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META-ANALYSIS

Incidence of Methicillin Resistant Staphylococcus Aureus Acquisition in Burn Intensive Care Unit, A meta-analysis study

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Abstract

Background: ***The skin acts as the body's first line of defense against harmful germs.***
Aim: ***To assess the incidence and outcomes of MRSA acquisition in admitted patients within burn ICU in the last ten years.***
Patients and methods: ***The current meta-analysis involved 16 articles with a total of 7623 individuals, the majority of these studies were retrospective and only four studies were prospective most of these studies were from USA and China, and no studies from Egypt were found, so more prospective studies were needed to be performed among ICU burn patients in Egypt.***
Results: ***In all, four studies examined the effect of MRSA on mortality rate. No significant heterogeneity was determined. Therefore, a fixed effect model was utilized for analysis (I^2 = 0%, P =.56). The combined OR & 95% CIs was 1.28 (0.69 to 1.40). The combined result suggested that MRSA-positive patients are not associated with a higher mortality rate (Z = 0.78, P =.44).***
Conclusion: ***The study found 14.7% MRSA infections in burn patients admitted to burn ICUs, with 3.8% colonization and 8.6% acquisition. Risk factors include age, burn surface area, male gender, inhalational injury, and burn cause.***

Keywords: Staphylococcus Aureus; Methicillin Resistant; Acquisition; burn intensive care unit

1. Introduction

The skin acts as the primary barrier, protecting against harmful microbes. This is lost with burns, along with systemic and topical immunosuppression. With significant morbidity Mortality for burn patients, infection is thus one of the most dangerous side effects.[1]

When it comes to burn patients, MRSA has become one of the biggest concerns. Burn wounds provide a breeding ground for bacteria that may cause a deadly chain reaction that includes septicemia, invasive infection, multi-organ failure, burn wound sepsis, and death.[2]

Surveillance and prophylactic treatment have parallel roles in the prevention of infection. Besides that, medical education of medical staff plays a role when dealing with carriers or cases such as hand wash, antiseptic use, wise use of antibiotic therapy, and isolation equipment. Surveillance is the key restriction during the use of antibiotics.[3]

The objective of this research was to evaluate the incidence and outcomes of MRSA acquisition in admitted individuals within burn ICUs in the last ten years.

2. Patients and methods

The current meta-analysis involved 16 articles with a total of 7623 individuals; the majority of these studies were retrospective, and only four studies were prospective. Most of these studies were from the USA and China, and no studies from Egypt were found, so more prospective studies need to be performed among ICU burn patients in Egypt.

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Types of included studies: A literature search was conducted in PUBMED, EMBASE, ScienceDirect, Web of Science, Scopus, Ovid, Proquest, Google Scholar, and the Cochran Library. The search was limited to English articles published between 2012 and 2022. Databases were approached through the Egyptian Knowledge Bank. The search was conducted in December 2022.

Study eligibility criteria

Inclusion criteria: Retrospective, prospective, or cross-sectional studies, Patients with major burn, Patients admitted in burn ICU, Patients with MRSA positive (nasal or wound); you were able to report on at least one of the outcome measures, the data could be extracted from the entire articles.

Exclusion criteria: Every item that failed to satisfy the inclusion requirements was eliminated. Studies without control groups, case reports, meta-analyses, letters, expert opinions, abstracts, editorials, and reviews without original data were also disqualified. Research on languages other than English was not included.

Data collection and data items

Data from each study was extracted into a form with the following parameters according to a prespecified protocol: primary author, publication year, type of the research, number of patients, age of patients, TBSA, male gender, cause of burn, inhalational injury, DM, duration of hospital stay, duration of ICU stay, intubation, active infection, numbers of operation and Mortality.

Statistical analysis of the data and synthesis of results

Data were entered into the computer system for analysis utilizing version 20.100 of the MedCalc software application. Statistical significance was assigned to p-values that were less than or equal to 0.05, with a CI of ninety-five percent established. I2 (observed variance for heterogeneity) and Q (total variance for heterogeneity) were utilized to evaluate statistical heterogeneity. Qualitative data are presented as the total number of occurrences and the number of events, whereas quantitative data are presented as the mean standard deviation.

