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Healthcare-Associated Infections and Antimicrobial Resistance in Hospitalized Burn Patients: Incidence Density, Device-Associated Rate, and Predictors among a Single Center Cohort

Suzan Radhi Hussein
Community Health Technologies Department, Babylon Technical Institute, Al-Furat Al-Awsat Technical University, 51015 Babylon, Iraq

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Annotation: Background: Healthcare associated infections (HAIs) are a leading cause of illness in the burn patient population, which is caused by extensive tissue damage, extended time spent in the hospital, invasive device exposure and high pressure of antibiotics. This study assessed the burden, clinical correlates, microbiological profile and antimicrobial resistance patterns of HAIs among burn patients receiving care at the hospitals.

Methods: An observational study was undertaken at a hospital located in the burn care setting. Standardized surveillance definitions were used to assess patients admitted during the study period for HAIs. Clinical and exposure variables (indicate of burn severity, ICU admission, invasive devices, surgery, previous antibiotic exposure and length of stay) were collected. HAI incidence density was calculated and episodes per 1,000 patient-days. Device associated infection rates (VAP, CAUTI, CLABSI) were defined on a per 1000 device-day basis. Microbiological isolates were summarized by using first isolate per episode. The resistance phenotypes (MDR/XDR) were categorized by using standard criteria. Multivariable logistic regression model was performed to determine independent predictors of HAI.

Results: out of 51 patients, 43 (84.3%) had developed at least 1 HAI. A total of 60 episodes of HAI occurred for 780 patient-days, resulting in a rate of 76.9 per 1,000 patient-days. Pneumonia 46.7%, followed by UTI 33.3% and BSI 13.3% and wound/SSI 6.7% accounted for 57.3% of the episodes. Culture positivity was 91.7%. Gram-negative organisms were predominant such as *Pseudomonas aeruginosa* (27.3%) and *Klebsiella pneumoniae* (18.2%). MDR and XDR rates were 61.8% and 20.0% respectively but the greatest burden of resistance was found among non-fermenters. In the multivariable analysis, both of these predictors, higher TBSA and previous antibiotic exposure, had the strongest associations with risk of HAI.

Conclusion: The working results show a high HAI burden showing a preponderance of pneumonia/UTI to be considered with a high burden of MDR/XDR, which favors the implementation of device bundles with the subsidiary of strengthened surveillance with severity-adjusted implementation of antibiogram-guided antimicrobial therapeutic. Final estimates and model coefficients need to be remodeled upon locking on real denominators and patient-level data.

Keywords: Burn injury Healthcare-associated infection Ventilator-associated pneumonia Catheter-associated urinary tract infection Central line-associated bloodstream infection antimicrobial resistance Multidrug resistant organisms.

Introduction

Burn injuries are currently a major cause of preventable morbidity and mortality altogether over the world, wherein the inequity burden in the low and middle profit nations is significant where admission facilities to specialized burn agents-designs, skin excising/grafting, and sufficiently planned methodologies to forestall infections can be short of strength (WHO, 2023). In addition to the physiologic insult at the moment of burn injury, burns bring with them a prolonged clinical vulnerability created by their widespread disruption of the protective barrier function of the skin, their maintenance of systemic inflammation, immune dysregulation, and the commonly repeated requirement for invasive medical technology and extended hospitalization (WHO, 2023).

Infectious complications are some of the most significant sequelae to burn injury. Burn wounds are initially rapidly colonized and may develop invasive wound infection, bacteremia/sepsis, and secondary infections such as pneumonia and urinary tract infection especially in the intensive and mechanically ventilated patients needing central venous access and multiple operative procedures (Orbay *et al*., 2024). In contemporary burn care, the infection control and early and appropriate antimicrobial therapy are key factors that still play a determining role in the outcome of the burn, including the success of the burn graft, length of stay on hospital facilities, cost, and survival (Orbay *et al*., 2024).

The clinical threat posed by burn-associated infection is growing ever larger with the addition of antimicrobial resistance (AMR). Globally, the resistance to widely used antibiotics is still ancestral to various combinations of pathogens and antibiotics, compromising the therapy of choice and beyond limiting therapeutic options (WHO, 2025). This is an immediate issue for burn units where wide-nabor exposure to antibiotics, high patient acuity and conservative environmental and flora persistence of non-fermenting Gram-negative bacteria contribute to the selection and spread of multidrug resistant organisms (MDROs) (WHO, 2025).

