

Addressing Neonatal Nosocomial Infections in a Bangladeshi Hospital Facility: Laboratory Findings and Infection Prevention Control Training for Special Care Newborn Unit Nurses and Physicians

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BACKGROUND

Nosocomial, or hospital-acquired, infections are a major clinical problem, contributing to significant global morbidity and mortality. Neonates (infants under 28 days of age) born prematurely are highly susceptible to infections due to immature immune function and impaired defense mechanisms. High-risk babies require admission to a Special Care Newborn Unit (SCANU) for more intensive, specialized care and treatment. Due to frequent intravenous transfusions and other invasive procedures, infections can be easily transmitted in SCANUs. Other contributing factors for infection transmission include poor hand hygiene, repeated use of instruments without sterilization, overcrowding, understaffing, and insufficient or inconveniently located equipment such as washbasins. Inadequately trained staff and limited resources for refresher training can also increase the risk of cross infection.

In a low middle-income country like Bangladesh, hospitals may struggle to maintain standard infection prevention control practices, increasing the risk of nosocomial infections. Currently, limited data exist on the prevalence of neonatal nosocomial infections and how they contribute to neonatal deaths in Bangladesh.

Child Health and Mortality Prevention Surveillance (CHAMPS) is a network with seven active country sites, including Bangladesh, that aims to better characterize the etiology of under-five deaths through minimally invasive tissue sampling (MITS). CHAMPS' aims include closing gaps in our understanding of causes of neonatal deaths. CHAMPS conducts extensive testing on MITS specimens, examines clinical records, and interviews families about each death. Panels consisting of local experts then review all information to determine causes of death (the "DeCoDe" process). Further descriptions of CHAMPS' foundational methods have been published broadly (Salzberg, 2019) and are available at www.CHAMPShealth.org.

The CHAMPS Bangladesh site began mortality surveillance in October 2018 in Faridpur District, with implementation activities led by the International Center for Diarrheal Disease Research (icddr), an international health research institute in Dhaka, Bangladesh.

According to CHAMPS Bangladesh Determination of Cause of Death (DeCoDe) data, neonatal infections are one of the leading causes of preventable early neonatal death. Of all neonatal deaths determined by the CHAMPS Bangladesh Team, 9% showed infection as an underlying cause and 19% as an immediate cause of death. These findings led the CHAMPS Bangladesh Team to conduct a laboratory investigation to assess environmental bacterial contamination. This was performed by swabbing various sites in the SCANU at Dr. Zahed Memorial Child Hospital (ZMCH), one of three health facilities in the CHAMPS Bangladesh catchment area.

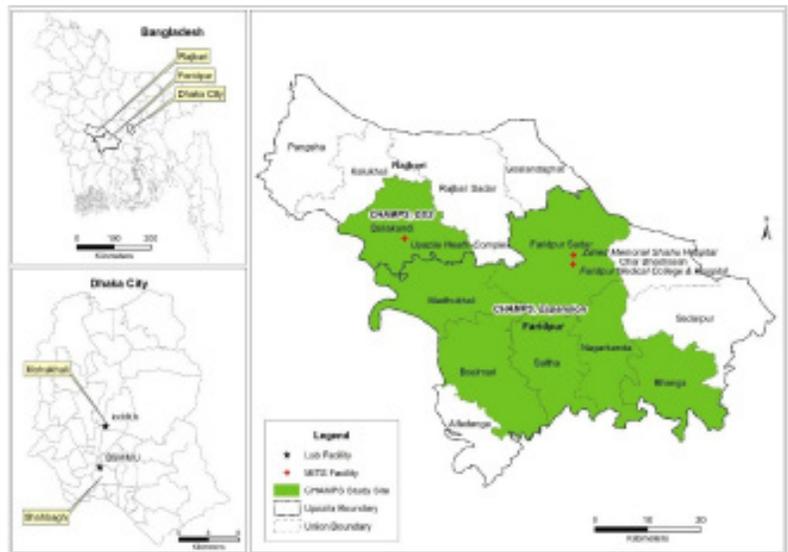


Figure 1. Map of the CHAMPS Bangladesh site and locations of healthcare and laboratory facilities

ZMCH is a private nonprofit hospital in Faridpur Sadar with 200 beds, 50 of which are designated for obstetric patients; the remaining beds are for pediatric patients. ZMCH's SCANU contains 22 incubators for managing severely ill neonates. A total of eight nurses and five support staff run the SCANU. In 2021, the CHAMPS Bangladesh Team conducted a limited laboratory investigation to gain insight into potential pathogenic bacteria present at different locations and on instruments in the SCANU.