3. Results

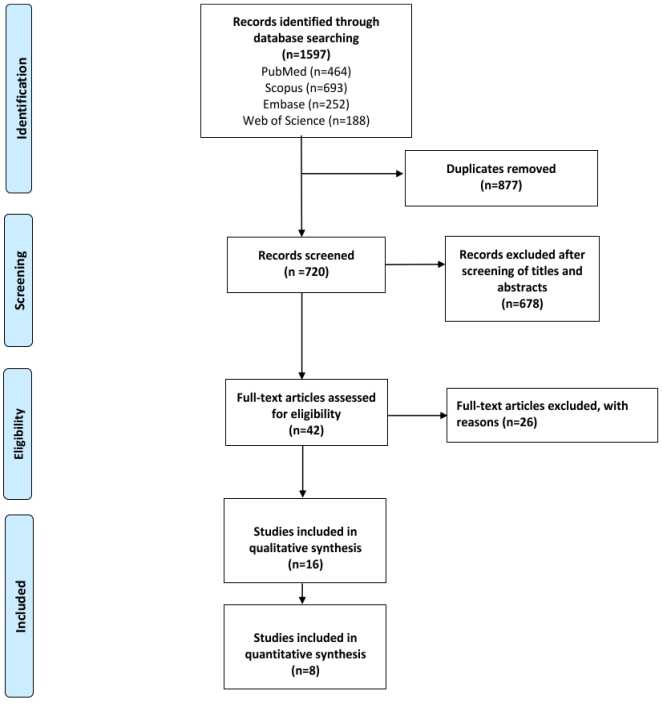

Figure 1. PRISMA Flow Diagram of the Study Selection Process

A total of 16 examined were selected for the current analysis, including a total of 7623 individuals admitted to regional specialized burn units. The number of included patients ranged from 31 patients by Schweitzer et al.[5] to 2036 patients by Cleland et al.[19] (Table 1)

Table 1. Study Characteristics (N = 16 studies, 7623 patients)

FIRST AUTHOR	YEAR	COUNTRY	DESIGN	STUDY PERIOD		SAMPLE SIZE
				From	To	
KAISER[4]	2011	USA	Retrospective	2007	2009	752
SCHWEITZER[5]	2012	USA	Prospective	2009	2010	31
ALRAWI [6]	2013	UK	Retrospective	NA	NA	139
RODRIGUES[7]	2013	Brazil	Retrospective	2006	2009	367
ISSLER-FISHER[8]	2015	Australia	Retrospective	2012	2013	357
JOHNSON[9]	2015	USA	Retrospective	2011	2014	554
HAITH[10]	2016	USA	Retrospective	2010	2011	826
DRUM[11]	2016	USA	Retrospective	2011	2016	725
TEJIRAM[12]	2017	USA	Retrospective	2012	2014	601
PARK[13]	2017	Australia	Retrospective	2013	2014	238
AMISSAH[14]	2017	Ghana	Prospective	2014	2015	62
LIU[15]	2018	China	Prospective	2012	2016	112
JIANG`[16]	2018	China	Prospective	2011	2016	177
PANGLI[17]	2019	Canada	Retrospective	2012	2016	396
MATER[18]	2020	Saudi Arabia	Retrospective	2016	2017	250
CLELAND[19]	2022	Australia	Retrospective	2014	2020	2036

NA: DATA NOT AVAILABLE

Table 2 summarizes the data related to screening techniques adopted by each study as regards site of sampling, method of MRSA testing, and timing of sampling.

Table 2. Screening Techniques (N = 16 studies, 7623 patients)

FIRST AUTHOR	SIT OF SAMPLING	METHOD OF TESTING	TIMING OF SAMPLING	
			Initial Sample	SUBSEQUENT SAMPLES
KAISER[4]	Nose	Culture	Before 72 hr	AFTER 72 HR
SCHWEITZER[5]	Nose	Culture	On Admission	NA
ALRAWI[6]	Wound	Culture	On Admission	EACH DRESSING
RODRIGUES[7]	Nose/Axilla/Throat/ Perineum/Wound	Culture	On Admission	WEEKLY
ISSLER-FISHER[8]	Nose/Groin/Wound	Culture	Before 48 hr	AFTER 48 HR
JOHNSON[9]	Nose/Wound	Culture	On Admission	WEEKLY
HAITH[10]	Nose	PCR	On Admission	WEEKLY
DRUM[11]	Nose/Groin/Axilla/ Wound	Culture	On Admission	NA
TEJIRAM[12]	Nose	Culture	Before 48 hr	NA
PARK[13]	Wound	Culture	Before 48 hr	NA
AMISSAH[14]	Nose/Wound	PCR/Culture	Before 24 hr	AFTER 24 HR
LIU[15]	Blood	Culture	NA	NA
JIANG[16]	Blood/Wound	PCR/Culture	NA	NA
PANGLI[17]	Nose/Perineum/ Wound	Culture	Before 48 hr	AFTER 48 HR
MATER[18]	Blood/Wound	Culture	NA	NA
CLELAND[19]	Nose/Wound	Culture	Before 48 hr	AFTER 48 HR

NA: DATA NOT AVAILABLE

Table 3 summarizes the colonization rate, acquistion rate, and prevalence of MRSA amongst burn individuals in included studies.