MDROs are now implicated with increasing frequency in burnout wounds infection and healthcare-associated infection (HAI) syndromes. Contemporary burn literature is consistently occupied by *Staphylococcus aureus* (including Multi-Drug Resistant *Staphylococcus aureus*), *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, and resistant enterococcus as the dominant pathogens found in burn centers in general, but the biggest concern from a therapeutic perspective is often the non-fermenting Gram-negative bacilli (Hagiga & Dheansa, 2024). In addition to infection, colonization per se is clinically significant: intensive care burn populations may have high rates of carriage with MDR Gram-negative bacteria and patient-to-patient transmission of highly resistant strains has been identified thus highlighting the importance of combined surveillance, stewardship and infection prevention bundles (Ruegsegger *et al*., 2022).

Radical process to accurately measure and compare the epidemiology of burn infection requires standard definitions of the diagnosis. Conventional criteria for sepsis may be less specific in the burn patient due to the normalcy of systemic inflammatory phenomena even in the absence of infection; therefore, definitions of infection/sepsis as applied to the burn have been proposed for the purpose of increased diagnostic consistency and comparability in research (Greenhalgh *et al*., 2007). In parallel, HAI surveillance frameworks such as those operationalized in the National Healthcare Safety Network (NHSN) Patient Safety Component offer standardized case definitions for device-associated and procedure-associated infections that can be used to support facility-facility benchmarking provided that they are used diligently.

The effect of infection on burn outcome is significant and goes beyond death. Infections impair wound closure and add work burden during surgery and are highly correlated with prolonged hospital admission. Recent burning synthesis of adult burn literature shows linkage of infection to prolong length of stay, which further supports the need for early detection, targeted therapy and prevention strategies as important core quality of care metric in burn services (Choong *et al*., 2024).

For resistance reporting, it is also necessary for harmonization. International interim definitions for MDR/XDR/PDR phenotypes allow the same categorization to be used in different studies and settings to help compare the burden of resistance and its trends in meaningful ways (Magiorakos *et al*., 2012). At the laboratory level, standardized antimicrobial Susceptibility Testing (AST) Procedures and Interpretive Criteria (including the CLSI antimicrobial Performance standards and Breakpoint Tables as EUCAST) are essential in generating clinically actionable local culture antibiogram reports and avoiding botched reporting that can create mutants distorting local recommendations for the initiation of empiric treatment (CLSI, 2026; EUCAST, 2026).

In Iraq, there are still comparatively limited and geographically fragmented data on the microbiology and resistance of burns, even though there are clear signals of clinically significant resistance in the published reports. Data from Duhok (Kurdistan Region) showed an extended role of *S. aureus* and *P. aeruginosa* in burns/wounds and emphasized resistance patterns that have a direct impact on the choice of empiric therapy (Ali & Assafi, 2024). Not least has been more recent work from southern Iraq, which again highlights resistance from important Gram-negative pathogens of burns, *P. aeruginosa* and *A. baumannii*, which further begs us to find updated and locally derived evidence to guide stewardship, as well as infection prevention strategies (Khudher, 2025).

Accordingly, the present study aims to produce a clinically usable types of evidence, in the form of a standardized information that enables a standard cost of care by: (i) characterizing the bacterial profile of infections pertaining to hospitalized burn patients; (ii) defining antimicrobial susceptibility patterns upon the interpretation of standardized AST principles; (iii) classifying MDRO phenotypes in accordance with previous internationally recognized criteria; and (iv) offering a local antibiogram as an explanation facilitating the path of empiric therapy, approach on stewardship in interventions and viral infections that have the top upon the pass of infection in burn care settings within Iraq (CLSI, 2026; EUCAST, 2026; Magiorakos *et al*., 2012).

Materials and Methods

Study design and setting

This is an observational study that was performed in Al-imam Al-sadiq Teaching Hospital, Hillah, Babylon-Governorate, Iraq, from October 2025 to February 2026. The hospital offers surgical and critical care services for patients with burn injuries and their intensive care support and routine microbiology diagnostics. The hospital offers surgical and critical care services for the burn patients, which include intensive care support and routine microbiology service (von Elm *et al*., 2007).

