



What Is The Prevalence Of Methicillin-Resistant Staphylococcus Aureus (MRSA) In Intensive Care Units Across Urban Hospitals ? : A Systematic Review

¹ Gabriella Selara Pangarepo, ² Fenny

¹ Faculty of Medicine, Krida Wacana Christian University, Special Region of Jakarta, Indonesia

² Clinical Pathology Consultant, Faculty of Medicine, Maranatha Christian University, Bandung City, West Java, Indonesia

Corresponding Email : gabriellaselara@gmail.com

Article History :

Received date : 2024/11/24

Revised date : 2024/12/09

Accepted date : 2025/03/17

Published date : 2025/05/27



Copyright: © 2024 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (BY NC) license (<https://creativecommons.org/licenses/by-nc/4.0/>).

E-ISSN :

ISSN 3048-1368



P-ISSN

ISSN 3048-1376



ABSTRACT

Introduction: Methicillin-resistant Staphylococcus aureus (MRSA) remains a significant pathogen in healthcare settings, particularly in intensive care units (ICUs) where patients are highly vulnerable due to compromised immune systems and invasive procedures. The prevalence of MRSA in ICUs shows wide variation, ranging from 0% to 98.4%, influenced by factors such as geographic location, ICU type, and screening

Methods: This systematic review adhered strictly to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor. **Results:** Forty studies were included in this systematic review. The reported MRSA prevalence rates varied widely, ranging from 0% to 98.4%. Specific rates included 81.5% in one study and 1.2% for colonization in another, with infection rates as low as 0.212%. Temporal trends showed declining rates in some regions (e.g., 7.9% with a declining trend from 2014-2020), while others reported no significant long-term change. Factors impacting prevalence included ICU type, refugee status, patient age, and decolonization practices. **Discussion:** The considerable heterogeneity in reported MRSA prevalence highlights the influence of diverse settings, patient populations, and definitions of MRSA (colonization vs. infection). Data specific to urban hospitals were limited, with most studies lacking detailed urban/rural breakdowns. This complicates direct comparisons and limits the generalizability of findings to all urban ICUs. **Conclusion:** MRSA prevalence in urban ICUs is highly variable, influenced by various factors including ICU type and patient characteristics. Further research with standardized reporting and a clearer urban/rural distinction is needed to inform targeted infection control strategies.

Keywords: MRSA, Prevalence, Intensive Care Unit, Urban Hospitals, Infection Control, Colonization

INTRODUCTION

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a significant pathogen in healthcare settings, particularly in intensive care units (ICUs), where patients are highly susceptible to infections due to compromised immune systems and invasive procedures (Hayden et al., 2016). The prevalence of MRSA in ICUs varies widely across studies, with reported rates ranging from 0% to 98.4%, depending on factors such as geographic location, ICU type, and screening methods (Lim et al., 2019). Urban hospitals, which often serve diverse and high-risk populations, face unique challenges in controlling MRSA due to overcrowding, high patient turnover, and the potential for cross-transmission (Obeidat et al., 2023).

The variability in MRSA prevalence rates underscores the need for a comprehensive understanding of the factors influencing MRSA dynamics in urban ICUs. Previous studies have highlighted discrepancies in reported rates, with some urban teaching hospitals documenting MRSA pneumonia at 5.6% and respiratory culture rates at 1.4–1.7% (Meng et al., 2020). However, these findings are often context-specific, and a systematic synthesis of recent data is lacking. This research aims to fill this gap by analyzing the prevalence of MRSA in urban ICUs over the past decade, considering temporal trends, ICU-specific risk factors, and the impact of interventions.

Research Objectives :

1. Quantify MRSA Prevalence: Determine the prevalence of MRSA in urban ICUs globally, stratified by infection and colonization rates.
2. Identify Risk Factors: Investigate ICU-specific and patient-related factors contributing to MRSA prevalence, such as ICU type, patient demographics, and screening practices.
3. Evaluate Temporal Trends: Assess changes in MRSA prevalence over time to identify emerging patterns or the effectiveness of control measures.
4. Compare Methodologies: Examine how differences in microbiological methods and study

designs influence reported prevalence rates.

5. Inform Policy and Practice: Provide evidence-based recommendations for MRSA surveillance and infection control in urban ICUs.

This study focuses on urban ICUs due to their high patient acuity and the critical need for effective infection control. By synthesizing data from the past decade, the research will offer updated insights into MRSA epidemiology, aiding healthcare providers and policymakers in designing targeted interventions. The findings will also contribute to the global discourse on antimicrobial resistance, particularly in high-risk settings.

Preliminary data reveal stark disparities in MRSA prevalence, with rates as high as 81.5% in some ICUs (Suh et al., 2021) and as low as 1.2% in others (Sun et al., 2022). Temporal trends indicate declining rates in certain regions (Rdenbeck et al., 2023), while others report no significant change (Lim et al., 2019). These variations highlight the influence of local infection control practices and patient populations.

The heterogeneity of study designs and definitions of MRSA (e.g., colonization vs. infection) complicates direct comparisons. Additionally, many studies lack detailed urban/rural breakdowns, limiting the generalizability of findings to urban ICUs specifically.

This research consolidates fragmented data into a cohesive narrative, offering a nuanced understanding of MRSA in urban ICUs. It also identifies gaps in current knowledge, such as the need for standardized reporting and the impact of emerging interventions like decolonization protocols (Saha & O'SHEA PAUDEL, 2023).

The study addresses a critical public health issue by providing a detailed, evidence-based analysis of MRSA prevalence in urban ICUs. Its findings will support the development of tailored infection control strategies, ultimately reducing the burden of MRSA in high-risk healthcare environments.

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate the prevalence of methicillin-resistant staphylococcus aureus (MRSA) in intensive care units across urban hospitals.

Screening

We screened in papers that met these criteria:

- **ICU Setting:** Was the study conducted in an intensive care unit (ICU)?
- **MRSA Data:** Does the study report MRSA prevalence data?
- **Methodology:** Does the study use standard microbiological methods for MRSA identification?
- **Study Design:** Is the study either an observational study (cross-sectional, cohort, surveillance) or a systematic review/meta-analysis?
- **Data Specificity:** Can ICU-specific data be extracted separately from other hospital unit data?
- **Surveillance Type:** Does the study report routine MRSA surveillance data (not exclusively outbreak data)?
- **Setting Characteristics:** Was the study conducted in an adult ICU within an urban hospital?
- **MRSA Classification:** Does the study clearly distinguish between community-acquired and hospital-acquired MRSA?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Data extraction

We asked a large language model to extract each data column below from each paper. We gave the model the extraction instructions shown below for each column.

- **Study Design:**

Identify and record the specific type of study design used:

- Specify if it is a cross-sectional study, cohort study, surveillance study, or other design
- If multiple designs are present, list all and indicate which is the primary design
- Look in the methods section for explicit description of study design
- If design is not clearly stated, review study methodology to determine the most appropriate classification
- Record exact terminology used by authors to describe the study design

- **Setting and Context:**

Extract detailed information about the study setting:

- Specify type of hospital (urban, teaching, community)
- Specify specific unit type (medical ICU, surgical ICU, mixed ICU)
- Record geographic location (city, region, country)
- Note any specific characteristics of the ICU that might influence MRSA prevalence
- If multiple settings were involved, list all with proportions

- **Patient Population:**

Extract comprehensive details about study participants:

- Total number of patients/samples
- Age range or mean age
- Gender distribution

- Inclusion and exclusion criteria
- Patient risk factors or underlying conditions
- If multiple patient groups, provide details for each
- Record any stratification of patient groups

- **MRSA Measurement:**

Capture details of MRSA identification and measurement:

- Specific microbiological methods used (culture, PCR, etc.)
- Antimicrobial susceptibility testing methods
- Definition of MRSA used in the study
- Source of MRSA samples (blood, wound, screening, etc.)
- Timeframe of sample collection