Table 3. MRSA Prevalence (N = 7623 patients)

STUDY	SAMPLE SIZE	MRSA COLONIZATION		MRSA ACQUISITION		MRSA PREVALENCE	
		No.	%	No.	%	No.	%
KAISER[4]	752	30	4.0	40	5.3	70	9.3
SCHWEITZER[5]	31	4	12.9	NA	NA	4	12.9
ALRAWI[6]	139	1	0.7	19	13.7	20	14.4
RODRIGUES[7]	367	8	2.2	88	24.0	96	26.2
ISSLER-FISHER[8]	357	10	2.8	47	13.2	57	16.0
JOHNSON[9]	554	37	6.7	51	9.2	88	15.9
HAITH[10]	826	59	7.1	18	2.2	77	9.3
DRUM[11]	725	60	8.3	NA	NA	60	8.3
TEJIRAM[12]	601	24	4.0	NA	NA	24	4.0
PARK[13]	238	2	0.8	NA	NA	2	0.8
AMISSAH[14]	62	7	11.3	5	8.1	12	19.4
LIU[15]	112	NA	NA	NA	NA	52	46.4
JIANG[16]	177	NA	NA	NA	NA	159	89.8
PANGLI[17]	396	10	2.5	71	17.9	81	20.5
MATER[18]	250	NA	NA	NA	NA	33	13.2
CLELAND[19]	2036	15	0.7	58	2.8	73	3.6

NA: DATA NOT AVAILABLE

Nine studies reported on the MRSA acquisition among burn patients. A random effect model was used as substantial heterogeneity was determined (I^2 = 97%, P=.000). The overall acquisition rate of MRSA ranged from 0.022 to 0.240, with the pooled estimate being 0.086 (95% CI: 0.048 – 0.150). (Figure 2)

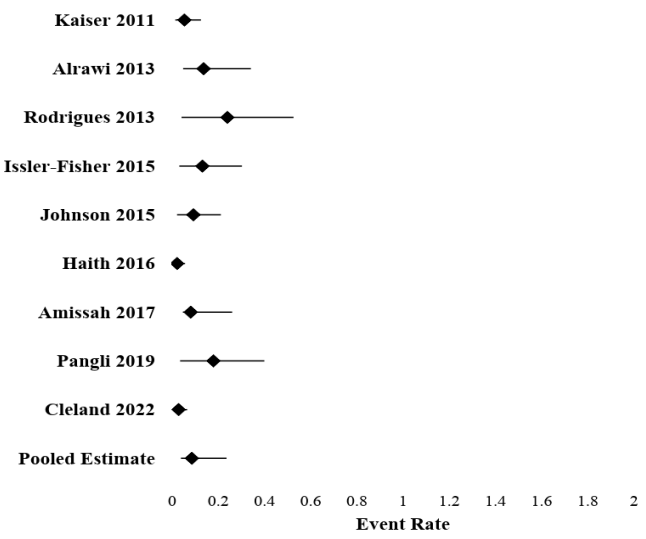

Figure 2. MRSA Acquisition

In all, four studies examined the effect of MRSA on ICU stay. We analyzed the data using the random-effects model after identifying substantial heterogeneity (I^2 = 91%, P <.001). The combined MD & 95% CIs was 2.79 (-2.21 to 7.8). The combined result suggested that MRSA positive patients are not associated with longer ICU stay (Z = 1.09, P =.27). (Figure 3)

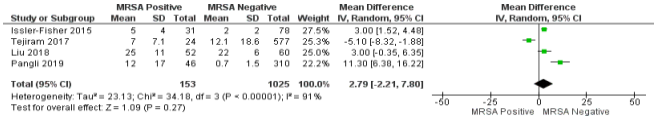

Figure 3. Forest plot of ICU stay demonstrates no statistically substantial variance amongst groups

In all, four studies examined the effect of MRSA on mortality rate. No significant heterogeneity was detected. Therefore, a fixed effect model was utilised for analysis (I^2 = 0%, P =.56). The combined OR & 95% CIs was 1.28 (0.69 to 1.40). The combined result suggested that MRSA positive patients are not associated with higher mortality rate (Z = 0.78, P =.44). (Figure 4)

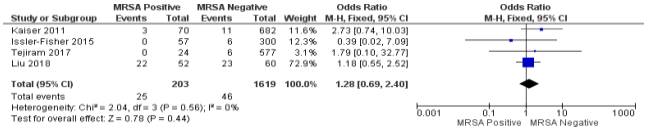

Figure (4): Forest plot of mortality rate shows no statistically substantial variance amongst collections

Patient isolation was carried out in two studies, including Kaiser et al.[4] and Johnson et al.[9] Contact precautions were described in three studies, including Kaiseret al.,[4] Fisheret al.,[8] and Johnson et al.[9] Weekly surveillance was reported in six studies, inclduing Kaiseret al.,[4] Rodrigueset al.,[7] Issler-Fisheret al.,[8] Johnsonet al.,[9] Haithet al.,[10] and Pangli et al.[17] (Table 4)