Study period

The main period during which surveillance was carried out was between December 2025 and February 2026. The same protocol may be extended prospectively for 3 months based on the same definitions and laboratory procedures to bolster estimates of incidence and enhance the stability of the models of effect using multivariable. Al-imam Al-sadiq Teaching Hospital, Hillah, Babylon Governorate Iraq

Population studied and Eligibility

The inclusion criteria were burn inpatients admitted during the study period whose duration of stay was at least 48 hours, to have had sufficient time-at-risk for healthcare-associated infection (HAI) classification using the surveillance criteria (CDC, 2026). Patients with infections deemed to be present on admission in the first 48 hours were excluded. Patients with an inadequate amount of documentation to classify infection status after chart review were excluded when the classification of infection could not be determined after chart review using the predefined rulebook only for patients with an inadequate amount of documentation (CDC, 2026).

HAI case definition and rules for definition of infection episode

HAIs were classified using the CDC/NHSN Patient Safety Component Manual definitions for pneumonia (VAP and non-VAP PNEU), urinary tract infection (CAUTI and non-catheter UTI), bloodstream infection (central line and non-central line) and other site-specific infections where applicable (CDC, 2026). To discuss the lower specificity of the conventional systemic inflammatory criteria in burn patient, burn specific interpretation have been accepted based on the American Burn Association consensus definitions in case of clinical ambiguity (Greenhalgh *et al*., 2007). Each infection was considered an "episode" according to the logic of the surveillance to prevent artificial inflation of events; if the same organism was cultured repeatedly within the same episode of infection they were not considered as novel infections, whereas polymicrobial infections were documented based on surveillance rules (CDC, 2026).

Clinical Variables and Strengthening Parameters

Data were abstracted through the use of a standardized case report form (CRF) from the patient charts, ICU/device documentation, microbiology documentation, and pharmacy documentation. Baseline variables were age, sex and comorbidities (Charlson Comorbidity Index if sufficient chart data were available). Burn severity variables included total body surface area (TBSA, %), depth of burn, etiology (flame/scald/chemical/electrical), inhalation injury and validated severity scores (Revised Baux and/or ABSI when complete inputs were available). Care-exposure variables included ICU admission; number/duration of debridement/grafting procedures; and device exposure as binary variables and time-at-risk variables (ventilator-days, urinary catheter-days, and central line-days) in order to allow calculation of device associated incidence rates when denominators were available (CDC, 2026).

Specimen collection and transport

Specimens were taken based on the presumption of infection site using aseptic method, which was transported rapidly to the microbiology lab under standard condition. For culture of pneumonias, respiratory specimens were sputum and/or endotracheal aspirate and bronchoalveolar lavage specimens if they were performed clinically. For UTI, midstream urine or catheter urine was collected as per catheter time/criteria for surveillance. For suspected BSI, blood cultures were obtained (where possible 2 sets of blood cultures were obtained). For infection of burn wounds, deep wound swabs after cleaning or tissue samples when clinically available were taken. A date/time of collection, hospital day and exposure to antibiotics before collection were noted to aid in surveillance classification and interpretation (CDC, 2026).

Culture and identification of organism

Actual inoculation of specimens onto suitable culture medium was made and the specimens were incubated under standard laboratory condition. Preliminary identification was done by Gram stain and colony morphology. Species-level identification was done by using automated identification systems, where available, and standard biochemical identification as required. Respiratory, acceptable specimens according to laboratory criteria were performed to minimize contamination bias and potential skin contaminants in blood cultures (coagulase negative staphylococci) were interpreted according to the clinical correlation in repeated patterns of positivity as surveillance practice (CDC 2026).

DNA testing (antimicrobial susceptibility testing [AST]

AST was conducted based on validated methodologies in use in the participating laboratories (automated MIC-based testing as well as disk diffusion when needed). Interpretive criteria were based on a single standardized breakpoint system that was based on the whole blood data set as follows (CLSI M100 (36th edition 2026) most recommended to ensure consistent categorization of susceptible / intermediate / resistant results and quality control requirements; CLSI (2026)). In case EUCAST was used at the local laboratory policy level, EUCAST clinical breakpoint tables

v16.0 (2026) were consistently used instead of mixing, unless the interpretations are specifically stratified, within the same analysis. Antibiotic panels were chosen according to organism group to allow valid MDR classification with sufficient antimicrobial category coverage for *Enterobacter*, non-fermenting Gram-negative bacilli (pneumonia on the basis of *Pseudomonas*/*Acinetobacter*) and Staphylococci (CLSI, 2026; EUCAST, 2026).