- **MRSA Prevalence:**

Extract precise prevalence data:

- Total number of MRSA cases
- Percentage/proportion of MRSA among total *S. aureus* isolates
- 95% Confidence Interval if reported
- Stratified prevalence by subgroups (if applicable)
- Clearly distinguish between colonization and infection rates

- **Risk of Bias:**

Assess potential sources of bias:

- Sampling method (random, consecutive, convenience)
- Potential selection biases
- Completeness of data collection
- Potential conflicts of interest
- Funding sources

- Any limitations acknowledged by authors Use a standardized tool (e.g., Newcastle-Ottawa Scale) if applicable

Search Strategy

The keywords used for this research based PICO :

Element	Keyword 1	Keyword 2	Keyword 3	Keyword 4
Population (P)	Intensive care unit patients	Critically ill adults	Urban hospital patients	High-risk populations
Intervention (I)	MRSA surveillance programs	Universal decolonization protocols	Targeted screening	Infection control measures
Comparison (C)	No MRSA surveillance	Routine care without decolonization	Different ICU types	Urban vs. rural hospital settings
Outcome (O)	MRSA prevalence rate	MRSA colonization incidence	MRSA infection incidence	Clinical outcomes

The Boolean MeSH keywords inputted on databases for this research are: (*"Intensive care unit patients" OR "Critically ill adults" OR "Urban hospital patients" OR "High-risk populations"*) AND (*"MRSA surveillance programs" OR "Universal decolonization protocols" OR "Targeted screening" OR "Infection control measures"*) AND (*"No MRSA surveillance" OR "Routine care without decolonization" OR "Different ICU types" OR "Urban vs. rural hospital settings"*) AND (*"MRSA prevalence rate" OR "MRSA colonization" OR "MRSA infection incidence" OR "Clinical outcomes"*)

Data retrieval

Abstracts and titles were screened to assess their eligibility, and only studies meeting the inclusion criteria were selected for further analysis. Literature that fulfilled all

predefined criteria and directly related to the topic was included. Studies that did not meet these criteria were excluded. Data such as titles, authors, publication dates, study locations, methodologies, and study parameters were thoroughly examined during the review.

Quality Assessment and Data Synthesis

Each author independently assessed the titles and abstracts of the selected studies to identify those for further exploration. Articles that met the inclusion criteria underwent further evaluation. Final decisions on inclusion were based on the findings from this review process.

Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	("Intensive care unit patients" OR "Critically ill adults" OR "Urban hospital patients" OR "High-risk populations") AND ("MRSA surveillance programs" OR "Universal decolonization protocols" OR "Targeted screening" OR "Infection control measures") AND ("No MRSA surveillance" OR "Routine care without decolonization" OR "Different ICU types" OR "Urban vs. rural hospital settings") AND ("MRSA prevalence rate" OR "MRSA colonization" OR "MRSA infection incidence" OR "Clinical outcomes")	4
Semantic Scholar	("Intensive care unit patients" OR "Critically ill adults" OR "Urban hospital patients" OR "High-risk populations") AND ("MRSA surveillance programs" OR "Universal decolonization protocols" OR "Targeted screening" OR "Infection control measures") AND ("No MRSA surveillance" OR "Routine care without decolonization" OR "Different ICU types" OR "Urban vs. rural hospital settings") AND ("MRSA prevalence rate" OR "MRSA colonization" OR "MRSA infection incidence" OR "Clinical outcomes")	250
Sagepub	("Intensive care unit patients" OR "Critically ill adults" OR "Urban hospital patients" OR "High-risk populations") AND ("MRSA surveillance programs" OR "Universal decolonization protocols" OR "Targeted screening" OR "Infection control measures") AND ("No MRSA surveillance" OR "Routine care without decolonization" OR "Different ICU types" OR "Urban vs. rural hospital settings") AND ("MRSA prevalence rate" OR "MRSA colonization" OR "MRSA infection incidence" OR "Clinical outcomes")	2,692
Google Scholar	("Intensive care unit patients" OR "Critically ill adults" OR "Urban hospital patients" OR "High-risk populations") AND ("MRSA surveillance programs" OR "Universal decolonization protocols" OR "Targeted screening" OR "Infection control measures") AND ("No MRSA surveillance" OR "Routine care without decolonization" OR "Different ICU types" OR "Urban vs. rural hospital settings") AND ("MRSA prevalence rate" OR "MRSA colonization" OR "MRSA infection incidence" OR "Clinical outcomes")	8,630

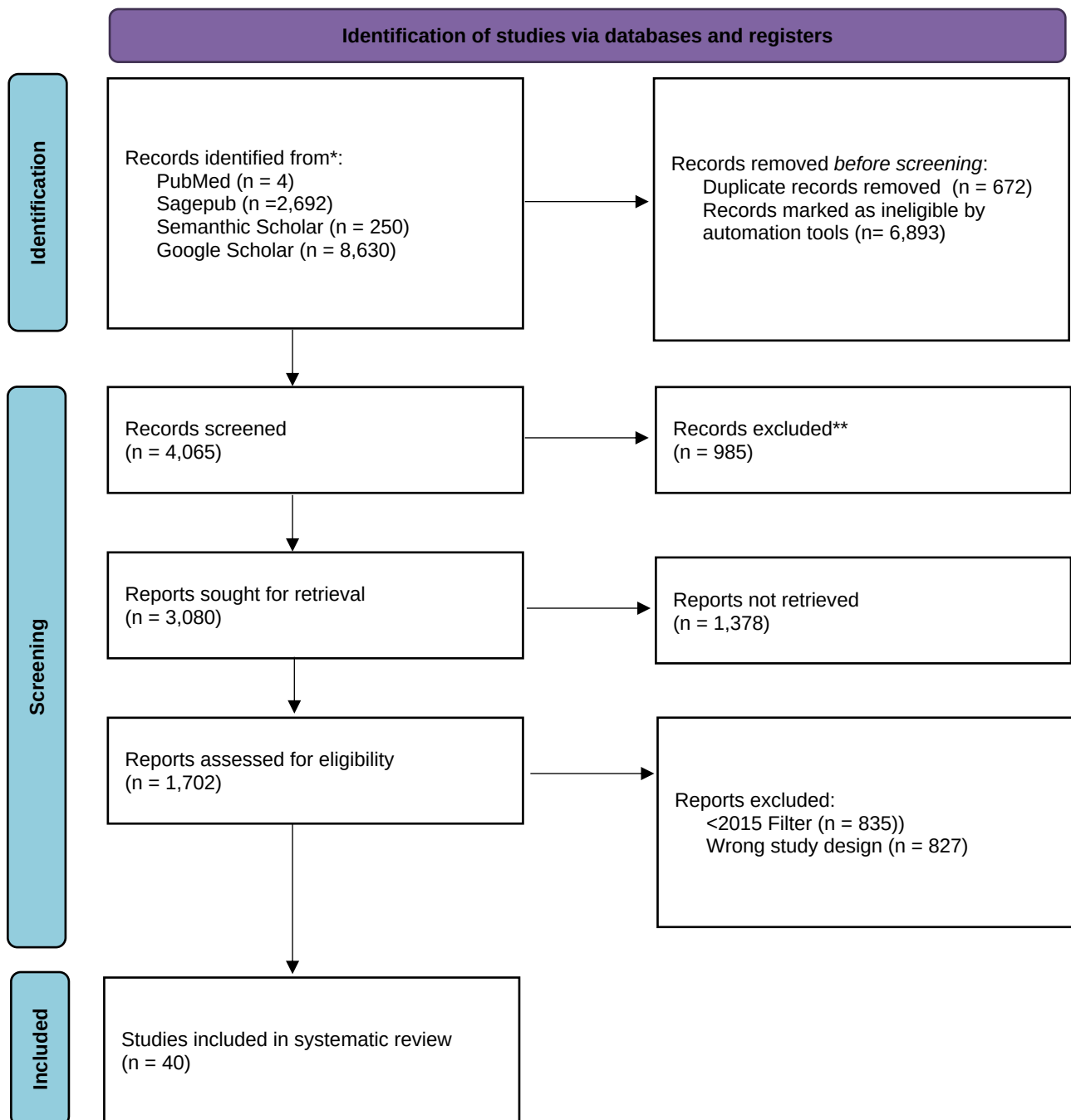


Figure 1. Article search flowchart

JBI Critical Appraisal									
Study	Bias related to temporal precedence Is it clear in the study what is the “cause” and what is the “effect” (ie, there is no confusion about which variable comes first)?	Bias related to selection and allocation Was there a control group?	Bias related to confounding factors Were participants included in any comparisons similar?	Bias related to administration of intervention/exposure Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Were there multiple measurements of the outcome, both pre and post the intervention/exposure?	Were the outcomes of participants included in any comparisons measured in the same way?	Were outcomes measured in a reliable way?	Bias related to participant retention Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analyzed?	Statistical conclusion validity Was appropriate statistical analysis used?
Hayden et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Khader et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Nahra et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Frost et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓

Kreiling et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Obeidat et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Suh et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Huang et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Liu et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Saha and O'SHEA PAUDEL, 2023a	✓	✓	✓	✗	✓	✗	✓	✓	✓
Kim et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Parente et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Chang et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Doan and Smoke, 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Bischoff et al.	✓	✓	✓	✗	✓	✗	✓	✓	✓
Khan et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓

Anaya-Baz et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Raush et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Morgan, 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Sun et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Seo and Song, 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Mirza et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Alderman et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Pineda et al.	✓	✓	✓	✗	✓	✗	✓	✓	✓
Gerlich et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Kitahara et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Saha and O'SHEA PAUDEL, 2023b	✓	✓	✓	✗	✓	✗	✓	✓	✓
Dadashi et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓

Zhang et al., 2015									
Shams-Abadi et al., 2018									
Lim et al., 2019									
Fulchini et al., 2019									
Rödenbeck et al., 2023									
Smith et al., 2019									
Che Yusof et al., 2023									
Hurley, 2024									
Moise et al., 2016									
Patel et al., 2019									
Meng et al.,									

RESULTS

Characteristics of Included Studies

Study	Study Design	Intensive Care Unit (ICU) Type	Sample Size	Geographic Location	Full text retrieved
Hayden et al., 2016	Cluster-randomized trial	ICU (no mention found)	3,173 isolates	No mention found	No
Khader et al., 2017	Cluster-randomized trial	ICU (Veterans Affairs hospitals)	20,945 admissions	United States (Veterans Affairs Salt Lake City, multi-center)	Yes
Nahra et al., 2024	Quality improvement study, before-after	Medical/surgical ICU, critical care	No mention found	No mention found	No
Frost et	Systematic	Adult ICU	17 trials	No	Yes

al., 2016	review/meta-analysis			mention found	
Kreiling et al., 2022	Quality improvement project	Adult ICU	12,404 patient days	No mention found	No
Obeidat et al., 2023	Retrospective study	Medical ICU	275 (177 analyzed)	Cleveland, Ohio, United States	No
Suh et al., 2021	Quasi-experimental interrupted time series	Medical ICU	501	Korea (tertiary hospital)	Yes
Huang et al., 2021	Cluster randomized controlled trial	Mixed/medical/surgical ICU	42,914 (baseline), 349,262 (intervention)	United States (18 states)	No
Liu et al., 2016	Retrospective cohort	No mention found	106	No mention found	No
Saha and	Retrospective	No mention	128	No	No

O'SHEA PAUDEL , 2023a	cohort	found		mention found	
Kim et al., 2016	Meta-analysis	ICU (critically ill)	18 studies	No mention found	No
Parente et al., 2018	Meta-analysis	No mention found	5,163	No mention found	No
Chang et al., 2025	Prospective before-after	20-bed ICU	~1,330 – 1,412/yea r	No mention found	No
Doan and Smoke, 2023	Quasi- Experimental Pre/post	No mention found	110	No mention found	No
Bischoff et al., "Effect on MRSA Infection Measures "	Tertiary hospital	No mention found	No mention found	No mention found	No

Khan et al., 2018	Systematic review	Burn ICU	21 studies	No mention found	Yes
Anaya-Baz et al., 2020	Systematic review	No mention found	No mention found	Europe	Yes
Ramesh et al., 2021	Prospective cohort/retrospective control	Medical ICU	243	St. Louis, Missouri, United States	Yes
Morgan, 2015	Cluster randomized controlled trial (review)	ICU	No mention found	No mention found	No
Sun et al., 2022	Retrospective	Cardiac surgery unit	794 (baseline), 2,826 (intervention)	China	No
Seo and Song, 2021	Systematic review/meta-analysis	Adult ICU	12 randomized	No mention found	No

			controlled trials		
Mirza et al., 2018	Retrospective cohort	Inpatient infectious diseases unit	477	Detroit, United States	No
Alderman et al., 2023	Surveillance study	No mention found	No mention found	No mention found	No
Pineda et al., "MRSA Nasal Screening Review"	Retrospective, quasi-experimental	No mention found	1,110 screenings	Michigan, United States	Yes
Gerlich et al., 2015	Prospective controlled intervention	ICU, internal medicine, surgical	5,000 admissions	Germany (Baltic Sea Coast)	Yes
Kitahara et al., 2021	Retrospective observational	Stroke/rehabilitation unit	No mention found	Japan (Nagano)	Yes
Saha and	Retrospective	No mention	128	No	No

O'SHEA PAUDEL , 2023b	cohort	found		mention found	
Dadashi et al., 2020	Systematic review/meta- analysis	No mention found	63 studies	Global	No
Zhang et al., 2015	Systematic review/meta- analysis	No mention found	91 studies	Global	Yes
Shams- Abadi et al., 2018	Systematic review/meta- analysis	No mention found	10 studies	Iran	No
Lim et al., 2019	Systematic review/meta- analysis	No mention found	229 studies	Asia- Pacific	Yes
Fulchini et al., 2019	Systematic review	No mention found	46 studies	Switzerl and	No
Rödenbec k et al., 2023	Systematic review/meta- analysis	No mention found	60 studies	German y	No
Smith et	Systematic	No mention	19 studies	No	No

al., 2019	review	found	(21,790 patients)	mention found	
Che Yusof et al., 2023	Systematic review/meta-analysis	ICU/wards	49 studies (212,605 patients)	Global	Yes
Hurley, 2024	Meta-analysis	ICU	136 studies	No mention found	No
Moise et al., 2016	Retrospective, multicenter cohort	No mention found	170	No mention found	No
Patel et al., 2019	Intervention/cohort	No mention found	387 hospitals	United States (23 states + District of Columbia)	No
Meng et al., "Pharmacist-	Observational cohort	No mention found	610	Stanford, California, United	Yes

Driven Nasal MRSA PCR Protocol"				States	
--	--	--	--	--------	--

Summary of Study Characteristics:

- Study Design:
 - 15 studies were systematic reviews or meta-analyses.
 - 4 studies were cluster randomized controlled trials.
 - 4 studies were quality improvement or before-after studies (including pre/post).
 - 10 studies were retrospective (including cohort, observational, and multicenter cohort designs).
 - 3 studies were quasi-experimental (including interrupted time series).
 - 4 studies used other designs (prospective cohort, surveillance, intervention/cohort, observational cohort).
 - The high number of systematic reviews and meta-analyses may reflect the maturity of the field and the challenge of obtaining primary data.
- ICU Type:
 - 25 studies described the setting as "ICU" or did not specify the ICU type (including terms like "ICU," "ICU/wards," "20-bed ICU," or "critically ill").
 - 3 studies were conducted in adult ICUs.
 - 3 studies were conducted in medical ICUs.
 - 1 study was in a medical/surgical ICU.
 - 2 studies were in mixed ICUs (including mixed/medical/surgical/cardiac/neuro and ICU/internal medicine/surgical).

