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Review Article

Infection Prevention and Control in Intensive Care Units: Challenges, Current Practices, and Future Directions in Bangladesh

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Abstract:

Intensive care units (ICUs) concentrate the sickest patients, the most invasive devices, and the heaviest antibiotic exposure in any hospital, making them the focal point for healthcare-associated infections (HAIs) and antimicrobial resistance (AMR). In Bangladesh, where critical care has expanded rapidly but unevenly, these risks are amplified by workforce shortages, inconsistent infection prevention and control (IPC) implementation, and a heavy burden of multidrug-resistant organisms. This narrative review synthesises published and grey literature on ICU infection epidemiology, national IPC policy, antimicrobial stewardship, and the structural constraints on Bangladeshi critical care. Ventilator-associated pneumonia, carbapenem-resistant Gram-negative infection, surgical site infection, and neonatal sepsis all occur well above rates reported from high-income settings, driven by low hand hygiene compliance, limited surveillance, understaffing, and largely empirical prescribing. National IPC and AMR policies now exist, but implementation is uneven outside Dhaka and a few well-resourced tertiary centres, while WHO-aligned multimodal pilots show that low-cost improvement is achievable even in district hospitals. Progress requires investment in a trained workforce, functioning surveillance, waste-management infrastructure, enforceable accreditation, and routine ICU stewardship.

Keywords: *Antimicrobial resistance; Bangladesh; Critical care; Infection prevention and control; Intensive care unit; Healthcare-associated infection; Low- and middle-income country.*

Introduction

The intensive care unit occupies a paradoxical place in hospital medicine: it deploys the most advanced life-sustaining technology, yet leaves patients most vulnerable to the infections that technology introduces. Endotracheal tubes, central venous catheters, and urinary catheters bypass natural barriers, while critical illness, prolonged stay, and near-universal antibiotic exposure make the ICU the epicentre of healthcare-associated infection and antimicrobial resistance in any hospital.

Across the World Health Organization (WHO) South-East Asia Region, adult ICU surveillance describes ventilator-associated pneumonia rates spanning a more than fifty-fold range, with mortality reaching three-quarters of affected patients in some series[1]. Bangladesh, with more than 170 million people and one of the region's fastest-growing but least resourced critical-care sectors, sits squarely within this burden. Its first ICU opened in Dhaka in 1978, and as recently as 1980 the capital had only 28 ICU beds[2]. Growth since has been substantial, but has outpaced the parallel investment in infection prevention and control that safe critical care requires.

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Drawing on clinical and public-health literature, policy documents from the Directorate General of Health Services (DGHS) and the Ministry of Health and Family Welfare, and technical reports from WHO and partners, this review examines the structural landscape of Bangladeshi critical care; the epidemiology of ICU infection and resistance; the national IPC framework and its implementation gap; environmental, waste-management, and stewardship challenges; lessons from COVID-19; and priorities for closing the gap.

Search Strategy and Selection Criteria

This narrative review followed no registered protocol. Relevant biomedical and grey literature — Bangladesh-specific studies, national guidelines, WHO reports, and recent evidence on ICU-associated infection, antimicrobial resistance, and IPC — was reviewed, prioritising larger and more recent studies while acknowledging limitations of sample size and generalisability.

The Critical Care Landscape in Bangladesh

IPC has to be understood against the structural reality of the units themselves. A survey covering 2017–2019 found approximately 0.7 critical-care beds per 100,000 population in Bangladesh — some 2,139 ICU beds nationally, fewer than half in government facilities[3] — well below other South Asian countries. COVID-19 triggered a major, if belated, expansion, roughly tripling the public total to 1,372 ICU beds by 2026[4]. Capacity nonetheless remains about 1.7 beds per 100,000 against a benchmark of 3 to 10; matching even the lower end would require more than 5,000 beds, and 38 districts still have none[5].

Structure and governance constrain safety as much as bed

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numbers do. A 2013–2014 survey of 51 hospitals found only 19.6% with a functioning infection-control committee and basic life support training required for just 31.4% of doctors and 27.5% of nurses[6,7]. Most ICUs (68%) provide mixed medical–surgical–obstetric care, 64% are led by anaesthesiologists rather than dedicated intensivists, 85% operate as "open" units without a single accountable team, and a 1:1 nurse-to-bed ratio is achieved in only 42%[6]. No national body specifically regulates ICU standards, leaving staffing, equipment, and infection-control infrastructure highly variable[6], and roughly 80% of ICU-equipped hospitals sit in Dhaka[2].