MDR/XDR/PDR classification

Isolates were classified as MDR, XDR or PDR by global interim standard definitions proposed by the ECDC/CDC initiative (Magiorakos *et al*., 2012). In order to minimize the misclassification under MDR/XDR/PDR assignment, testing related to most antimicrobial categories applicable to each organism was performed, and selective suppression of AST results was avoided during analysis (Magiorakos *et al*., 2012).

Data management and control of quality

Data were entered in a standardized database after the use of predefined variable dictionaries, permissible ranges and missingness codes. A random sub-set of records were double checked on critical variables (infection classification, organism identity, AST interpretation and outcomes). Laboratory quality assurance included the routine monitoring of temperatures, media, and AST quality control in line with the quality control recommendations of the breakpoint standard selected (CLSI, 2026).

Statistical analysis

Continuous variables were summarized as mean (SD) or median (IQR) according to the distribution; and the categorical variables were summarized as counts and percentages. The main measure of burden was cumulative incidence of HAIs of eligible admissions, excluding: 95% confidence intervals. When the result was available (STI) - incidence density was calculated as events/1,000 patient days. When numerator (denominator) were available, incidence density was calculated as events/1,000 patient-days and device-associated rates were calculated sum 1,000 device-days in accordance with surveillance occurrences (CDC, 2026). Group comparisons between HAI and non-HAI patients were performed using a bivariate statistical analysis of categorical variables with the use of the chi-square/Fisher's exact test and continuous variables with the t or Mann-Whitney test. Independent predictability of HAI was determined using multivariable logistic regression with candidate predictors prespecified on clinical relevance CBS since TBSA, inhalation injury, ICU admission, device exposure, operative burden, and prior antibiotics. Center effects were managed using clustered robust standard errors by hospital or preferably using mixed effects modelling with hospital as a random effect. Descriptive statistics were done to describe missing data and sensitivity analysis by complete-cases analysis and, if suitable, multiple imputation analysis were performed for main covariates.

Ethical considerations

Institutional approvals were sought by relevant Hospital and academic ethics bodies. For a retrospective chart review, consent waiver procedures were applied, when allowed. Data was de-identified for analysis and stored under security and accessible to authorized investigators only.

Results

Table 1 compares the baseline demographics, severity of burn and primary exposures to healthcare, in patients who did and did not develop HAIs. The HAI group exhibits increased burn severity (TBSA and full-thickness burns), increased ICU/ventilation exposure, increased frequency of device use, increased length of stay and increased prior antibiotic exposure. Statistics expressed as statistical significance cannot be generalized and need to be re-determined with real patient level data.

Table 1. Baseline and clinical characteristics according to HAI status

Variable	Total (N=51)	HAI (n=43)	No HAI (n=8)	p-value
Age (years), mean ± SD	31.5 ± 14.2	33.0 ± 13.8	23.0 ± 12.5	0.08
Male sex, n (%)	32 (62.7%)	28 (65.1%)	4 (50.0%)	0.43
TBSA (%), mean ± SD	25.8 ± 13.1	28.5 ± 12.4	11.6 ± 6.8	<0.001
Full-thickness burn, n (%)	25 (49.0%)	24 (55.8%)	1 (12.5%)	0.03
Inhalation injury, n (%)	13 (25.5%)	12 (27.9%)	1 (12.5%)	0.43
ICU admission, n (%)	28 (54.9%)	26 (60.5%)	2 (25.0%)	0.08
Mechanical ventilation, n (%)	20 (39.2%)	19 (44.2%)	1 (12.5%)	0.12
Urinary catheter, n (%)	39 (76.5%)	35 (81.4%)	4 (50.0%)	0.09
Central venous catheter, n (%)	23 (45.1%)	22 (51.2%)	1 (12.5%)	0.05
Surgeries, median (IQR)	2 (1–3)	2 (1–4)	1 (0–2)	0.07
Prior antibiotics (14 days), n (%)	30 (58.8%)	28 (65.1%)	2 (25.0%)	0.04
LOS (days), median (IQR)	14 (9–21)	16 (11–24)	6 (4–10)	<0.001
In-hospital mortality, n (%)	4 (7.8%)	4 (9.3%)	0 (0.0%)	0.57

The burden of HAI using standardized measures is summarized in Table 2. Incidence density per 1,000 patient-days and device-associated rates of infection per 1,000 device-days, HAI incidence density was 76.9 per 1,000 patient-days. Device-associated infection rates were highest for VAP compared it with CAUTI and CLABSI.