METHODS

The Swab Assessment

In September 2021, the CHAMPS Bangladesh MITS Supervisor collected single swabs from 10 sites in the SCANU. Swabbed sites were randomly selected and included desks, hands of nurses, baby beds and bedside railings, as well as a prepared (i.e., ready to use) nasal aspirator and oxygen tube, an entry door and handle, stethoscope, washbasin, toilet tap, floor, medicine tray, and trolley. The collected swabs were preserved in commercially-available Amies Transport Medium, and specimens were transported at 2-8°C to Dhaka, Bangladesh's capital city, within 24 hours of collection.



Image 1. SCANU baby bed



Image 2. Nasal aspirator and suction machine



Image 3. Swabbing medical tray

Table 1. Sites of the collected swab and bacterial growth

Swabbed Sites	Laboratory Findings
1. Hands of on-duty nurse	Insignificant growth
2. Incubator bed and railing	Insignificant growth
3. Nasal aspirator tube	<i>Klebsiella pneumoniae</i>
4. Oxygen tube	Insignificant growth
5. Entry door and handle	Insignificant growth
6. Nurse desk	Insignificant growth
7. Stethoscope	Insignificant growth
8. Basin & tap surface of adjacent toilet in SCANU	<i>Aeromonas caviae, Acinetobacter baumannii</i>
9. Floor	<i>Serratia odorifera, Pantoea spp</i>
10. Medicine tray and trolley	Insignificant growth

Table 2. Antibiotic resistance of bacteria

Source	Nasal aspirator tube		Basin + Toilet		SCANU Floor	
	<i>Klebsiella pneumoniae</i>	<i>Acinetobacter baumannii</i>	<i>Aeromonas caviae</i>	<i>Serratia odorifera</i>	<i>Pantoea spp</i>	
Amikacin	Resistant	Not tested	Resistant	Sensitive	Sensitive	
Amoxiclav	Resistant	Not tested	Resistant	Sensitive	Resistant	
Ampicillin	Resistant	Not tested	Not tested	Not tested	Not tested	
Cefepime	Resistant	Sensitive	Resistant	Sensitive	Sensitive	
Cefixime	Resistant	Sensitive	Not tested	Sensitive	Sensitive	
Cefoperazone/Salbactam	Resistant	Sensitive	Resistant	Sensitive	Sensitive	
Ceftazidime	Resistant	Sensitive	Not tested	Sensitive	Sensitive	
Ceftriaxone	Resistant	Sensitive	Not tested	Sensitive	Sensitive	
Cefuroxime	Resistant	Not tested	Resistant	Resistant	Intermediate	
Ciprofloxacin	Resistant	Sensitive	Resistant	Sensitive	Sensitive	
Colistin	Sensitive	Sensitive	Not tested	Resistant	Sensitive	
Cotrimoxazole	Resistant	Sensitive	Sensitive	Sensitive	Sensitive	
Ertapenem	Resistant	Not tested	Not tested	Sensitive	Sensitive	
Gentamicin	Resistant	Sensitive	Resistant	Sensitive	Sensitive	
Imipenem	Resistant	Sensitive	Sensitive	Sensitive	Sensitive	
Meropenem	Resistant	Sensitive	Not tested	Sensitive	Sensitive	
Nalidixic Acid	Resistant	Not tested	Not tested	Sensitive	Sensitive	
Nitrofurantoin	Resistant	Not tested	Not tested	Resistant	Resistant	
Piperacillin+Tazobactam	Resistant	Sensitive	Resistant	Sensitive	Resistant	
Tigecycline	Resistant	Sensitive	Sensitive	Sensitive	Sensitive	

The Virology Laboratory, which also processes bacterial cultures, inoculated the swabs in blood culture and MacConkey Agar for 24 hours. From the culture plates, colonies that resembled potential pathogens were isolated and characterized using a VITEK 2 system at icddr,b's Clinical Microbiology Laboratory. Disc-diffusion methods were used to determine antimicrobial susceptibility. Finally, the results were analyzed, and the report findings were shared with ZMCH authorities in November 2021.

