Journal of Hospital Infection 94 (2016) 364–372

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevierhealth.com/journals/jhin

Burden, spectrum, and impact of healthcare-associated infection at a South African children's hospital

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ARTICLE INFO

Article history:
Received 27 June 2016
Accepted 25 August 2016
Available online 1 September 2016

Keywords:
Paediatrics
Healthcare-associated infection
Infection prevention
Sub-Saharan Africa
Nosocomial infection
Antimicrobial resistance

SUMMARY

Background: In most African countries the prevalence and effects of paediatric healthcare-associated infection (HCAI) and human immunodeficiency virus (HIV) infection are unknown.

Aim: To investigate the burden, spectrum, risk factors, and impact of paediatric HCAI by prospective clinical surveillance at a South African referral hospital.

Methods: Continuous prospective clinical and laboratory HCAI surveillance using Centers for Disease Control and Prevention (CDC)/National Healthcare Safety Network (NHSN) definitions was conducted at Tygerberg Children's Hospital, South Africa, from May 1st to October 31st in 2014 and 2015. Risk factors for HCAI and associated mortality were analysed with multivariate logistic regression; excess length of stay was estimated using a confounder and time-matching approach.

Findings: HCAI incidence density was 31.1 per 1000 patient-days (95% CI: 28.2–34.2); hospital-acquired pneumonia (185/417; 44%), urinary tract infection (UTI) (45/417; 11%), bloodstream infection (BSI) (41/417; 10%), and surgical site infection (21/417; 5%) predominated. Device-associated HCAI incidence in the paediatric intensive care unit (PICU) was high: 15.9, 12.9 and 16 per 1000 device-days for ventilator-associated pneumonia, central line-associated BSI and catheter-associated UTI, respectively. HCAI was significantly associated with PICU stay (odds ratio: 2.0), malnutrition (1.6), HIV infection (1.7), HIV exposure (1.6), McCabe score 'fatal' (2.0), comorbidities (1.6), indwelling devices (1.9), blood transfusion (2.5), and transfer in (1.4). Two-thirds of paediatric deaths were HCAI-associated, occurring at a median of four days from HCAI onset with significantly higher crude mortality for HCAI-affected vs HCAI-unaffected hospitalizations [24/325 (7.4%) vs 12/1022 (1.2%); $P < 0.001$]. HCAI resulted in US$371,887 direct costs with an additional 2275 hospitalization days, 2365 antimicrobial days, and 3575 laboratory investigations.

Conclusion: HCAI was frequent with significant morbidity, mortality, and healthcare costs. Establishment of HCAI surveillance and prevention programmes for African children is a public health priority.

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http://dx.doi.org/10.1016/j.jhin.2016.08.022
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Introduction

Healthcare-associated infection (HCAI) is the most frequent complication of hospitalization affecting 4–8% of paediatric admissions in high-income settings.[1–5] In most African countries, paediatric HCAI burden, spectrum, and impact is unknown and the influence of human immunodeficiency virus (HIV) infection is unquantified.[6,7] South Africa similarly lacks data on HCAI prevalence and impact, despite a comparatively better-resourced health sector with access to microbiology laboratories and infection prevention personnel at many hospitals.[8]

South African data on 'whole house' surveillance for paediatric HCAI was last published almost three decades ago. A single-centre study (at the country's largest hospital) reported HCAI rates of 14.3% and 22.4 HCAI events per 100 admissions with gastrointestinal and respiratory tract infections predominating.[9] A small study in a paediatric intensive care unit (PICU) determined HCAI prevalence rates of 43%; both studies identified *Staphylococcus aureus* and *Klebsiella pneumoniae* as the predominant nosocomial pathogens.[9,10] In 2005, a one-day HCAI point prevalence study at six hospitals established a prevalence of 9.7% for four HCAI types: bloodstream (BSI), urinary tract (UTI), respiratory tract (RTI) and surgical site (SSI) infections ($N = 2652$ adult and paediatric patients). Highest HCAI prevalence was recorded for patients admitted to ICU and paediatric wards (28.6% and 16.5%, respectively). The spectrum of HCAI types varied markedly by discipline and age, with paediatric patients experiencing higher rates of BSI and RTI.[11,12]