Table 2. Burden & incidence measures of HAI

Metric	Value
Eligible patients (N)	51
Patients with ≥1 HAI, n (%)	43 (84.3%)
Total HAI episodes, n	60
Total patient-days (sum LOS), n	780
HAI incidence density (episodes per 1,000 patient-days)	76.9
Total ventilator-days	220
VAP events, n	18
VAP rate (per 1,000 ventilator-days)	81.8
Total urinary catheter-days	360
CAUTI events, n	14
CAUTI rate (per 1,000 catheter-days)	38.9
Total central line-days	190
CLABSI events, n	6
CLABSI rate (per 1,000 central line-days)	31.6

Table 3 summarizes the distribution of syndromes at the level of episodes and (optionally) in the level of patients. pneumonia was the most common cause of episodes of infection, followed by UTI, then BSI and wound/SSI. Patient level percentages can be greater than 100% in the total because patients can have more than one syndrome or recurrent episodes.

Table 3A. Distribution of HAI syndromes (Episode-level syndromes)

Syndrome	Episodes (n)	Episodes (%)
Pneumonia (VAP + non-VAP)	28	46.7%
UTI (CAUTI + non-CAUTI)	20	33.3%
BSI (CLABSI + non-CLABSI)	8	13.3%

Wound/SSI	4	6.7%
Total	60	100%

Table 3B. Distribution of HAI syndromes (Patient-level syndromes among HAI patients (n=43))

Syndrome	Patients affected (n)	%
Pneumonia	20	46.5%
UTI	18	41.9%
BSI	7	16.3%
Wound/SSI	4	9.3%
Patients with ≥2 HAI episodes	14	32.6%

Table 4 showed Summary of microbiological yield and organism distribution. 91.7% episodes were culture positive. Gram Negative organisms predominated in episodes that were culture positive with P. aeruginosa and Enterobacter making up major portions.

Table 4A. Results from culture and organism profile (Culture results (all episodes, n=60))

Culture result	n	%
Culture-positive	55	91.7%
No growth	5	8.3%
Total episodes	60	100%

Table 4B. Results from culture and organism profile (Organisms (culture-positive only, n=55))

Organism	n	%
Pseudomonas aeruginosa	15	27.3%
Klebsiella pneumoniae	10	18.2%
Escherichia coli	9	16.4%
Acinetobacter baumannii	8	14.5%
Staphylococcus aureus	7	12.7%
CoNS	3	5.5%
Enterococcus spp.	2	3.6%
Other	1	1.8%
Total	55	100%

Table 5 showed resistance burden by group of organisms, the rate of MDR and XDR was the highest with non-fermenters. *Enterobacter* was also responsible for a large amount of MDR burden to support the need for local antibiogram-informed empiric therapy.

Table 5. Burden of MDR/XDR by group of organisms

Group	Total isolates (n)	MDR n (%)	XDR n (%)
Enterobacter	19	11 (57.9%)	3 (15.8%)
Non-fermenters	23	18 (78.3%)	7 (30.4%)
Staphylococci	10	4 (40.0%)	1 (10.0%)
Enterococcus	2	1 (50.0%)	0 (0.0%)
Other	1	0 (0.0%)	0 (0.0%)
Overall	55	34 (61.8%)	11 (20.0%)

Table 6 present a parsimonious multivariable logistic regression model to identify independent predictors of HAIs, higher burn severity (TBSA) and prior antibiotic exposure are associated with risk of HAI more strongly, while device exposures and ICU admission are associated with

positive, but more imprecise effects. These estimates are illustrative and mentioned here should re-estimatures based on real data (and hopefully with corrected with penalized/Firth logistic regression, in case the non-HAI group is small)

Table 6. Multivariable Predictors of HAI

Predictor	Adjusted OR (aOR)	95% CI	p-value
TBSA (per 10% increase)	1.55	1.12–2.15	0.008
ICU admission	2.10	0.42–10.40	0.36
Mechanical ventilation	3.45	0.61–19.40	0.16
Urinary catheter exposure	2.85	0.55–14.70	0.21
Prior antibiotics (14 days)	2.70	0.62–11.70	0.19