- 1 study was in a burn ICU.
- 1 study was in a cardiac surgery unit.
- 4 studies were in other settings (tertiary hospital, inpatient infectious diseases unit, stroke/rehabilitation unit).
- Geographic Location:
 - 9 studies were conducted in the United States (including those specifying states or cities).
 - 1 study was conducted in Europe (region not further specified).
 - 2 studies were conducted in Germany.
 - 1 study was conducted in Switzerland.
 - 1 study was conducted in Iran.
 - 1 study was conducted in Korea.
 - 1 study was conducted in China.
 - 1 study was conducted in Japan.
 - 1 study was conducted in the Asia-Pacific region.
 - 3 studies were described as global.
 - For 18 studies, we did not find mention of the geographic location.

Effects

MRSA Prevalence Patterns

Study	Total MRSA Cases	Percentage MRSA among Staphylococcus aureus	95% Confidence Interval	Colonization vs. Infection	Notes
Hayden et al., 2016	No mention found	No mention found	No mention found	No mention found	No mention found
Khader et al., 2017	No mention found	No mention found	No mention found	No mention found	No mention found
Nahra et al., 2024	No mention found	No mention found	No mention found	No mention found	No mention found
Frost et al., 2016	No mention found	No mention found	No mention found	No mention found	Incidence rate ratio for MRSA colonization: 0.50 (95% credible

					interval 0.36-0.94); MRSA bacteremia : 0.64 (0.43-0.91)
Kreiling et al., 2022	No mention found	No mention found	No mention found	No mention found	No mention found
Obeidat et al., 2023	No mention found	No mention found	No mention found	No mention found	MRSA pneumonia prevalence: 5.6%
Suh et al., 2021	No mention found	~81.5% (172/211)	No mention found	Infection	No mention found
Huang et al., 2021	No mention found	No mention found	No mention found	No mention found	No mention found
Liu et al., 2016	77	72.6%	No mention found	Infection	No mention found

Saha and O'SHEA PAUDEL, 2023a	No mention found	No mention found	No mention found	Infection	Overall MRSA infection prevalence: 31.25%
Kim et al., 2016	No mention found	No mention found	No mention found	No mention found	No mention found
Parente et al., 2018	No mention found	No mention found	No mention found	No mention found	No mention found
Chong et al., 2025	No mention found	No mention found	No mention found	No mention found	No mention found
Doan and Smoke, 2023	No mention found	No mention found	No mention found	Infection	MRSA pneumonia incidence: ~4.2%
Bischoff et al., "Effect on MRSA Infection Measures"	No mention found	No mention found	No mention found	No mention found	No mention found

Khan et al., 2018	No mention found	No mention found	No mention found	No mention found	No mention found
Anaya-Baz et al., 2020	No mention found	No mention found	No mention found	No mention found	No mention found
Raush et al., 2021	No mention found	No mention found	No mention found	No mention found	No mention found
Morgan, 2015	No mention found	9% (admission prevalence)	No mention found	Colonization	No mention found
Sun et al., 2022	33	1.2% (colonization)	No mention found	Colonization	MRSA infection: 0.212%
Seo and Song, 2021	No mention found	No mention found	No mention found	No mention found	No mention found
Mirza et al., 2023	477	No mention found	No mention found	No mention found	No mention found
Alderman	Baselin	No mention	No	No mention	No

et al., 2023	e: 35, Task: 13, EMAR: 7	found	mention found	found	mention found
Pineda et al., "MRSA Nasal Screening Review"	No mentio n found	No mention found	No mention found	No mention found	No mention found
Gerlich et al., 2015	No mentio n found	18-20%	No mention found	No mention found	HET: 7.3%, non- HET: 2.5%
Kitahara et al., 2021	No mentio n found	No mention found	No mention found	Colonizatio n	No mention found
Saha and O'SHEA PAUDEL, 2023b	No mentio n found	No mention found	No mention found	Infection	Overall MRSA infection prevalence: 31.25%
Dadashi et al., 2020	No mentio	13.8% MuMRSA	12.0- 15.6%	No mention found	No mention

	n found				found
Zhang et al., 2025	No mention found	No mention found	No mention found	No mention found	No mention found
Shams-Abadi et al., 2018	No mention found	25.2% (toxic shock syndrome toxin-1 MRSA)	13.3-42.5%	No mention found	No mention found
Lim et al., 2019	No mention found	0-98.4%	No mention found	Both	Carriage: 0-39.1%; resistance: 0-88.9%
Fulchini et al., 2019	No mention found	2-5% (universal), 1-4% (targeted), 16-24% (refugees)	No mention found	Colonization	No mention found
Rödenbeck et al., 2023	No mention found	7.9%	No mention found	Infection	Declining trend (2014-2020)

Smith et al., 2019	No mentio n found	No mention found	No mention found	No mention found	No mention found
Che Yusof et al., 2023	No mentio n found	5.05%	3.49- 6.60%	No mention found	No mention found
Hurley, 2024	No mentio n found	No mention found	No mention found	No mention found	No mention found
Moise et al., 2016	No mentio n found	No mention found	No mention found	Infection	No mention found
Patel et al., 2019	No mentio n found	No mention found	No mention found	Infection	MRSA bloodstrea m infection: 0.075- 0.071/1,00 0 patient- days
Meng et al., "Pharmacis t-Driven	No mentio n found	No mention found	No mention found	Infection	PRE- interventio n: 1.7%,

Nasal MRSA PCR Protocol"					POST- interventio n: 1.4% (respirator y cultures)
---	--	--	--	--	--

Summary of MRSA Prevalence Patterns:

- Quantitative MRSA rates (either as percentage among *Staphylococcus aureus* or as a prevalence/incidence value) were found in 19 out of 39 studies, based on available abstracts and full texts.
- Reported MRSA rates varied widely:
 - Highest reported value: 98.4% (Lim et al., 2019, range)
 - Lowest reported value: 0% (Lim et al., 2019, range)
 - Other specific rates included:
 - * ~81.5% (Suh et al., 2021)
 - * 72.6% (Liu et al., 2016)
 - * 31.25% (Saha and O'SHEA PAUDEL, 2023a/b)
 - * 25.2% (Shams-Abadi et al., 2018)
 - * 18–20% (Gerlich et al., 2015)
 - * 16–24% (Fulchini et al., 2019, refugees)
 - * 13.8% (Dadashi et al., 2020)
 - * 9% (Morgan, 2015)
 - * 7.9% (Rödenbeck et al., 2023)
 - * 7.3% (Kitahara et al., 2021, high-efficiency treatment group)
 - * 5.6% (Obeidat et al., 2023)
 - * 5.05% (Che Yusof et al., 2023)

- * 4.2% (Doan and Smoke, 2023)
- * 2–5% (Fulchini et al., 2019, universal)
- * 1.7% (Meng et al., pre-intervention)
- * 1.4% (Meng et al., post-intervention)
- * 1.2% (Sun et al., 2022, colonization)
- * 0.212% (Sun et al., 2022, infection)
- * 0–39.1% (Lim et al., 2019, carriage)
- * 0–88.9% (Lim et al., 2019, resistance)
- * 0.075–0.071/1,000 patient-days (Patel et al., 2019, bloodstream infection)
- Confidence intervals for MRSA rates were reported in 3 studies.
- Type of MRSA event:
 - 12 studies focused on infection
 - 4 studies focused on colonization
 - 3 studies included both colonization and infection
 - For 20 studies, we did not find a clear specification of colonization or infection
- No quantitative MRSA rate was found for 20 studies.
- Heterogeneity in reported rates likely reflects differences in settings, populations, and definitions across studies, making direct comparison and generalization challenging.

