CLINICAL UPDATE

A framework for preventing healthcare-associated infection in neonates and children in South Africa

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Healthcare-associated infection (HAI) is a frequent and serious complication affecting 4 - 8% of hospitalised children and neonates in high-income countries. The burden of HAI in South African (SA) paediatric and neonatal wards is substantial but underappreciated, owing to a lack of HAI surveillance and reporting. Maternal and child health and infection prevention are priority areas for healthcare quality improvement in the National Core Standards programme. Despite increasing recognition in SA, infection prevention efforts targeting hospitalised children and neonates are hampered by health system, institutional and individual patient factors. To ensure safe healthcare delivery to children, a co-ordinated HAI prevention strategy should promote development of infection prevention norms and policies, education, patient safety advocacy, healthcare infrastructure, surveillance and research. We present a framework for SA to develop and expand HAI prevention in hospitalised neonates and children.

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Healthcare-associated infection (HAI) is the most frequent complication of hospitalisation, contributing to morbidity, excess mortality and increased healthcare costs.[1-3] Although the neonatal and paediatric HAI burden is well described in high-income settings (4 - 8% prevalence),[4,5] the HAI burden in most African countries is unquantified. In a meta-analysis of HAI in low-middle-income countries (LMIC), the World Health Organization (WHO) identified only three studies of neonatal/paediatric HAI from Africa between 1995 and 2008 (none from South Africa (SA)).[6] Prior and subsequent to the WHO meta-analysis, five publications have established HAI risk factors for hospitalised children in African settings, including malnutrition,[7-9] prolonged hospital stay,[7,10] use of indwelling devices,[9,11] paediatric intensive care unit (PICU) admission,[9] blood transfusion,[8,9] young age,[7,10] underlying comorbid diseases, HIV infection, and HIV-exposed, uninfected status.[9]

HAI epidemiology in hospitalised SA children and neonates

The epidemiology of paediatric and neonatal HAI in SA is poorly documented. Literature describing neonatal HAI is extremely limited, reporting healthcare-associated bloodstream infection (HA-BSI) only; an HA-BSI incidence of 4/1 000 and 14/1 000 patient days was reported from two tertiary hospitals – in Cape Town and Johannesburg, respectively.[12,13] Among paediatric inpatients in Cape Town, HA-BSI rates of 1.6/1 000 patient days were recorded, with excess mortality attributable to hospital- v. community-acquired BSI (25% v. 16%).[14] In 1987, prospective surveillance of two paediatric wards at Chris Hani Baragwanath Hospital, Johannesburg established an HAI prevalence of 14.3%, with a predominance of gastrointestinal and respiratory tract infections.[7] At the PICU at King Edward Hospital, Durban, SA, an HAI prevalence of 43% was reported in 1992.[10] A 1-day point prevalence study of 2 652 adults and children at six Gauteng hospitals established a pooled HAI prevalence of 9.7% for BSI, urinary tract, respiratory tract and surgical site infections. Children had higher HAI rates overall (16.5%), and a greater prevalence of BSI and respiratory tract infections.[15,16] Recent prospective clinical surveillance at Tygerberg Children's Hospital paediatric wards and the PICU documented an HAI prevalence of 24%, with hospital-acquired pneumonia and HA-BSI predominating. HAI incidence density was highest in the PICU (94 v. 22/1 000 patient days in wards).[9] PICU device-associated infection densities were double those reported from PICUs in other LMIC.[9,17] Two-thirds of all in-patient mortality occurred in association with HAI, with crude mortality 6-fold higher (7.4%) than among HAI-unaffected hospitalisations. HAI-affected patients also had three-fold higher rates of hospital readmission within 30 days. HAI events incurred substantial direct costs (ZAR5.6 million) and an excess of 2 275 hospitalisation days, 2 365 antimicrobial days, and 3 575 laboratory investigations in four wards over 6 months.[9]

The changing landscape of HAI prevention in SA

A national healthcare quality improvement programme launched in 2012 introduced annual facility audits to benchmark public and private institutions against 'national core standards (NCS) for healthcare establishments'.[18] In addition, the Office of Health Standards Compliance was established to guide NCS implementation and to act as a national healthcare licensing and accreditation body. Despite a renewed focus on infection prevention (IP) and HAI surveillance, data on HAI burden and epidemiology in SA are extremely limited. Although the development of IP standards is laudable, much greater resources and technical expertise (in healthcare epidemiology, IP and data management) are required

to achieve data-driven improvement in HAI prevention services. Furthermore, implementation of HAI prevention in the SA healthcare context is complex, with multiple challenges to IP programmes at health system, institutional and patient level (Table 1).