FINDINGS

Bacterial growth was found in the nasal aspirator tube, washbasin, toilet and floor. Laboratory results showed *Klebsiella pneumoniae* growth in the nasal aspirator tube. At the time, it was found that SCANU nurses used the same nasal aspirator tube several times for admitted babies without sterilization between uses. Another discovery indicated that there was no standard practice for sterilizing instruments, and staff were not aware of the dangers in their routine practices. All admitted babies were under threat of infection due to the single nasal aspirator contaminated with extensive antibiotic resistant bacteria; the only antibiotic to which *Klebsiella pneumoniae* was not resistant was Colistin, an antibiotic that is not approved for treating children.

Alerting Hospital Authorities

These findings emphasize the critical importance of standard instrument sterilization practices in the SCANU. In November 2021, the CHAMPS MITS Team convened with the ZMCH General Secretary and Medical Officer to share these alarming findings. A plan was developed to conduct training for senior level clinical staff focused on the threat of antibiotic resistance, proper sterilization procedures, and the possible role of bacterial biofilms on SCANU instruments. The training program was organized by ZMCH hospital authorities with the CHAMPS Bangladesh Team presenting laboratory findings and providing technical support.

IMPLEMENTING DATA TO ACTION

This extensive, hands-on training was conducted the following month, in December 2021 at ZMCH and focused on Infection Prevention Control (IPC) practices for eight key staff. Two physicians attended as well as six senior staff nurses who supervise other SCANU nurses.

The following training topics were covered:

1. Importance of cross infection prevention in the SCANU ward
2. Laboratory findings from SCANU investigations at ZMCH
3. Nosocomial infection and antimicrobial resistance
4. Best practices to prevent nosocomial infections
5. Common disinfectants and utilization methods
6. Standard of use of nasal aspirators in the SCANU
7. Importance of handwashing, disinfection of utensils, and related health education
8. Basics of biofilm formation
9. Emergence of antibiotic resistance in biofilm
10. Strategies to prevent bacterial biofilm formation

After the training, participants acted as IPC experts and were charged to train other SCANU nurses and physicians.



Images 4 & 5. Senior-level SCANU nurses at IPC training

Training Outcomes and Future Assessment

The CHAMPS Bangladesh Team conducted this training to address urgent hygiene and sterilization issues with SCANU health care providers, stressing the importance of their IPC role and responsibilities. One week after the training, the following changes were observed in clinical practice and procedure:

- Hospital authorities arranged individual nasal aspirators for each SCANU patient. Previously, a single aspirator was used for several neonates.
- Teams practiced proper disinfection procedures after every use of an aspirator tube.
- SCANU nurses and physicians adequately answered questions on IPC procedures, indicating an increase in knowledge.
- Unfortunately, no significant improvement was observed regarding the cleanliness of the basin and tap, both of which looked similar during the initial assessment.

This investigation was limited in scope and served as a pilot test for further investigation and training. The CHAMPS Bangladesh Team will hold a second laboratory investigation to increase the number of swabbed sites and perform observations to evaluate the impact of the training on current routine practices. More strategic sampling and investigation will be useful to better understand the extent of these sanitation issues. Further training will increase awareness among healthcare professionals, encouraging them to maintain microbiologically safe practices. The CHAMPS Bangladesh Team will organize another IPC training, this time engaging support and expertise from the Bangabandhu Sheikh Mujib Medical College's national resource representative and utilizing the country's standardized IPC guidelines. Training provided by these government stakeholders will ensure that participants are trained in line with national guidelines.

CHAMPS Recommendations and Future Actions

Similar laboratory investigations should be done in health facility wards on a regular basis to assess contamination, verify that IPC practices adhere to national guidelines, and determine if refresher training is necessary. Hospital authorities and clinical staff should be immediately notified when laboratory investigations find bacterial growth in health wards, so they can take swift action to protect their vulnerable patients' well-being. Similar laboratory investigations and training will be arranged at other CHAMPS surveillance facilities. These interventions have tremendous potential to decrease neonatal infections and deaths by preventing nosocomial infections.

REFERENCES

Salzberg, N., et al (2019) Mortality Surveillance Methods to Identify and Characterize Deaths in Child Health and Mortality Prevention Surveillance Network Sites. *Clinical Infectious Diseases*. Volume 69, Issue Supplement_4 Pages S262-273. <https://doi.org/10.1093/cid/ciz599>