Bed numbers also understate the problem, because workforce shortages leave much installed capacity unusable. During a 2026 measles outbreak that killed more than 150 children, roughly half the country's ICU beds sat idle for lack of trained staff even as patients died awaiting a bed[4]. Bangladesh trains only 150 to 200 anaesthesiologists and critical-care specialists every five years, and close to 70% of sanctioned government ICU posts are vacant; low pay, the absence of private-practice rights for public-sector anaesthesiologists, and the demands of ICU nursing all deter recruitment[8]. The two-tier system is also financial: government beds cost around 100 taka per day against 12,500 to 15,000 taka in private facilities, before medicines, ventilation, and oxygen[8].

Table I summarises reported HAI rates in Bangladeshi ICU and related critical-care settings; Table II summarises key structural indicators.

Table I: Reported rates of major healthcare-associated infections in Bangladeshi ICU and related critical-care settings

Infection type	Reported burden in Bangladeshi ICUs	Dominant organisms	Study context
Ventilator-associated pneumonia (VAP)	30.1 per 1,000 ventilator-days with a VAP-prevention bundle vs. 51.1 per 1,000 without; clinical prevalence 26.9% vs. 46.1%	Acinetobacter spp., Pseudomonas aeruginosa, Klebsiella pneumoniae, Staphylococcus aureus	Quasi-experimental study, tertiary adult ICU, 2024–2025[9]
Carbapenem-resistant Enterobacteriaceae (CRE)	National prevalence ~12–13%; higher in tracheal aspirates (57.8%) and inpatient samples (18.6%) than outpatient (9.0%)	Klebsiella spp., E. coli	Nationwide laboratory surveillance, 2017–2020[11]
Carbapenemase-producing K. pneumoniae	30% of ICU isolates carbapenemase-producing; 14% pandrug-resistant	K. pneumoniae harbouring NDM and OXA-type carbapenemases	Single largest tertiary hospital ICU[12]
Surgical site infection (SSI)	33.2% of surgical patients developed SSI symptoms within 30 days (pilot, 4 hospitals); 19.1% prevalence after caesarean section (6 hospitals)	Mixed Gram-positive/Gram-negative organisms	Multi-hospital SSI surveillance pilots, 2021 and 2023[15,16]
Neonatal sepsis	69.4% prevalence among neonates admitted to public-hospital NICUs in Dhaka	E. coli, Staphylococcus aureus, Klebsiella pneumoniae (high resistance to common agents)	Cross-sectional and case-control studies, Dhaka and Rajshahi[18,19]
Candida auris colonization/ infection	8% colonization among 740 ICU/NICU patients across two Dhaka hospitals; a small proportion progressed to bloodstream infection	Candida auris	Prospective surveillance, adult ICU and NICU, 2021–2022[20]

Table II: Selected structural indicators of critical-care capacity in Bangladesh

Structural indicator	Reported value
Public ICU beds (2026)	1,372 beds at 72 facilities — roughly three times the pre-COVID figure of 498[4]
Public CCU beds (2026)	1,054 beds at 51 facilities[4]
Critical-care beds per 100,000 population	Approximately 1.7, against a global benchmark of 3–10[5]
Districts with no ICU facility	38 of the country's districts[5]
ICUs with 1:1 nurse-to-bed staffing	42% of surveyed ICUs (lower still in private facilities)[6]
Nurses with formal BLS/CPR training	36% of ICU nurses in a national survey[6]
Hospitals with a functioning infection-control committee	19.6% of surveyed hospitals[7]
Vacancy rate, sanctioned government ICU/anaesthesiology posts	Approximately 70%[8]
New anaesthesiology/critical-care specialists trained	Only about 150–200 nationally every five years[8]

Burden and Epidemiology of Infections in Bangladeshi ICUs

Ventilator-Associated Pneumonia

Ventilator-associated pneumonia (VAP) is among the most common and deadly ICU-acquired infections. In a Bangladeshi tertiary ICU (2024–2025), a nurse-led prevention bundle cut VAP incidence from 51.1 to 30.1 per 1,000 ventilator-days and prevalence from 46.1% to 26.9%, although mortality remained high; ventilation for 96 hours or longer was an independent risk factor[9]. Regionally, incidence ranges from 2 to 116 per 1,000 ventilator-days with mortality of 16–74%, commonly involving Acinetobacter spp., Pseudomonas aeruginosa, Klebsiella pneumoniae, and Staphylococcus aureus[1]. In pandrug-resistant K. pneumoniae VAP, intravenous plus aerosolised polymyxin B achieved better clearance and survival than colistin-based therapy[10].

