DOI Link: https://doi.org/10.61586/ebGuG
Vol.410, Issue.10, Part.1, Oct 2025, PP.2-11

The Role of Hospital Surfaces in Transmission of Nosocomial Infections in an Armenia Maternity Hospital

Tigran P. Ugujyan[1,2], Armen Brotgandel[3], David A. Samvelian[3], Shushanna Samvelian[4], Mary M. Ter-Stepanyan[1]

[1]Department of Epidemiology, Yerevan State Medical University after M.Heratsi, Yerevan, Armenia
[2] National Center for Disease Control and Prevention, Yerevan, Armenia
[3]Morsani College of Medicine at the University of South Florida
[4]Saint Louis University School of Medicine
Word Count: 2635 Words

Received Feb 2025 Accepted Sep 2025 Published Oct 2025

Abstract
Background: Nosocomial infections are one of the leading causes of neonatal mortality, especially in Low and Middle-Income Countries. While maternal UTIs and ICU stays are well known risk factors, this study looks at hospital surfaces as well as the bacteria present on mothers' and workers' hands to identify additional sources of infection for nosocomial infections in newborns at hospitals in Yerevan, Armenia. **Methods**: This observational study was conducted at the Research Center of Maternal and Child Health Protection in Yerevan, Armenia, during 2020-2024. Microbial culture samples were taken from departments related to neonates as well as high traffic areas in the hospital (n=1099). Samples from healthcare workers (n=118) and mothers (n=107) were taken from palms, fingertips, and nails. All samples were appropriately cultured and data analysis included t-tests, χ^2 tests, and logistic regression. **Results**: Most of the sampled surfaces were negative for microbial growth (n=1009 (84%)), but 98% of positive cultures could be accounted for by *S. aureus*, *Enterobacter spp.*, and *E. coli*. The maternity hospital had the greatest number of positive samples (26.5%). 52.8% of samples from healthcare workers showed growth of *S. aureus*, *Enterobacter spp.*, and *E. Coli*. 53.3% of samples from mothers' hands showed growth, with 5% of samples also growing *Pseudomonas aeruginosa*. The presence of artificial nails and jewelry on mothers' hands showed a statistically significant increase in bacterial growth. **Conclusion**: This study highlights the need for continued microbiological surveillance and hand hygiene stewardship to understand local epidemiological trends and decrease rates of neonatal infections in Armenia.
Keywords: Surface contamination, hand contamination, health care workers, mothers, standard precautions

Introduction:

Neonatal mortality is a tragic loss of life that causes immense suffering to new parents as well as the hospital staff working to bring this new life into the world. Leading causes of neonatal mortality include prematurity, labor complications, and neonatal infections;(1) while some of these factors are difficult to modify, we must always look for areas of improvement. Infections are one of the modifiable risk factors for neonatal mortality, but healthcare systems around the world vary in the tools, medications, and training they have available to reduce infections.

Nosocomial infections are one of the leading causes of neonatal mortality, and they are particularly worrisome in Low and Middle-Income Countries (LMIC) where 99% of global neonatal mortality occurs.(2) There is currently limited data on the prevalence of nosocomial infections in Armenia itself.(3) Previous studies in Armenia and surrounding countries have found that common types of infection in the ICU setting are ventilator associated infections (VAI), urinary tract infections (UTI), and bloodstream catheter associated infections (BSCAI).(3, 4) For neonatal mortality specifically, the greatest prevalence of infections worldwide is from UTIs which can escalate into sepsis, especially from multiple drug-resistant strains.(5, 6) The strains of bacteria that were most found in these studies were *E. Coli*, *Candida spp*., *Klebsiella spp.*, and *Enterococcus spp*.(5-7) Similar bacteria were found in pregnant women with UTIs that came as a sequela of asymptomatic bacteriuria.(8) *Staphylococcus spp.* are another bacterium of interest that has been found to be the most prevalent bacteria cultured from the blood of neonates that developed sepsis.(9)