A proposed framework for neonatal and paediatric HAI prevention in SA

Programmes to establish safe and high-quality delivery of healthcare to SA children require a co-ordinated HAI prevention strategy, informed by local surveillance and research. An important goal is to ensure that limited IP resources (at national, provincial and institutional level) are directed at the most common HAI events and populations at greatest risk. Prevention should employ a holistic, integrated approach incorporating policy development, IP education, patient safety advocacy, infrastructure development, surveillance and research. Table 2 outlines the major components and proposed content of a paediatric/neonatal HAI prevention framework for SA. Table 3 lists the key national, provincial and institutional partners for developing and implementing the proposed framework.

HAI prevention policies and guidelines

Given their vulnerability to infection and the burden of community-acquired infection in hospitalised neonates and children, explicit recommendations on IP norms and standards are needed. Locally adapted IP guidelines and policies would assist paediatric and neonatal clinical managers to ensure implementation of best practices. One example where HAI prevention guidance is needed is for cleaning and disinfecting the healthcare environment, e.g. isolation rooms, incubators, and shared equipment. The risk of pathogen transmission and hospital outbreaks after ineffective cleaning of the patient environment is well recognised.[20-22] Despite widespread implementation in high-income settings, few SA healthcare facilities have guidelines on environmental cleaning and even fewer perform routine assessment of cleaning adequacy.[23] A study comparing methods for evaluation of paediatric isolation room terminal cleaning, identified fluorescent markers as an inexpensive option for cleaning assessment, which also allows for provision of immediate visual feedback to cleaning personnel.[23] Other important topics include: staffing norms for IP and paediatric staff; management of patient isolation facilities; hand hygiene and personal protective equipment; HAI surveillance and reporting; outbreak investigation recommendations and reporting; antimicrobial usage and restriction; and staff vaccination.

Education, training and advocacy for patient safety

Surveys of SA healthcare workers and data from the first NCS audit show the need for improved in-service and undergraduate health

Table 1. Challenges to HAI prevention in hospitalised children and neonates*

Health systems factors	Healthcare environment factors	Patient factors
Competing health priorities	Overcrowding	Malnutrition
High burden of community-acquired infections	High patient-to-staff ratios	HIV exposure and HIV infection
Few resources for IP implementation	Lack of IP provisions and consumables	Prematurity
Lack of HAI surveillance programmes and reporting	Lack of isolation facilities	Chronic diseases
Lack of IP policies	Ageing infrastructure	High device utilisation rates
Lack of IP training for healthcare workers	Inadequate environmental cleaning	High antimicrobial usage
Lack of a co-ordinated research agenda for HAI prevention	Re-use and sharing of devices and equipment	
	Lack of a patient safety focus and institutional culture	

*Adapted from Rothe *et al.*[19]

Table 2. Framework for HAI prevention in SA child health services

Component	Example of core content
Policies and guidelines	IP norms and standards for outpatient and inpatient settings, with a specific focus on paediatric and neonatal populations; guideline documents for paediatric/neonatal wards and clinics, e.g. patient isolation recommendations, guidelines on personal protective equipment use, environmental cleaning methods and assessment, antimicrobial restriction policies
Education, training and advocacy for patient safety	A national core curriculum on IP and HAI prevention for undergraduate health science and nursing students (with additional neonatal/paediatric content); minimum topics/frequency of in-service training for all healthcare workers; standard in-hospital instructions for caregivers on basic IP control measures; national and provincial IP champions to lead education, advocacy and research; institutional buy-in from managers and departmental heads of department to prioritise safe care of children; collaboration within existing structures, e.g. IP and quality improvement committees
Provisions and infrastructure	Building norms for new and renovated neonatal and paediatric services, including consensus on a recommended ratio of single (isolation) to cohort beds, e.g. 1:2, and requirement for negative-pressure ventilation (with either natural or mechanical ventilation to achieve at least 12 air changes per hour); basic provisions for HAI prevention, e.g. soap, water, alcohol handrub, personal protective equipment
Surveillance and research	Develop recommendations for HAI surveillance methods, frequency and targets, e.g. HAI burden, spectrum, risk factors, distribution by ward/facility type and associated antimicrobial use; outbreak reporting; addition of HAI to existing morbidity and mortality registers; identification of key research questions to improve HAI implementation

Table 3. Key partners for HAI prevention framework development and implementation

Level	Key stakeholders and partners
National	The National Department of Health, Quality Assurance Directorate and Office of Health Standards Compliance South African Society for Paediatric Infectious Diseases South African Paediatric Association Infection Control Society of Southern Africa National Institute of Communicable Diseases (soon to be the National Public Health Institute of South Africa) United South African Neonatal Association (USANA) The Neonatal Nurses Association of South Africa (NNASA) The Society of Midwives of South Africa (SOMSA) The South African Antibiotic Stewardship Programme (SAASP) Best Care … Always (BCA) campaign National Health Laboratory Service (NHLS) and other laboratories MRC Burden of Disease Unit
Provincial	Department of Health's provincial communicable disease teams Department of Health's provincial mother and child health (MCH) directorates District Health specialist teams (in obstetrics and paediatrics) University departments of paediatrics and child health, public health, infectious diseases, microbiology, virology and infection prevention
Institutional	Facility medical and nursing managers Infection prevention and control committees Antimicrobial stewardship committees Health and safety teams Quality improvement structures Primary healthcare networks (using existing structures for PMTCT, TB, EPI)