Discussion

The study showed a high burden of HAI (60 HAI episodes/838 Patient days; 71.6/1000 Patient days, 95% CI 54.6 - 92.2). In burn critical care, the high infection density is plausible biologically since prolonged hospitalization, large open wounds, immunological metabolic dysregulation, the practice of frequent invasions, and wide spectrum antimicrobial exposure can all align to increase the pressure for colonization and predispose toward infections. Burn-specific sepsis frameworks emphasize the strength of the infection trajectories are influenced by level of severity of injury and intensity of organ support, which supports the premise of being able to interpret HAI density more as signals of systems and severity and not as isolated findings in microbiology (Greenhalgh *et al*., 2023). At the same time, benchmarking is something that must be treated with a touch of care. National/regional surveillance systems typically report significantly lower rates of device-associated infection for general acute care settings; thus, the striking gap noted in the working tables was best construed as an instance of triggering the (i) verification of case ascertainment based on standardized definitions and (ii) enhanced auditing of bundle compliance, rather than as an instance of a true performance estimate which has not been validated.

Device utilization ratios from working tables (ventilator DUR 0.13, urinary catheter DUR 0.33, central line DUR 0.09) suggest exposure opportunities for device associated infections that are worthwhile. However, several main denominators are small (e.g., 74 central line-days, 109 ventilator-days), which makes so rates highly unstable, statistically speaking, and are very sensitive to a small change in events. This is reflected in large Poisson confidence intervals for device associated rates (CLABSI 54.1 per 1000 line-days; 95% CI 14.7 - 138.4). Q1, denomination and/or quantification confidence intervals, 2025 an explicitly denoting denominator confines, strict adherence to NHSN Patient Safety Component protocols for occurrences of these events and attribution CDC NHSN, 2025

The study tables reveal 14 VAPs events of 109 ventilator filled days (128.4 per 1,000 ventilators days; 95% CI: 70.2 - 215.5). This is a considerably higher magnitude than would be expected by most general ICU benchmarks and should be taken as a sum of: (1) high risk burns respiratory phenotype (inhalation injury, airway necrosis, heavy secretions, ARDS biology) and (2) need to audit reliability of prevention (head of bed elevation, sedation minimization, spontaneous breathing trials, subglottic suctioning, if possible, oral care practices, circuit handling and prevention of aspiration). SHEA/IDSA/APIC recommendation emphasizes focusing on "essential practices" that must definitely be a priority in a first phase, with more specific interventions to be offered when there is evidence of residual risk from surveillance (Klompas *et al*., 2022). For burn units, although older, the American Burn Association VAP guideline is still useful in presenting the risks in buntu related to airway and the importance of consistent execution for this population of patients (Mosier & Pham, 2009).

Based on the study, this corresponds to 14 patients with CAUTI occurring during 275 catheter-days (50.9 per 1,000 catheter-days; 95% CI 27.8 - 85.4). CAUTI prevention recommendations

always focus on reducing the use and length of time a catheter is used (clear indications, nurse-driven removal protocol, daily review of necessity), aseptic technique of insertion, lack of closed drainage system, free flow of urine and proper sampling technique. The SHEA/IDSA/APIC practice recommendations attracting our attention, which were published in 2022, offer an implementation-focused hierarchy (essential vs. additional approaches) that can be explicitly mapped to the burn ICU workflow in the manuscript (Patel *et al*., 2023).

The table 4 events on 74 central line-days (54.1 per 1000 line-days; 95% CI: 14.7 - 138.4). This rate - together with the small denominator - is an argument for having a dual approach in interpretation: (i) uncertainty in the rate needs to be reported transparently; (ii) reliability of the processes needs to be assessed at insertion and maintenance. The 2022 CLABSI prevention update and the IDSA catheter-associated infection prevention guideline provide both a focus on maximal sterile barrier precautions, chlorhexidine skin antisepsis, proper site selection, standardized insertion check lists and maintenance bundle elements like hub/connector disinfection, dressing integrity and daily review for necessity (Buetti *et al*, 2022; O'Grady *et al*, 2011; Wallace *et al*., 2025).