The goal of this study is to find the source of these hospital acquired infections, especially in the neonatal and maternity hospital. Several studies have shown that contaminated surfaces in the hospital play a greater role in transmission of infection than previously thought.(10, 11) The greatest evidence for this comes from studies that have shown that a previous occupant with *Vancomycin Resistant Enterococcus*(12) and *Acinetobacter baumannii*(13) were an independent risk factor for future occupants to develop the same infection. The link to patients from surfaces has been hypothesized to be healthcare workers who are less likely to perform hand hygiene after interacting with the environment than with infected patients.(14) In addition to patient room surfaces, this study analyzes maternal hands and whether factors like artificial nails and jewelry are a significant contributor to neonatal infections. By studying the primary contributing factors of nosocomial infections in Armenian hospitals, structural changes can be enacted at the key links of bacterial transmission to reduce neonatal mortality in these settings.

Methods:

Samples were taken at the Research Center of Maternal and Child Health Protection (RCMCHP) in Yerevan, Armenia, during 2020-2024 and sampling locations were chosen based on risk factors, including departments related to neonates (maternity ward, neonatal unit, operating room, peri-operative areas, etc.). Samples were also taken from the hospital environment (cafeteria, sterilization

department, polyclinic). Swabs were collected according to standard microbiological methods using sterile swabs. Samples from healthcare workers' and mothers' hands were taken from the palms, fingertips, and nails. Environmental samples were collected from work surfaces and high-touch areas (faucets, tables, soap dispensers).

Samples were inoculated on standard culture media (e.g., blood agar, MacConkey agar, Mannitol Salt agar, Endo agar). Incubation was performed under appropriate temperature conditions (35-37°C for 24-48 hours). Grown colonies were identified based on morphology and biochemical properties. Antibiotic resistance was determined using the disk diffusion method (Kirby-Bauer) and Minimum Inhibitory Concentration (MIC) testing. Special attention was given to *Methicillin-resistant S. Aureus (MRSA), Carbapenem-resistant Enterobacter spp.*, and strains expressing *Extended-Spectrum Beta-Lactamases (ESBL)*.

Data analysis was performed using t-tests, χ^2 tests, and logistic regression to assess the impact of various factors. The effect of artificial nails and jewelry on bacterial contamination was evaluated using p-value calculations (α=0.05).

Results:

Table 1: Frequency of bacterial growth on individual plates

Bacteria	Number of Surfaces	Percent of Surfaces	Percent of Contaminated Surfaces
S. Aureus	86	7.825295723	49.14285714
Enterobacter spp.	30	2.729754322	17.14285714
S. Aureus + Enterobacter spp.	23	2.092811647	13.14285714
E. Coli	17	1.546860783	9.714285714
S. Aureus + E. Coli	15	1.364877161	8.571428571
E. Coli + Enterobacter spp.	2	0.181983621	1.142857143
S. Aureus + Klebsiella spp.	1	0.090991811	0.571428571
S. Aureus + E. Coli + Enterobacter spp.	1	0.090991811	0.571428571

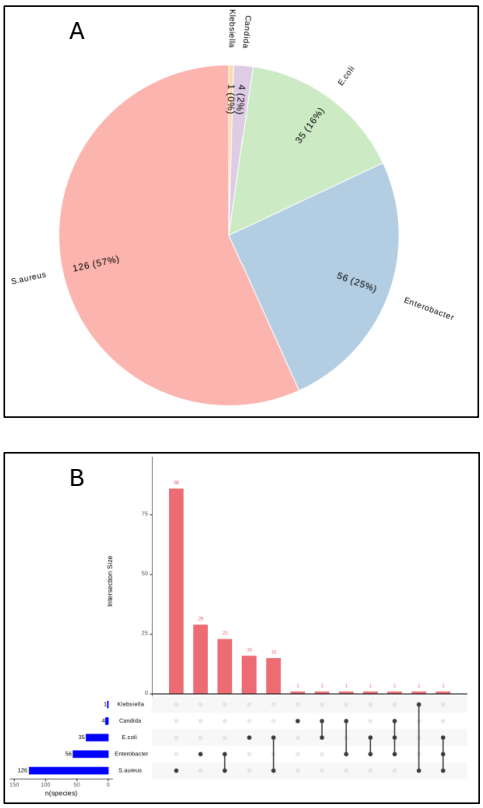


Figure 1: Percentage of growth of different strains of bacteria (Figure 1A) and the frequency of growth patterns on each plate (Figure 1B).