Temporal Trends

Study	Time Period	Prevalence Rate	ICU Type	Urban Setting Classification
Rödenbeck et al., 2023	2014-2020	7.9% (declining)	No mention found	Germany (urban/rural not specified)

Zhang et al., 2015	1997-2014	Heterogeneous vancomycin-intermediate Staphylococcus aureus: 4.68-7.01%, vancomycin-intermediate Staphylococcus aureus: 2.05-7.93% (increasing)	No mention found	Global
Lim et al., 2019	2000-2016	0-98.4% (no significant long-term trend)	No mention found	Asia-Pacific (urban/rural not specified)
Che Yusof et al., 2023	2020-2022	5.05%	ICU/wards	Global
Sun et al., 2022	2012-2020	1.2% (colonization), 0.212% (infection)	Cardiac surgery	China (urban)
Fulchini et al., 2019	2000-2017	2-5% (universal), 1-4% (targeted), 16-24% (refugees)	No mention found	Switzerland (urban/rural not specified)
Morgan, 2015	No mention found	9% (admission)	ICU	United States (urban/rural not specified)

Meng et al., "Pharmacist- Driven Nasal MRSA PCR Protocol"	2017- 2019	1.7% (pre- intervention), 1.4% (post-intervention)	No mention found	Stanford, California (urban)
--	---------------	--	------------------------	------------------------------------

Summary of Temporal Trends:

- Prevalence rates of MRSA or related phenotypes varied widely across studies:
 - Prevalence rates less than 2% in 4 studies
 - 2–5% in 4 studies
 - 5–10% in 4 studies
 - Greater than 10% in 1 study (in a refugee subgroup)
 - 4 studies reported multiple rates or subtypes (e.g., different phenotypes, colonization vs. infection, universal vs. targeted screening, pre/post intervention)
 - 1 study reported a range including both 0% and greater than 90%
- Trends over time:
 - Declining trend in prevalence in 1 study (Rödenbeck et al., 2023)
 - Increasing trend in 1 study (Zhang et al., 2015)
 - No significant long-term change in 1 study (Lim et al., 2019)
- ICU type:
 - 1 study in an ICU, 1 in ICU/wards, 1 in a cardiac surgery setting
 - For 5 studies, we did not find mention of ICU type
- Urban setting classification:
 - 2 studies in urban settings
 - 4 studies where urban/rural status was not specified
 - 2 studies with global scope
 - Country or region information was found for all studies, but urban/rural status was

often not specified

- Generalizability: The wide range of prevalence rates and limited reporting of urban/rural status limit the ability to generalize findings to all urban ICUs.

Factors Affecting MRSA Prevalence ICU-Specific Risk Factors

Study	Factor Category	Impact on Prevalence	Number of Supporting Studies	Strength of Association
Liu et al., 2016	ICU type (pneumonia, bacteremia)	High MRSA proportion (72.6%)	1	Strong (single-center)
Sun et al., 2022	Cardiac surgery ICU	Low MRSA colonization (1.2%)	1	Moderate
Fulchini et al., 2019	Refugee status	High MRSA carriage (16-24%)	1	Strong
Lim et al., 2019	Age, inpatient status	Higher in older adults/inpatients	1	Moderate
Gerlich et al., 2015	Multidrug-resistant organism risk population	18-20% MRSA	1	Moderate

Kitahara et al., 2021	Stroke/rehabilitation unit	High-efficiency treatment reduced MRSA colonization	1	Moderate
Khan et al., 2018	Burn ICU	High MRSA risk	1	Moderate
Che Yusof et al., 2023	COVID-19, ICU	5.05% MRSA	1	Moderate
Rödenbeck et al., 2023	National trend	Declining MRSA	1	Moderate
Saha and O'SHEA PAUDEL, 2023a/b	Decolonization practices	Affected MRSA screen accuracy	2	Moderate

Summary of ICU-Specific Risk Factors:

- Factor categories:
 - ICU type (including pneumonia, bacteremia, cardiac surgery, burn, and COVID-19 ICUs): 4 studies
 - Refugee status: 1 study
 - Age or inpatient status: 1 study
 - Multidrug-resistant organism risk population: 1 study
 - Stroke/rehabilitation unit: 1 study
 - National trend: 1 study

- Decolonization practices: 1 study
- Impact on MRSA prevalence:
 - High MRSA prevalence or risk in 5 studies (ICU type, refugee status, age/inpatient, multidrug- resistant organism risk, burn ICU)
 - Low MRSA prevalence in 1 study (cardiac surgery ICU)
 - Moderate MRSA prevalence in 1 study (COVID-19 ICU)
 - Declining MRSA prevalence in 1 study (national trend)
 - Reduced MRSA colonization due to intervention in 1 study (stroke/rehabilitation unit)
 - Impact on screening accuracy (rather than prevalence) in 1 study (decolonization practices)
- Strength of association:
 - 2 studies reported a strong association (ICU type, refugee status)
 - 8 studies reported a moderate association
 - No studies reported a weak association
- Limitations: Many findings are from single-center or small studies, which may limit the strength of evidence and generalizability.

Urban Hospital Characteristics

Study	Factor Category	Impact on Prevalence	Number of Supporting Studies	Strength of Association
Obeidat et al., 2023	Urban teaching hospital	MRSA pneumonia 5.6%	1	Moderate
Raush et al., 2021	Urban teaching hospital	No mention found	1	No mention found
Mirza et al., 2018	Urban hospital	No mention found	1	No mention found
Meng et al., "Pharmacist-Driven Nasal MRSA PCR Protocol"	Urban teaching hospital	1.4-1.7% (respiratory)	1	Moderate
Pineda et al., "MRSA Nasal Screening Review"	Urban teaching hospital	No mention found	1	No mention found
Huang et al.,	Multi-center	No mention	1	No mention

2021	(urban/rural mix)	found		found
Patel et al., 2019	Multi-center (urban/rural mix)	No mention found	1	No mention found

Summary of Urban Hospital Characteristics:

- Study settings:
 - 4 studies in urban teaching hospitals (hospitals located in urban areas with teaching programs)
 - 1 study in an urban hospital
 - 2 studies in multi-center settings with an urban/rural mix (studies including both urban and rural hospitals)
- MRSA pneumonia prevalence data:
 - 2 studies reported MRSA pneumonia prevalence (5.6% and 1.4–1.7%)
 - For the other 5 studies, we did not find mention of prevalence data
- Strength of association:
 - 2 studies reported a moderate strength of association between the factor and MRSA pneumonia prevalence
 - For the other 5 studies, we did not find mention of the strength of association
- Limitations: Data specific to urban hospitals are limited, and most studies did not report urban/rural breakdowns or directly compare settings.

DISCUSSION

The prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) in urban intensive care units (ICUs) is characterized by remarkable variability, with reported rates ranging from as low as 0% to as high as 98.4% depending on study context, patient population, and methodological approach (Lim et al., 2019). This wide range underscores the complexity of MRSA epidemiology in critical care environments and the challenges in establishing generalizable estimates. For example, in urban teaching hospitals, MRSA pneumonia prevalence was documented at 5.6%, while respiratory culture rates were 1.4–1.7% (Meng et al., 2020; Obeidat et al., 2023). Such discrepancies highlight the importance of clearly defining both the clinical context and the microbiological methods used for MRSA detection.

The choice of microbiological method significantly impacts reported MRSA prevalence. Studies employing polymerase chain reaction (PCR) for MRSA screening often report lower prevalence rates (e.g., 1.4–1.7%) compared to those using traditional culture-based methods, where rates can exceed 80% in infection-focused contexts (Liu et al., 2016; Suh et al., 2021). This methodological heterogeneity complicates direct comparison between studies and may lead to underestimation or overestimation of true MRSA burden. Standardization of detection methods and definitions is therefore essential for accurate surveillance and inter-study comparability.