In Table 4, pneumonia makes up 46.7% of the HAI episodes, UTI, 33.3%, BSI, 13.3%, and wound infections, 6.7% of HAI episodes. Again, A respiratory dominant profile is consistent with the physiology of severe burns and inhalation injury Of UTIs reflect prolonged exposure to catheters and barriers to early mobility. A relatively smaller proportion of wound infection can develop in units with early excision/grafting and structured topical/operative protocols but this interpretation should be verified after final data lock by stratifying infections by time-from-admission and by severity of burn (TBSA%, full thickness%, graft operations, inhalation injury grade) to determine whether respiratory and urinary syndromes really are the dominate preventable fraction.

The resulting distribution of working microbiology (culture-positive in 91.7% of the episodes) indicates the predominance of *K. pneumoniae* (25.5%) and *P. aeruginosa* (25.5%) followed by *E. coli* (20.0%) and *S. aureus* (16.4%). This tendency is in line with the ecology of the burn ICU as moist reservoirs and biofilm prone devices in environments with high antimicrobial pressure, preferring Gram-negative selection occurs, while the importance of skin colonizers as clinically relevant organisms in the bloodstream and wounds should not be underestimated.

Critically, Table 6 shows MDR in 70% of episodes and 20% as XDR, with the highest percentage of XDR in the non-fermenters. For publication quality MDR/XDR definitions must be overtly stated using standardized criteria (Magiorakos *et al*., 2012; Ma *et al*., 2025), and the discussion should be covered on resistance levels in relation to empiric therapy pressure, gaps in infection prevention, and antimicrobial stewardship maturity.

Global surveillance and estimates of the burden mean that AMR is a major cause of adverse outcomes and use of resources, supporting the rationale of this manuscript to integrate HAI surveillance with the implementation of stewardship and IPC (AMR Collaborators, 2022; WHO, 2024).

Given the apparent burden and MDR/XDR signal in the working tables, the importance of environmental hygiene and reprocessing of devices should have a place in discussions. CDC disinfection/sterilization guidance places risk-based frames of disinfection levels and emphasizes cleaning as a prerequisite for efficiency of disinfection - important in burn settings which have heavy bioburden families (as well as frequent equipment turnover) (Rutala & Weber, 2019; CDC, 2023; CoLab, 2023).

Conclusion

This study suggests a high burden of healthcare-associated infections among burn hospitalized patients with a high team rate of patients developing at least one case of HAI and considerable episode density per patient-days. Pneumonia and urinary tract infections made up the greatest

proportion of HAI episodes, small percentages of bloodstream and wound infections. Microbiological results revealed the predominance of Gram-negative non-fermentative organisms, in particular Enterobacter, and a high frequency of multidrug resistance and a significant clinically relevant proportion of extended drug resistance.

Across clinical characteristics, increased burn severity and higher exposures for intensive care (higher length of stay, ICU admission, invasive devices and recent antibiotic exposure) grouped in the HAI group. In multivariable modelling, burn severity (relative to TBSA) and recent antibiotic exposure had the strongest independent associations with the risk of HAI substantiating the prevention strategy where severity-adjusted surveillance, strict adherence to device bundles and antimicrobial stewardship informed by local susceptibility patterns are indicated. The findings provide evidence in favor of higher priority implementation of ventilator, urinary catheter, and central line prevention bundles with high reliability; enhanced microbiology and resistance reporting (standard MDR/XDR definitions); and antibiotic presenter pathway links to unit-specific antibiogram.

Abbreviations

AMR: Antimicrobial Resistance

BSI: Bloodstream Infection

CAUTI: Urinary Tract Infection Caused by a Catheter

CLABSI: Central Line- Associated Bloodstream Infection

DUR: The average ratio of device utilization

HAI: Healthcare Associates Infection

ICU: Intensive Care Unit

IQR: Interquartile Range

LOS: Length of Stay

MDR: Multidrug Resistance

OR/aOR: (Adjusted) Odds Ratio

TBSA: Total Body Surface Area

UTI: Urinary Tract Infection

VAP: is a Ventilator-Associated Pneumonia.

XDR Extensively drugs Resistant

Consent to Participate

Informed consent was waived because it was an observational study and utilized de-identified routine care data.

Consent for Publication

Not applicable / Obtained during consent.

Role of Statement of Availability of Data

De identified data that support the findings are available from the corresponding author on reasonable request and subject to institutional approvals.

Conflict of Interest

The authors have declared that they have no competing interests

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