Of the samples that were taken and cultured (n=1099), 84% (923) did not show any bacterial growth. 12% of the plates showed the growth of one bacterium while 4% of the plates showed growth of multiple bacteria. The most common bacteria that was grown on the plates was *Staphylococcus aureus*, accounting for 57% of the cultures that were isolated. 98% of samples that grew anything in culture could be accounted for by *S. aureus*, *Enterobacter spp.*, and *E. coli*. The only other microbes that were isolated were *Candida spp.* and *Klebsiella spp.*, but both were only found in specific locations. *Candida spp.* was only found in samples taken from soap dispensers and *Klebsiella spp.* was only found on a faucet in an OB clinic.

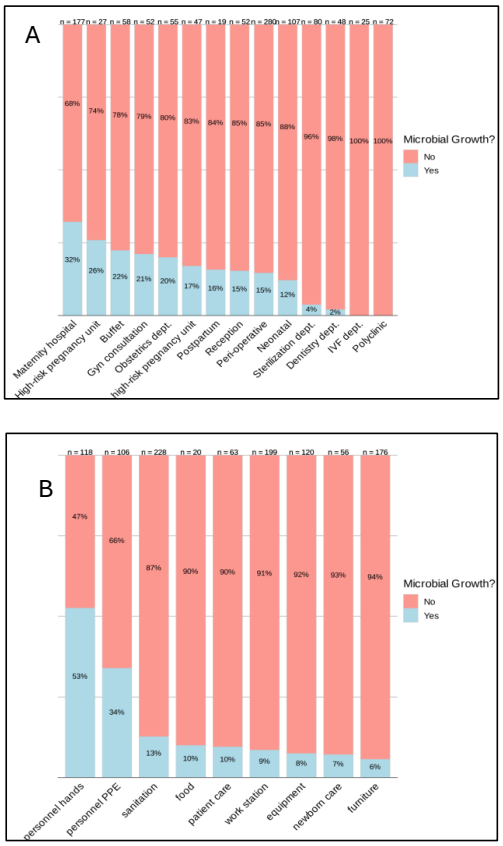


Figure 2: Percentage of samples showing microbial growth based on the department they were taken from (Figure 2A) and the type of surface they were sampled from (Figure 2B)

When dividing the samples based off their site of origin, specific departments of the hospital were associated with greater levels of bacterial growth. Samples taken from the maternity hospital had the greatest amount of bacterial growth with 26.5% of the samples showing contamination. Other departments that showed similar high amounts of bacterial growth were the peri-operative area (22.4%) and the cafeteria (22.4%). The department, with the lowest levels of bacterial growth, was from the polyclinics with none of the 72 plates growing bacteria. Dentistry and the sterilization departments were similarly low with 2.1% and 3.8% respectively.

Samples that were cultured off the hands of healthcare workers at various departments had 52.8% showing growth. 36.0% of the samples had one species of bacteria grow while 15.8% had two species of bacteria, with an average of 0.59 bacteria growing on each sample. Once again most of the bacteria grown was *S.*

aureus (54.5%), but there was a greater percentage of *Enterobacter spp.* (27.3%) and *E. Coli* (18.2%).