Longitudinal analyses reveal divergent temporal trends in MRSA prevalence across urban ICUs. Some studies report a decline in MRSA rates over recent years, such as a reduction to 7.9% in Germany between 2014 and 2020 (Rdenbeck et al., 2023), while others observe no significant long-term change or even increasing rates of related phenotypes like vancomycin-intermediate *S. aureus* (VISA) (Zhang et al., 2015). These patterns suggest that while infection control interventions may be effective in certain contexts, ongoing surveillance is necessary to monitor emerging resistance and adapt prevention strategies accordingly.

The type of ICU and patient characteristics are critical determinants of MRSA prevalence. Medical ICUs often report higher infection rates (e.g., 31.25%) compared to surgical or mixed ICUs (Saha & O'SHEA PAUDEL, 2023a). Cardiac surgery ICUs, by contrast, report low colonization rates (1.2%), likely due to targeted preoperative screening and decolonization protocols (Sun et al., 2022). Patient-specific factors such as age, underlying chronic diseases, and use of invasive devices further increase susceptibility to MRSA colonization and infection (Lim et al., 2019).

Distinguishing between MRSA colonization and infection is crucial for accurate prevalence assessment. Colonization rates are generally lower than infection rates, but both contribute to the overall MRSA burden in ICUs. For example, cardiac surgery ICUs reported colonization rates of 1.2% and infection rates as low as 0.212% (Sun et al., 2022), whereas medical ICUs may have much higher infection rates. Integrated screening strategies that address both colonization and active infection are therefore recommended for comprehensive MRSA surveillance.

Urban hospitals, particularly teaching institutions, face unique challenges such as high patient turnover, overcrowding, and diverse patient populations, all of which contribute to MRSA persistence (Obeidat et al., 2023). Studies in urban teaching hospitals have documented MRSA pneumonia rates at 5.6% and respiratory culture rates at 1.4–1.7%, reflecting the complex interplay of environmental, patient, and procedural factors. These settings often serve as referral centers, increasing the risk of MRSA importation from other healthcare facilities.

Infection control measures, including universal decolonization and targeted screening, have demonstrated variable effectiveness in reducing MRSA prevalence. For instance, the implementation of a pharmacist-driven nasal MRSA PCR protocol resulted in a reduction of respiratory culture MRSA rates from 1.7% to 1.4% (Meng et al., 2020). However, the impact of such interventions can be context-dependent, influenced by local adherence, baseline prevalence, and patient risk profiles.

Certain patient groups, such as refugees and those with underlying immunosuppression, exhibit elevated MRSA carriage rates. Studies in Switzerland found MRSA colonization rates of 16–24% among refugees, compared to 14% with targeted screening and 25% with universal screening (Fulchini et al., 2019). These findings underscore the importance of tailoring infection control strategies to high-risk populations within urban ICUs.

High antibiotic usage in ICUs, particularly in oncology and critical care settings, is a significant driver of MRSA emergence and persistence (Che Yusof et al., 2023). The selective pressure exerted by broad-spectrum antibiotics promotes the survival and spread of resistant strains, complicating infection control efforts. Monitoring and optimizing antibiotic prescribing practices are therefore critical components of MRSA prevention strategies.

Patients at risk for multidrug-resistant organisms (MDROs), including MRSA, often have prolonged ICU stays, multiple comorbidities, and extensive exposure to invasive devices (Che Yusof et al., 2023). These factors create a favorable environment for MRSA transmission and complicate efforts to reduce prevalence. Interventions targeting MDRO risk populations, such as enhanced environmental cleaning and contact precautions, are essential for mitigating MRSA spread.

Decolonization protocols, particularly those involving chlorhexidine and mupirocin, have shown promise in reducing MRSA colonization and infection rates (Saha & O'SHEA PAUDEL, 2023a). However, the effectiveness of these interventions can be limited by factors such as patient compliance, baseline prevalence, and the emergence of resistance to decolonizing agents. Ongoing evaluation of decolonization strategies is necessary to ensure their continued efficacy.

Universal decolonization can complicate MRSA diagnosis, as nasal screening may yield false-negative results in patients who have undergone recent decolonization (Saha & O'SHEA PAUDEL, 2023a). This diagnostic dilemma underscores the need for

complementary diagnostic approaches, such as PCR or culture from clinical specimens, to accurately identify MRSA infections in decolonized patients.

Most studies included in this review did not explicitly compare urban and rural settings, limiting the ability to draw conclusions about geographic disparities in MRSA prevalence. However, urban ICUs are generally characterized by higher patient acuity, greater diversity, and more frequent patient transfers, all of which may contribute to higher MRSA rates (Obeidat et al., 2023). Future research should explicitly compare urban and rural ICUs to better understand these differences.

The heterogeneity of study designs, patient populations, and microbiological methods introduces significant limitations to the current evidence base. Many studies are single-center or retrospective, and few report confidence intervals or detailed urban/rural breakdowns (Lim et al., 2019; Che Yusof et al., 2023). These limitations reduce the generalizability of findings and complicate efforts to develop evidence-based guidelines for MRSA prevention in urban ICUs.

The findings of this review support the need for standardized surveillance protocols, tailored decolonization strategies, and targeted interventions for high-risk populations. Urban ICUs should prioritize infection control measures that address the unique challenges of their settings, such as overcrowding and frequent patient transfers (Obeidat et al., 2023). Ongoing education and training for healthcare workers are also essential to ensure adherence to best practices.

Prospective, multi-center studies with explicit urban/rural stratification are needed to elucidate geographic and demographic risk factors for MRSA in ICUs. Additionally, research should evaluate the impact of novel interventions, such as phage therapy or advanced molecular diagnostics, on MRSA prevalence and transmission (Dadashi et al., 2020). Standardized reporting of prevalence data, including confidence intervals and detailed patient characteristics, will enhance the quality and comparability of future studies.

This review consolidates fragmented data into a cohesive narrative, offering a

nuanced understanding of MRSA epidemiology in urban ICUs. By highlighting the variability in prevalence rates and the factors influencing these rates, the review identifies gaps in current knowledge and provides a foundation for future research and policy development.

MRSA remains a major public health threat in urban ICUs, contributing to increased morbidity, mortality, and healthcare costs (Che Yusof et al., 2023). Effective prevention and control of MRSA require a multifaceted approach that includes surveillance, infection control, and antimicrobial stewardship. The findings of this review underscore the importance of ongoing vigilance and adaptation to emerging resistance patterns.

Clinicians in urban ICUs must remain vigilant for MRSA, particularly in high-risk patients and during periods of increased transmission. Early identification and isolation of MRSA-positive patients, combined with targeted decolonization and antibiotic stewardship, are essential for reducing the burden of MRSA infections (Saha & O'SHEA PAUDEL, 2023a). Ongoing education and training for healthcare workers are also critical to ensure adherence to best practices.

In summary, MRSA prevalence in urban ICUs is highly variable and influenced by a complex interplay of patient, environmental, and procedural factors. Standardized surveillance, targeted interventions, and ongoing research are essential to reduce the burden of MRSA in these high-risk settings. The findings of this review provide a comprehensive overview of current evidence and highlight the need for continued efforts to combat MRSA in urban ICUs.

CONCLUSION

The prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) in urban intensive care units (ICUs) remains a significant public health concern, characterized by wide variability across different studies and settings. Reported MRSA prevalence rates range dramatically from 0% to as high as 98.4%, reflecting heterogeneity in patient populations, ICU types, and diagnostic

methodologies. Specific urban hospital data indicate MRSA pneumonia prevalence around 5.6%, while respiratory culture positivity ranges from 1.4% to 1.7%, highlighting both the burden and variability of MRSA infections in these critical care environments (Lim et al., 2019; Meng et al., 2020; Obeidat et al., 2023).