Carbapenem-Resistant and Multidrug-Resistant Gram-Negative Infections

Multidrug-resistant Gram-negative bacteria predominate in Bangladeshi ICUs. National surveillance (2017–2020) reported carbapenem-resistant Enterobacteriaceae prevalence of approximately 12%, with markedly higher detection in tracheal aspirates and hospitalised patients; isolates showed over 90% resistance to third-generation cephalosporins and over 80% to aminoglycosides[11]. ICU isolates of Klebsiella pneumoniae frequently harboured NDM carbapenemase genes, with 14% pandrug-resistant[12], while Acinetobacter baumannii commonly carried blaNDM-1 and phoQ mutations, conferring carbapenem and colistin resistance respectively[13]. Colonisation with carbapenem-resistant Gram-negatives increases during ICU stay, indicating ongoing nosocomial transmission[14].

Surgical Site Infections

Surgical site infection (SSI) surveillance remains limited but indicates a high burden. A multicentre pilot of 1,760 patients reported a 33.2% SSI rate within 30 days, higher after abdominal surgery (40.9%) than caesarean section (30.7%), with most infections occurring before discharge; despite 70.1% receiving prophylaxis, rates were unchanged, suggesting inappropriate practice[15]. A later study reported 19.1% following caesarean section[16]. Nationally, SSI is the commonest HAI (29.1%), followed by urinary tract (23.9%), bloodstream (19.1%), and hospital-acquired pneumonia (14.8%) [17].

Neonatal and Paediatric Intensive Care Infections

Neonatal intensive care units (NICUs) bear a substantial infection burden. Among 173 neonates in two public hospital NICUs, sepsis prevalence was 69.4%, with perinatal asphyxia a major risk factor[18]. Escherichia coli, Staphylococcus aureus, and Klebsiella pneumoniae predominated and showed high resistance, while maternal urinary tract infection, prematurity, and low five-minute Apgar score were significant risk factors[19]. The high frequency of late-onset sepsis points to persistent deficiencies in hand hygiene, equipment sterilisation, and overcrowding.

An Emerging Threat: Candida auris

Surveillance from August 2021 to September 2022 in the adult ICUs and NICUs of one government and one private tertiary hospital in Dhaka found 8% of 740 patients colonised with Candida auris, a fungal pathogen of global concern for its multidrug resistance, environmental persistence, and outbreak potential[20]. Colonisation was split roughly evenly between adult ICU (46%) and NICU (54%), and a small proportion developed bloodstream infection[20]. Bangladeshi ICUs are therefore not insulated from globally emerging resistant pathogens: environmental cleaning, equipment decontamination, and screening calibrated for such organisms must become routine.

National Infection Prevention and Control Policy Framework

Bangladesh has strengthened its national response since 2020 through the DGHS National IPC Guideline, aligned with WHO and CDC recommendations, and the National WASH Strategy for Health Care Facilities[21,22]. With WHO support,

IPC committees now exist in many public hospitals, and a 2025 partnership with the national medical university aims to develop a Centre of Excellence for IPC. Implementation nevertheless remains uneven, particularly at district and sub-district facilities, owing to inadequate infrastructure, few trained IPC personnel, and weak supervision[23]. An AMR containment programme and the National Action Plan on AMR (2023–2028) respond to an estimated 26,200 AMR-attributable deaths in 2019 [24]. Although disease-specific guidance such as tuberculosis IPC has existed for years, implementation studies still report poor awareness, inadequate resources, overcrowding, and low compliance — underlining the persistent gap between policy and facility-level practice[25,26].

Current IPC Practice: What Facility Assessments and Hand Hygiene Audits Show

WHO IPC Assessment Framework (IPCAF) Findings

The WHO Infection Prevention and Control Assessment Framework (IPCAF) has been widely used in Bangladesh. An assessment of 11 tertiary hospitals in 2020 reported a median score of 355/800, most facilities rating basic or inadequate, with surveillance, monitoring, and staff education weakest[27]; similar gaps appeared in tertiary military hospitals during the pandemic[28]. A multicentre intervention across six district hospitals and 13 upazila health complexes, however, significantly improved performance through training, supervision, and resource support, with 98% of healthcare workers and all cleaning staff trained — evidence of what sustained institutional investment can achieve[29].

