<sup>d</sup> Tracheal aspirate.

collected daily by healthcare workers. This latter discrepancy may have contributed to the lack of the diagnoses for short-term infections, and both conditions represent limitations of this study.

In conclusion, preventive measures that focus on health-care-associated pneumonia are of great importance for children in HHCS. The use of written protocols and continuous training of the entire assisting team (including parents and caregivers) are recommended. Further studies should focus on dynamics of multidrug-resistant bacteria acquisition to better determine, for example, requirements for contact precautions for patients in PHHCS.

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