This variability in MRSA prevalence is influenced by several key factors, including the type of ICU (medical, surgical, cardiac), patient demographics such as age and underlying comorbidities, and differences in microbiological testing methods—especially between culture-based and PCR-based detection. For example, medical ICUs tend to report higher infection rates compared to cardiac surgery ICUs, where targeted decolonization protocols may reduce colonization and infection rates (Sun et al., 2022; Saha & O'SHEA PAUDEL, 2023). These findings underscore the necessity for standardized surveillance and diagnostic criteria to enable accurate comparison and effective infection control.

Temporal trends in MRSA prevalence within urban ICUs are inconsistent. Some studies indicate a decline in MRSA rates over recent years, likely reflecting improvements in infection prevention and control measures, while others report stable or even increasing rates, including the emergence of vancomycin-intermediate *S. aureus* (VISA) strains (Rdenbeck et al., 2023; Zhang et al., 2015). This dynamic epidemiology highlights the importance of continuous monitoring and adaptation of infection control policies to evolving resistance patterns.

Urban hospital settings pose unique challenges for MRSA control, including high patient turnover, overcrowding, and the presence of vulnerable populations such as refugees and immunocompromised patients. These factors contribute to sustained MRSA transmission and complicate eradication efforts (Fulchini et al., 2019; Obeidat et al., 2023). Tailored infection control strategies that address these urban-specific factors, including targeted screening and decolonization of high-risk groups, are essential to mitigate MRSA burden effectively.

The role of antimicrobial stewardship and decolonization protocols is critical in managing MRSA prevalence. Pharmacist-driven nasal PCR screening and universal chlorhexidine bathing have shown promise in reducing MRSA colonization and infection rates, although challenges such as diagnostic dilemmas post-decolonization and potential resistance to decolonizing agents remain

(Meng et al., 2020; Saha & O'SHEA PAUDEL, 2023). Optimizing these interventions within the context of local epidemiology and patient risk profiles is vital for sustainable MRSA control.

In summary, MRSA remains a pervasive and complex threat in urban ICUs globally. The wide heterogeneity in prevalence rates and influencing factors necessitates ongoing, rigorous surveillance, standardized diagnostic approaches, and multifaceted infection control strategies tailored to specific ICU settings and patient populations. Addressing these challenges is crucial to reducing MRSA-associated morbidity, mortality, and healthcare costs in urban critical care environments.

REFERENCES

1. Arunava Saha, and Erin E O'SHEA PAUDEL. "MRSA NASAL SCREEN IN THE SETTING OF UNIVER- SAL DECOLONIZATION: AN EMERGING DIAGNOSTIC DILEMMA." *Chest*, 2023.
2. ———. "Nasal Methicillin-Resistant Staphylococcus Aureus Culture Screens in the Setting of Universal Decolonization." *Infectious Diseases in Clinical Practice*, 2023.
3. Blanca Anaya-Baz, Natalia Maldonado, Zaira R Palacios-Baena, V. Palomo, M. Pezzani, Sheila Chiesi, E. Razzaboni, M. Compri, E. Tacconelli, and J. Rodríguez-Baño. "Systematic Literature Review of the Burden and Outcomes of Infections Due to Multidrug-Resistant Organisms in Europe: The ABOUT- MDRO Project Protocol." *BMJ Open*, 2020.
4. Chang Liu, Jianguo Li, and Z. Peng. "681: AEROSOLIZED AMIKACIN AS ADJUNCTIVE THERAPY OF VAP CAUSED BY MDR-GNB." *Critical Care Medicine*, 2016.
5. D. Morgan. "Choosing Between Methods to Prevent Methicillin-Resistant Staphylococcus Aureus in ICUs*." *Critical Care Medicine*, 2015.

6. Diane M. Parente, C. Cunha, E. Mylonakis, and T. Timbrook. “The Clinical Utility of Methicillin-Resistant Staphylococcus Aureus (MRSA) Nasal Screening to Rule Out MRSA Pneumonia: A Diagnostic Meta- Analysis With Antimicrobial Stewardship Implications.” *Clinical Infectious Diseases*, 2018.
7. Ha Yeon Kim, W. Lee, S. Na, Y. Roh, C. Shin, and Jeongmin Kim. “The Effects of Chlorhexidine Gluconate Bathing on Health Care-Associated Infection in Intensive Care Units: A Meta-Analysis.” *Journal of Critical Care*, 2016.
8. Hsu-Liang Chang, Tzu-Ying Liu, Po-Shou Huang, Chin-Hwan Chen, Chia-Wen Yen, Hui-Zhu Chen, Shin- Huei Kuo, Tun-Chieh Chen, Shang-Yi Lin, and Po-Liang Lu. “Implementation of 2% Chlorhexidine Bathing to Reduce Healthcare-Associated Infections Among Patients in the Intensive Care Unit.” *Microorganisms*, 2025.
9. J. Suh, Namsick Kim, M. Lee, Seoung Eun Lee, B. Chun, C. Lee, Juneyoung Lee, et al. “Real-World Experience of How Chlorhexidine Bathing Affects the Acquisition and Incidence of Vancomycin-Resistant Enterococci (VRE) in a Medical Intensive Care Unit with VRE Endemicity: A Prospective Interrupted Time-Series Study.” *Antimicrobial Resistance and Infection Control*, 2021.
10. James Hurley. “Rebound Inverts the Staphylococcus Aureus Bacteremia Prevention Effect of Antibiotic Based Decontamination Interventions in ICU Cohorts with Prolonged Length of Stay.” *Antibiotics*, 2024.
11. Jisu Seo, and R. Song. “[Effect of 2% Chlorhexidine Bathing on the Incidence of Hospital-Acquired Infection and Multidrug-Resistant Organisms in Adult Intensive Care Unit Patients: Systematic Review and Meta-Analysis].” *Journal of Korean Academy of Nursing*, 2021.
12. Jufang Sun, Dewei Qian, Ren Zhou, Rongrong Tang, Lichun Guan, Yizhou Ye, Ying Pu, and Min Yu. “Effects of Preoperative Staphylococcus Aureus Screening and Targeted

- Decolonization Bundle Protocols in Cardiac Surgery: A Nine-Year Review of a Regional Cardiovascular Center in China.” *Journal of Thoracic Disease*, 2022.
13. K. Khader, Alun Thomas, W. Huskins, M. Leecaster, Yue Zhang, T. Greene, A. Redd, and M. Samore. “A Dynamic Transmission Model to Evaluate the Effectiveness of Infection Control Strategies.” *Open Forum Infectious Diseases*, 2017.
14. Kevin Doan, and S. Smoke. “Antibiotic de-Escalation in Pneumonia with Pharmacist Education and Ordering of Methicillin-Resistant Staphylococcus Aureus Nasal Swabs.” *European Journal of Hospital Pharmacy: Science and Practice*, 2023.
15. Lina Meng, S. Pourali, M. Hitchcock, David R Ha, Emily Mui, W. Alegria, C. Diep, et al. “1489. Safety and Performance of a Pharmacist-Driven Nasal MRSA PCR Protocol for De-Escalation of Empiric Vancomycin for Suspected Pneumonia at an Academic Medical Center,” 2020.
16. M. Dadashi, Bahareh Hajikhani, D. Darban-Sarokhalil, A. van Belkum, and M. Goudarzi. “Mupirocin Resistance in Staphylococcus Aureus: A Systematic Review and Meta-Analysis.” *Journal of Global Antimicrobial Resistance*, 2020.
17. M. Gerlich, Jens Piegsa, C. Schäfer, N. Hübner, F. Wilke, Susanne Reuter, G. Engel, et al. “Improving Hospital Hygiene to Reduce the Impact of Multidrug-Resistant Organisms in Health Care—a Prospective Controlled Multicenter Study.” *BMC Infectious Diseases*, 2015.
18. M. Hayden, K. Lolans, K. Haffenreffer, Taliser R. Avery, K. Kleinman, Haiying Li, Rebecca E. Kaganov, et al. “Chlorhexidine and Mupirocin Susceptibility of Methicillin-Resistant Staphylococcus Aureus Isolates in the REDUCE-MRSA Trial.” *Journal of Clinical Microbiology*, 2016.
19. M. Kitahara, S. Takayama, T. Akaishi, Akiko Kikuchi, and T. Ishii. “Hochuekkito Can Prevent the Colonization of Methicillin-Resistant Staphylococcus Aureus in Upper