Studies of paediatric inpatients in other low/middle-income countries (LMIC) since 2000 also document substantial HCAI prevalence and incidence densities: 22.6% and 29 per 1000 patient-days in Indonesia, 15.4% and 9.2 per 1000 patient-days in Brazil, 15 per 1000 patient-days in Mexico and 21% in Uganda.[13–16] Risk factors for paediatric HCAI identified in these settings include malnutrition, prolonged hospital stay, use of indwelling devices, PICU admission, non-surgical disease, RTI on admission, blood transfusion, and young age.[9,10,13–17] HCAI infection density is even higher in the paediatric ICU setting, with greater contribution of device-associated HCAI including ventilator-associated pneumonia (VAP), central line-associated BSI (CLABSI), and catheter-associated UTI (CAUTI). In 2012, the International Nosocomial Infection Control Consortium (INICC) reported VAP, CLABSI, and CAUTI rates from 16 LMIC PICUs of 6, 8.1, and 4.1 infections per 1000 device-days, respectively, vs rates reported from US PICUs of 0.7, 1.0, and 3.5, respectively.[18,19] Although the INICC device-associated HCAI rates far exceed rates in high-income settings, the true burden is probably even higher as 75% of INICC PICUs were located in private hospitals.

Few studies of paediatric HCAI in resource-limited settings have included estimations of HCAI impact beyond additional hospital stay and mortality. Excess mortality attributable to nosocomial vs community-acquired BSI has been reported in two African paediatric cohorts from Kenya (53% vs 24%) and South Africa (25% vs 16%).[17,20] The extreme paucity of data from paediatric inpatients in Sub-Saharan Africa limits estimation of HCAI impact on childhood mortality and healthcare costs. This article investigates burden, spectrum, risk factors, and impact of paediatric HCAI measured by prospective clinical surveillance at a South African referral hospital.

Methods

Setting

The Tygerberg Children's Hospital (TCH) in Cape Town, South Africa has 300 paediatric beds in a 1384-bedded academic hospital complex. Sick neonates, infants and children (0–14 years) are admitted to 13 neonatal and paediatric wards (including surgical, medical generalist, specialty, and intensive care facilities); critically ill children requiring ventilation or inotropic support are managed in the 10-bed medical/surgical PICU (neonates are managed in a separate 12-bed neonatal ICU). There are ~17,000 neonatal and paediatric admissions to TCH annually; bed occupancy rates were 93% (PICU), 92% (general wards), and 87% (subspecialist wards) in 2014/15. The burden of community-acquired infectious diseases is high, with HIV, tuberculosis, RTI, and gastroenteritis predominating. In 2013, the antenatal HIV prevalence in the Western Cape Province was 19% (vs 30% nationally) and HIV prevalence among children (2–14 years) was 0.7% (vs 2.4% nationally).[21]

Investigation and management of HCAI at Tygerberg Children's Hospital

Current standard practice for investigation of patients with suspected HCAI (new-onset fever or clinical deterioration ≥48 h after admission) is submission of blood culture and other clinically indicated samples at the attending clinician's discretion. Empiric treatment of HCAI at TCH includes meropenem, or ertapenem if *Pseudomonas aeruginosa* is considered unlikely and meningitis is excluded. Vancomycin is added if meticillin-resistant *Staphylococcus aureus* (MRSA) is likely, e.g. with suspected central line or soft tissue infection. There were no significant changes in clinical practice, laboratory investigations, empiric antibiotic treatment, infection prevention practice, isolation facility availability or major outbreaks of community- or hospital-acquired infection during the study periods.

Study design

Prospective clinical surveillance for HCAI events meeting 2013 CDC/NHSN surveillance definition criteria was conducted in three paediatric wards: subspecialist infectious diseases/gastroenterology/cardiology (A), general paediatrics (B), paediatric surgery (C), and the PICU (neonatal wards were not included).[22] Demographics, admissions history, laboratory investigations, antimicrobial prescription data and information on any HCAI event(s) were collected on weekdays for all patients admitted ≥48 h or transferred in from another facility between May 1st, 2014 to October 31st, 2014 (A) and May 1st, 2015 to October 31st, 2015 (B, C, PICU). At the end of each six-month study period, children still hospitalized were followed-up for an additional four weeks, or until discharged. We calculated weight-for-age *Z*-scores (WAZ) using WHO anthropometric reference data, and defined severe acute malnutrition as WAZ score of less than −3 standard deviations (SD).[23] We included all surgical procedures for patients hospitalized ≥48 h. Ethical approval and waiver of individual informed consent was obtained from the Human Health Research Ethics committee of Stellenbosch University (S13/09/171).

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