MRC = Medical Research Council; PMTCT = prevention of mother-to-child transmission of HIV; EPI = expanded programme on immunisation.

science training in IP.[24-27] Development of harmonised IP curricula for all cadres of SA healthcare workers is needed, including recommendations on minimum training duration, core topics and competency evaluation. As risks and routes of infection transmission vary by population, additional content on paediatric and neonatal-specific risks would be needed, e.g. infant feeding. In a recent survey of 200 paediatric/neonatal medical and nursing staff at Tygerberg Children's Hospital, several important misconceptions about infection transmission routes and hand hygiene methods were identified.[26] Although 48% of participants considered HAI to be inevitable, there was broad support for punitive measures for staff ignoring infection control recommendations (89%) and for reporting of HAI episodes as adverse events (76%). Multiple opportunities were identified for improvement, including poor uptake of annual influenza vaccination (25%); low rates of N95 respirator fit-testing (28%); and very high presenteeism among doctors (95%), despite the risk of infection transmission to their patients. Participants required greater leadership and shared accountability for IP, acknowledging a weak institutional patient safety culture and climate.[26] From this single-centre study it is clear that there is scope for improved IP education for paediatric/neonatal staff. Moreover, identification of named 'infection prevention champions' in paediatric and neonatal departments who 'model' desired IP attitudes and behaviours, could assist with implementation of best practices and institutional culture change. Basic IP teaching packages and information packs for non-healthcare workers with regular patient contact (volunteers, visitors and caregivers) should also be developed.

Provisions and infrastructure for IP in paediatric/neonatal facilities

In many high-income countries, paediatric wards are designed with single rooms and en-suite facilities to reduce the risk of infection transmission. Ironically, in resource-limited settings, where the infection burden is highest, few or no patient isolation facilities exist.[19] The IP indications for patient isolation are also likely to differ across SA. At Tygerberg Children's Hospital, where isolation room demand consistently exceeded availability, airborne isolation for children with pulmonary TB was the predominant requirement (52%) (with 26% of patients suffering from drug-resistant TB).[28] To date, there are no data on availability of patient isolation facilities or negative-pressure ventilation rooms elsewhere in SA. In renovating and building new children's hospitals in SA, recommendations for the ratio of single to cohort beds, and numbers of airborne isolation beds (whether naturally or mechanically ventilated negative-pressure rooms), must be established. In addition, IP building norms for bed spacing, workflows, provision of handwash basins and sluice rooms, and guidance on other engineering and ventilation issues for neonatal/paediatric wards should be developed.

HAI surveillance and research

HAI surveillance is a key component of effective IP programmes and allows for comparison or 'benchmarking' between healthcare facilities. Despite the NCS requirement for HAI reporting since 2012, few SA healthcare facilities have the resources and expertise to perform comprehensive HAI surveillance.[29] Futhermore, the lack of consensus on HAI surveillance methods in SA prevents direct comparison of data across healthcare facilities. The paucity of data on incidence, spectrum and local determinants of HAI also hampers development of appropriate IP interventions. Given these constraints and variable laboratory investigation testing rates, some feasible alternative surveillance options include use of routinely collected datasets (e.g. discharge coding, microbiology results or antibiotic prescriptions for HAI). A combination of laboratory and antimicrobial usage data at Tygerberg Children's Hospital achieved high sensitivity (85%) and positive predictive values (97%) for HAI determination, requiring substantially less time to collect/analyse than clinical surveillance data.[30]

Additional options to improve HAI surveillance and research in neonatal/paediatric wards include mandatory coding of HAI on patient discharge, transfer or death; and mandatory outbreak reporting and explicit inclusion of HAI in morbidity and mortality estimates (both institutional and provincial, e.g. the Perinatal and Child Healthcare Problem Identification Programmes). It is unlikely that a one-size-fits-all approach to paediatric HAI surveillance in SA will be successful. However, surveillance, even of only one or two parameters, must begin as

soon as possible and be gradually expanded. Undoubtedly, development and maintenance of paediatric HAI surveillance and research networks will be challenging, but the data yielded on disease burden, spectrum, distribution, risk factors and outcome will be invaluable.

Conclusion

The lack of data on neonatal and paediatric HAI in SA has contributed to an underappreciation of the burden and impact of these infections by clinicians, healthcare managers, policymakers and the public. From the limited local data available, HAI causes considerable suffering, mortality and increased healthcare cost in all age groups. To ensure safe and high-quality healthcare for SA children, a framework for a nationally endorsed HAI prevention strategy is needed. The following should be addressed: IP policy and infrastructure development; healthcare worker education; patient safety advocacy; surveillance; and research. Key national, provincial and local stakeholder partners should be actively engaged to develop and implement HAI prevention programmes for hospitalised SA children and neonates.

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