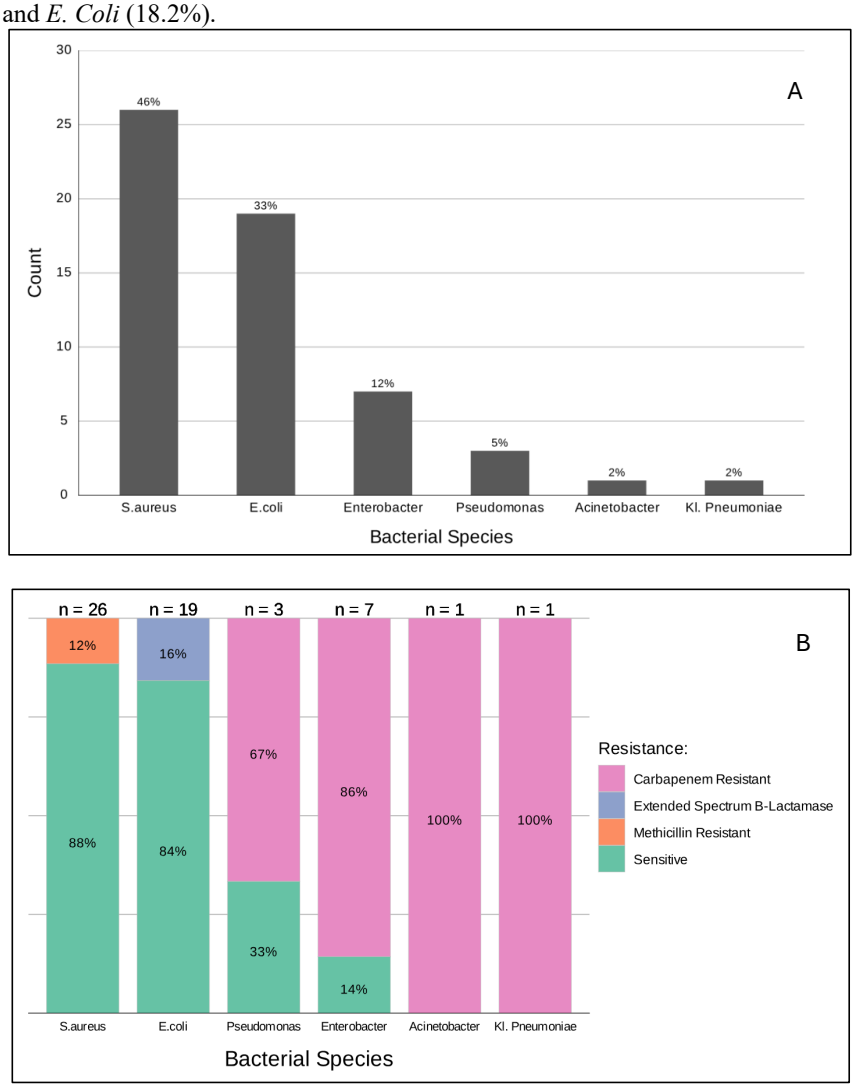
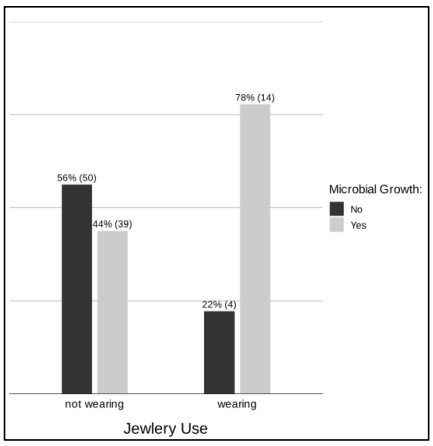


Figure 3: Percentage of each bacteria grown on mother's hands (Figure 3A) as well as the prevalence of antibiotic resistance for each species (Figure 3B)

Samples that were cultured off mother's hands (n=107) at RCMCHP showed the same top three bacteria with *S. aureus* on 46% of hands, *E. Coli* on 33% and *Enterobacter spp.* on 12%. Unlike on the environmental surfaces, *Pseudomonas aeruginosa* grew on 5% of the maternal hand samples, *Acinetobacter spp.* on 2% and *Klebsiella spp.* on 2%. For these samples the resistance to

antibiotics was measured and 12% of the *S. aureus* grown was resistant to methicillin. For the *Pseudomonas aeruginosa* and *Enterobacter spp.* cultured, they were 67% and 86% resistant to Carbapenems respectively. Three of the samples grew cultures that were shown to express Extended Spectrum B-Lactamases.