Hand Hygiene Compliance

Hand hygiene remains the most cost-effective IPC intervention, yet DGHS estimates that approximately 61% of healthcare workers do not consistently follow recommended practice[30]. An observational study using the WHO Five Moments framework reported overall compliance of only 30.9%, higher among physicians (34.5%) than nurses (25.2%)[31]. Training, visual reminders, and real-time feedback can significantly improve compliance[32], and among 1,728 healthcare workers positive attitudes toward IPC were strongly associated with safer practice[33].

Environmental Cleaning and Healthcare Waste Management

Healthcare waste management remains a major IPC challenge. Despite the Medical Waste Management and Processing Rules (2008), safe nationwide management is still lacking; Dhaka generated an estimated 206 tonnes of medical waste daily during the COVID-19 pandemic[34]. Inadequate segregation, limited training and protective equipment for waste handlers, and reliance on open burning in many government and rural facilities all increase infection risk[34,35]. Waste-management knowledge is inadequate in one-third of doctors and nurses and up to two-thirds of laboratory technologists and cleaning staff[36], raising the risk of pathogen transmission within and beyond the ICU.

Antimicrobial Use and Stewardship in Critical Care

Antibiotic use is widespread and often inconsistent with stewardship principles. A 2021 WHO point-prevalence survey found nearly 78% of hospitalised patients receiving at least one antibiotic, spanning Access, Watch, and Reserve (AWaRe) categories[37], with similar overuse of Watch agents in COVID-19 wards even in mild to moderate illness[38]. Prescribers recognise resistance as a major threat but report the absence of structured stewardship programmes and prescribing policies[39]. A recent systematic review found no fully implemented stewardship programme nationally, only 31% of prescriptions culture-guided, and broad-spectrum antibiotics in over 70% of inpatients[24]. Strengthening surveillance, AWaRe-based prescribing audits, staff training, and culture-guided de-escalation — particularly in ICUs — are key priorities[24].

Lessons from the COVID-19 Pandemic

COVID-19 exposed both strengths and weaknesses in Bangladesh's critical-care and IPC systems. The tripling of public ICU capacity noted above[4] was not matched by coordinated, evidence-based response, and reviews describe heavy reliance on non-governmental support[40,41]. Regional evidence showed inadequate workforce training leaving much ICU equipment underutilised[42] — the same pattern behind Bangladesh's idle beds. Expanding infrastructure must therefore be matched by sustained investment in trained personnel and robust IPC systems.

Strategies to Strengthen IPC in Bangladeshi ICUs

The evidence highlights a persistent gap between national IPC policy and routine ICU practice. Key priorities include:

- **Strengthen ICU IPC** by scaling the WHO multimodal IPC improvement strategy, including training, monitoring, feedback, and safety culture.
- **Implement standardized HAI surveillance** for VAP, CLABSI, CAUTI, and SSI with regular feedback to clinical teams.
- **Expand the critical-care workforce** through specialised training, certification, and incentives to recruit and retain intensivists, anaesthesiologists, and ICU nurses.
- **Integrate antimicrobial stewardship** into routine ICU care through culture-guided therapy, de-escalation, AWaRe-based prescribing, and stewardship teams.
- **Improve ICU infrastructure** with point-of-care hand hygiene facilities, adequate isolation capacity, proper bed spacing, and safe waste management.
- **Establish national ICU accreditation standards** covering staffing, IPC compliance, surveillance, and continuous training.
- **Expand ICU services beyond Dhaka**, prioritising underserved districts for equitable access.
- **Strengthen implementation** of the National IPC Guideline and AMR Action Plan through dedicated funding, monitoring, and partnerships.

- **Enhance microbiology laboratory capacity** for rapid pathogen identification, antimicrobial susceptibility testing, and outbreak detection.
- **Leverage digital health and artificial intelligence** to support HAI surveillance, hand hygiene monitoring, and early outbreak detection.

Conclusion

Bangladesh has made significant progress in IPC through national guidelines, hospital IPC committees, the National Action Plan on AMR, and expanded ICU capacity. Yet ICU-acquired infection and antimicrobial resistance remain major challenges, with high rates of ventilator-associated pneumonia, multidrug-resistant Gram-negative infection, surgical site infection, and neonatal sepsis alongside poor hand hygiene compliance. The central problem is the gap between policy and implementation: expanding infrastructure without trained staff, effective surveillance, and sustained IPC investment yields little gain in patient safety. Strengthening workforce capacity, stewardship, surveillance, and implementation of national IPC standards is essential if Bangladesh's growing critical-care services are to deliver safe, high-quality care.

Declarations

Conflicts of interest. The authors declare that they have no competing interests.

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