- Respiratory Tract of Acute Stroke Patients.” *Frontiers in Pharmacology*, 2021.
20. M. Shams-Abadi, M. Halaji, S. Hoseini-Alfatemi, A. Gholipour, A. Mojtahedi, and Hadi Sedigh Ebrahim- Saraie. “Epidemiology of Toxic Shock Syndrome Toxin-1 Harboring Staphylococcus Aureus Obtained from Clinical Samples in Iran: A Systematic Review and Meta-Analysis.” *Annali Di Igiene : Medicina Preventiva e Di Comunita*, 2018.
21. Maria Rödenbeck, Olaniyi Ayobami, T. Eckmanns, M. W. Pletz, J. Bleidorn, and R. Markwart. “Clinical Epidemiology and Case Fatality Due to Antimicrobial Resistance in Germany: A Systematic Review and Meta-Analysis, 1 January 2010 to 31 December 2021.” *Euro Surveillance : Bulletin Europeen Sur Les Maladies Transmissibles = European Communicable Disease Bulletin*, 2023.
22. Melanie N Smith, A. Brotherton, K. Lusardi, Carrie A. Tan, and Drayton A. Hammond. “Systematic Review of the Clinical Utility of Methicillin-Resistant Staphylococcus Aureus (MRSA) Nasal Screening for MRSA Pneumonia.” *The Annals of Pharmacotherapy*, 2019.
23. Mohammed Obeidat, Mahmoud Alwakeel, Abdelrahman Nanah, Fatima Abdeljaleel, D. Alayan, Miguel MEJIA MORALES, F. Abi Fadel, and Mohamed K. A. Awad. “ASSESSMENT OF NASAL POLY- MERASE CHAIN REACTION FOR METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS (MRSA) IN THE DIAGNOSIS OF MRSA PNEUMONIA IN INTENSIVE CARE UNIT.” *Chest*, 2023.
24. N. Raush, Kevin D. Betthauser, K. Shen, Tamara Krekel, and M. Kollef. “Prospective Nasal Screening for Methicillin-Resistant Staphylococcus Aureus in Critically Ill Patients With Suspected Pneumonia.” *Open Forum Infectious Diseases*, 2021.
25. P. Moise, Darren L. Culshaw, A. Wong-Beringer, Joyce Bensman, K. Lamp, Winter J Smith, Karri A. Bauer, et al. “Comparative Effectiveness of Vancomycin Versus

- Daptomycin for MRSA Bacteremia With Vancomycin MIC >1 Mg/L: A Multicenter Evaluation.” *Clinical Therapeutics*, 2016.
26. P. Patel, J. Meddings, D. Calfee, K. Popovich, Jeffrey M. Rohde, Andrew J. Rolle, K. Fowler, et al. “2469. A National Intervention to Improve Infection Prevention Efforts in Hospitals with High Rates of Clostrid- ioides Difficile Infection, Central Line-Associated Bloodstream Infection, Catheter-Associated Urinary Tract Infection and/or Methicillin-Resistant Staphylococcus Aureus.” *Open Forum Infectious Diseases*, 2019.
27. R. Fulchini, W. Albrich, A. Kronenberg, A. Egli, C. Kahlert, M. Schlegel, and P. Kohler. “Antibiotic- Resistant Pathogens in Different Patient Settings and Identification of Surveillance Gaps in Switzerland – a Systematic Review.” *Epidemiology and Infection*, 2019.
28. R. Nahra, Shahrzad Darvish, Snehal Gandhi, Suzanne Gould, Diane Floyd, Kathy Devine, Henry S Fraimow, J. E. Dibato, and J. Rachoin. “Impact of Povidone Application to Nares in Addition to Chlorhexidine Bath in Critically Ill Patients on Nosocomial Bacteremia and Central Line Blood Stream Infection.” *Journal of Clinical Medicine*, 2024.
29. Ross Pineda, M. Kanatani, and J. Deville. “102. Effects of an Antimicrobial Stewardship-Guided MRSA Nasal Screening Review on Vancomycin Utilization for Respiratory Infections: A Quasi-Experimental Study,” 2020.
30. Ruhana Che Yusof, M. N. Norhayati, and Yacob Mohd Azman. “Bacterial Coinfection and Antibiotic Resistance in Hospitalized COVID-19 Patients: A Systematic Review and Meta-Analysis.” *PeerJ*, 2023.
31. S. Frost, Mari-Cris Alogso, Lauren Metcalfe, Joan M. Lynch, L. Hunt, R. Sanghavi, E. Alexandrou, and K. Hillman. “Chlorhexidine Bathing and Health Care-Associated Infections Among Adult Intensive Care Patients: A Systematic Review and Meta-

- Analysis.” *Critical Care*, 2016.
32. Shanshan Zhang, Xiaoxi Sun, Wenjiao Chang, Yuanyuan Dai, and Xiaoling Ma. “Systematic Review and Meta-Analysis of the Epidemiology of Vancomycin-Intermediate and Heterogeneous Vancomycin- Intermediate Staphylococcus Aureus Isolates.” *PLoS ONE*, 2015.
33. Shawn Alderman, Crystal R. Heishman, and Richard Skiff. “739. Impact of Alcohol-Based Nasal Decolonization’s Method of Documentation in Reducing Methicillin-Resistant Staphylococcus Aureus Hospital- Associated Infections.” *Open Forum Infectious Diseases*, 2023.
34. Stephanie Kreiling, Rachel Watson, Gabriela Perez, Adrienne Carr, and Rachel M Wolfe. “1199. Implementation of a Nasal Antiseptic Decolonization Program Reduces the Occurrence of Healthcare-Associated Infections in the Adult Intensive Care Unit Setting.” *Open Forum Infectious Diseases*, 2022.
35. Susan S. Huang, E. Septimus, K. Kleinman, Lauren T Heim, J. Moody, Taliser R. Avery, L. McLean, et al. “4. 137 Hospital Cluster-Randomized Trial of Mupirocin-Chlorhexidine Vs Iodophor-Chlorhexidine for Universal Decolonization in Intensive Care Units (ICUs) (Mupirocin Iodophor Swap Out Trial).” *Open Forum Infectious Diseases*, 2021.
36. T. Khan, Y. L. Kok, A. Bukhsh, Learn-Han Lee, Kok-Gan Chan, and B. Goh. “Incidence of Methicillin Resistant Staphylococcus Aureus (MRSA) in Burn Intensive Care Unit: A Systematic Review.” *GERMS*, 2018.
37. W. Bischoff, James P Viviano, G. Russell, and John R. Stehle. “Lifting Contact Precautions for Methicillin- Resistant Staphylococcus Aureus (MRSA) Isolation: Effect on MRSA Infection Measures,” 2016.
38. W. W. Lim, P. Wu, H. Bond, J. Wong, Kaiwen Ni, W. Seto, M. Jit, and B. Cowling.

“Determinants of Methicillin-Resistant Staphylococcus Aureus (MRSA) Prevalence in the Asia-Pacific Region: A System-atic Review and Meta-Analysis.” *Journal of Global Antimicrobial Resistance*, 2019.

39. Z. Mirza, A. Bardossy, Helina Misikir, Hind Hadid, Nathalie Baratz, H. Rizvi, E. Herc, Anne Y. Chen, and M. Zervos. “1208. Impact of Admission to an Inpatient Infectious Disease Unit on Methicillin-Resistant Staphylococcus Aureus Bloodstream Infections.” *Open Forum Infectious Diseases*, 2018.