A



B

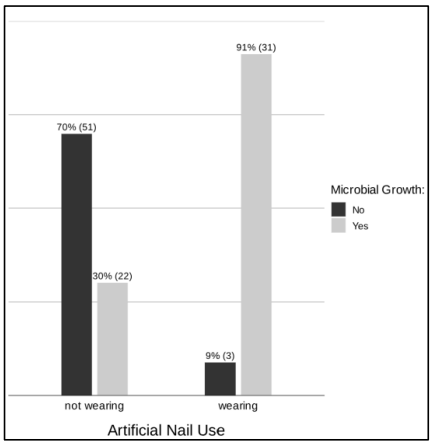


Figure 4: Prevalence of bacterial growth on maternal hands based on wearing jewelry (Figure 4A) or having artificial nails (Figure 4B)

Analysis was completed to see if there was a statistical difference in samples grown if the mother had artificial nails or jewelry. Microbial growth was present on 91% of samples taken from mothers with artificial nails (n=34) versus 30% of mothers without them, which was statistically significant (p=0.00000001). For mothers that had jewelry on their hands (n=18) 78% had bacterial growth versus 44% in the group that did not (p = 0.02). It is possible that these effects seen in artificial nails or jewelry are being modified by each other as 38% of those with

artificial nails had jewelry while those without artificial nails had jewelry on 7%. Additionally, of the bacteria that showed antibiotic resistance, 56.3% were cultured from the hands of mothers with artificial nails. This is a potential source of nosocomial infection in neonates, particularly with bacteria that are more difficult to treat.

Conclusion:

The purpose of this study was to propose possible sources of infection for nosocomial infections in newborns at hospitals in Yerevan, Armenia. The data provides evidence that infections of *S. aureus* are largely from the environment in the hospital with surfaces around the hospital showing a greater percentage of *S. aureus* growth than in either healthcare workers' or mothers' hands. Additionally, pregnant women may have a higher risk of exposure to *S. aureus* based on the samples from the maternity hospital having the greatest amount of bacterial growth. Efforts must be made to highlight infection control and hand washing in specific departments with greater levels of bacterial growth such as the maternity hospital, cafeteria, and peri-operative area.

Samples taken from the hands of mothers and healthcare workers showed greater bacterial growth and more similarity to each other than they did to the samples taken from the environment. Still, it remains unclear if the spread of bacteria is from healthcare workers' hands to mothers, as there were differences in the percentages of bacteria grown between the two. Additionally, *Pseudomonas aeruginosa* were found on 5% of the mothers' hands while it was not found on any healthcare workers' hands.

Another factor that this study found to be of great significance in predicting the level of bacterial growth on mothers' hands was the presence of artificial nails and jewelry. Greater awareness of this can be spread during prenatal visits as well as social media sites that target pregnant women in Armenia. One goal of this study is to highlight the importance of mother's hands in the transmission of neonatal infection. Results from this study suggest that guidelines that are already in place for the hand hygiene of healthcare workers should be applied to maternal hand hygiene. From the baseline levels found in this study, the effectiveness of future interventions can be measured. Additionally, it can be seen if interventions that lower the number of bacteria grown on mothers' hands influence the rates of nosocomial infections in their children.

A conclusion that can be made is that greater efforts must be made in Yerevan, Armenia to promote hand washing, in a specific manner that targets local factors. Particularly, more research must be done to identify sources of certain infections and in all maternal clinics throughout Armenia. This has been done in other countries by optimizing methods used for disinfection between patients(15) and increased screening of infections with more frequent blood cultures.(16) A specific intervention in Armenia to stop the chain of infection, could be monitoring hand hygiene efforts(17) with greater education on the need for hand hygiene after interacting with the environment, not just after treating patients.(14)

References:

1. Newborn Mortality: World Health Organization; 2024 [Available from: https://www.who.int/news-room/fact-sheets/detail/newborn-mortality.
2. Milton R, Gillespie D, Dyer C, Taiyari K, Carvalho MJ, Thomson K, et al. Neonatal sepsis and mortality in low-income and middle-income countries from a facility-based birth cohort: an international multisite prospective observational study. Lancet Glob Health. 2022;10(5):e661-e72.
3. Saroyan G.E. Manukyan R.R., Ohan G.G., Ter-Stepanyan M.M. GROUP B STREPTOCOCCUS IN PREGNANCY, EPIDEMIOLOGICAL PECULIARITIES OF EARLY AND LATE ONSET STREPTOCOCCAL INFECTIONS IN NEWBORNS. The New Armenian Medical Journal. 2024;18(4):37-45.
4. Izadi N, Eshrati B, Mehrabi Y, Etemad K, Hashemi-Nazari SS. The national rate of intensive care units-acquired infections, one-year retrospective study in Iran. BMC Public Health. 2021;21(1):609.
5. Savas L, Guvel S, Onlen Y, Savas N, Duran N. Nosocomial urinary tract infections: micro-organisms, antibiotic sensitivities and risk factors. West Indian Med J. 2006;55(3):188-93.
6. Kouassi-M'bengue A, Folquet-Amorissani M, Nassirou F, Guessennd-Kouadio N, Kacou-N'Douba A, Houenou Y, et al. [Neonatal urinary tract infections in Abidjan: the problem of bacterial resistance]. Mali Med. 2008;23(1):34-7.
7. Russell NJ, Stöhr W, Plakkal N, Cook A, Berkley JA, Adhisivam B, et al. Patterns of antibiotic use, pathogens, and prediction of mortality in hospitalized neonates and young infants with sepsis: A global neonatal sepsis observational cohort study (NeoOBS). PLoS Med. 2023;20(6):e1004179.
8. Oli AN, Okafor CI, Ibezim EC, Akujiobi CN, Onwunzo MC. The prevalence and bacteriology of asymptomatic bacteriuria among antenatal patients in Nnamdi Azikiwe University Teaching Hospital Nnewi; South Eastern Nigeria. Niger J Clin Pract. 2010;13(4):409-12.
9. Sands K, Carvalho MJ, Spiller OB, Portal EAR, Thomson K, Watkins WJ, et al. Characterisation of Staphylococci species from neonatal blood cultures in low- and middle-income countries. BMC Infect Dis. 2022;22(1):593.
10. Otter JA, Yezli S, Salkeld JA, French GL. Evidence that contaminated surfaces contribute to the transmission of hospital pathogens and an overview of strategies to address contaminated surfaces in hospital settings. Am J Infect Control. 2013;41(5 Suppl):S6-11.
11. Pochtovyi AA, Vasina DV, Kustova DD, Divisenko EV, Kuznetsova NA, Burgasova OA, et al. Contamination of Hospital Surfaces with Bacterial Pathogens under the Current COVID-19 Outbreak. Int J Environ Res Public Health. 2021;18(17).
12. Drees M, Snydman DR, Schmid CH, Barefoot L, Hansjosten K, Vue PM, et al. Prior environmental contamination increases the risk of acquisition of vancomycin-resistant enterococci. Clin Infect Dis. 2008;46(5):678-85.

13. Nseir S, Blazejewski C, Lubret R, Wallet F, Courcol R, Durocher A. Risk of acquiring multidrug-resistant Gram-negative bacilli from prior room occupants in the intensive care unit. Clin Microbiol Infect. 2011;17(8):1201-8.
14. Otter JA, Yezli S, French GL. The role played by contaminated surfaces in the transmission of nosocomial pathogens. Infect Control Hosp Epidemiol. 2011;32(7):687-99.
15. Han JH, Sullivan N, Leas BF, Pegues DA, Kaczmarek JL, Umscheid CA. Cleaning Hospital Room Surfaces to Prevent Health Care-Associated Infections: A Technical Brief. Ann Intern Med. 2015;163(8):598-607.
16. Ombelet S, Barbé B, Affolabi D, Ronat JB, Lompo P, Lunguya O, et al. Best Practices of Blood Cultures in Low- and Middle-Income Countries. Front Med (Lausanne). 2019;6:131.
17. Randle J, Arthur A, Vaughan N. Twenty-four-hour observational study of hospital hand hygiene compliance. J Hosp Infect. 2010;76(3):252-5.