Table (4): MRSA Control Policies (N = 16 Studies)

	DECOLONIZATION PROTOCOL	PATIENT ISOLATION	CONTACT PRECAUTIONS	SURVEILLANCE TIMELINE
KAISER[4]	NA	Yes	Yes	WEEKLY
SCHWEITZER[5]	NA	NA	NA	NA
ALRAWI[6]	NA	NA	NA	NA
RODRIGUES[7]	No	NA	NA	WEEKLY
ISSLER-FISHER[8]	No	NA	Yes	WEEKLY
JOHNSON[9]	Nasal mupirocin for 5 days and chlorhexidine baths	Yes	Yes	WEEKLY
HAITH[10]	Nasal mupirocin for 5 days	NA	NA	WEEKLY
DRUM[11]	NA	NA	NA	NA
TEJIRAM[12]	NA	NA	NA	NA
PARK[13]	NA	NA	NA	NA
AMISSAH[14]	NA	NA	NA	NA
LIU[15]	NA	NA	NA	NA
JIANG[16]	NA	NA	NA	NA
PANGLI[17]	NA	NA	NA	WEEKLY
MATER[18]	NA	NA	NA	NA
CLELAND[19]	NA	NA	NA	NA

NA: DATA NOT AVAILABLE

4. Discussion

Prolonged MRSA epidemics in multiple hospitals have led to individuals with burns developing complications, including bacteremia , sepsis, and pneumonia. As a consequence, the burn intensive care unit has emerged as a significant reservoir for MRSA in the hospital environment.[20]

The current meta-analysis involved 16 articles with a total of 7623 individuals; the majority of these studies were retrospective, and only four studies were prospective. Most of these studies were from the USA and China, and no studies from Egypt were found, so more prospective studies need to be performed among ICU burn patients in Egypt.

The majority of studies used nasal and burn wound sampling, all studies used culture, and a small proportion used PCR, and some studies used both.

All studies reported on the overall incidence of MRSA among burn patients. Given the presence of high heterogeneity (I2 = 97%, P =.000), a random effect model was used to analyze the data. The meta-analysis demonstrated that the overall incidence of MRSA ranged from 0.8% to 89.8%, with the pooled estimate being 14.7% (95% CI: 0.092 – 0.226).

The lowest incidence (0.8%) was reported in an Australian study by Park et al.[13] reflecting the higher hygiene level in burn ICU, while the highest incidence (89.8%) was reported in a Chinese study by Jiang et al.[16] reflecting lower hygiene practices, may be due to the higher burden on medical service higher due to population density.

Beyond the scope of the most recent meta-analysis, Khan et al. assessed the occurrence of MRSA, which comprised 21 publications and a total of 481 patients with illness. The meta-analysis was conducted on burned individuals who were brought to the intensive care unit. A meta-analysis was conducted, and the findings showed that the probability of MRSA isolates in the burn intensive care unit was 55.0% higher (odds ratio = 0.55, 95% confidence interval = 0.32-0.94). According to the authors, the high prevalence of MRSA isolates was explained by the fact that the majority of the studies that were included were from South Asia.[21]

For the purpose of determining the prevalence of Methicillin-Resistant Staphylococcus aureus that was isolated from burned individuals in Iran, Emaneini et al. conducted yet another meta-analysis. This review covered thirteen different research. Among culture-positive cases, the incidence of MRSA infections in burn patients was found to be 77.9%, with a 95% confidence interval (CI) ranging from 70.2-84. This was determined by the meta-analyses.[22]

However, in contrast to the present investigation, another meta-analysis conducted by Kalligeros et al. evaluated the incidence of MRSA colonization upon admission as well as the occurrence of MRSA acquisition inside burn units; the meta-analysis included 16 articles that showed that MRSA incidence on admission was 4.1% (95% CI 2.7%–5.7%). The lower incidence is because most of the included studies were conducted in North America and Europe, reflecting the higher level of medical care.[23]

Thirteen studies in this thesis reported on MRSA colonization among burn patients. A random effect model was used as significant heterogeneity was detected (I^2 = 90%, P =.000). The overall colonization rate of MRSA ranged from 0.7% to 12.9%, with the pooled estimate being 3.8% (95% CI: 0.025 – 0.057).

The lowest MRSA colonization (0.7%) was reported by an Australian study by Cleland et al.[19] and a study from USA by Kaiser et al.[4] reflecting the higher hygiene and infection control level in burn ICU, while the highest prevalence (89.8%) was reported in USA study Schweitzer et al.,[5] may be due to the higher severity of the studied patients.

Another meta-analysis conducted by Kalligeros et al. indicated that the total pooled occurrence of MRSA colonization during the first 72 hours after admission (also known as colonization on admission) to the burn unit was 4.1 percent (95% confidence interval: 2.7%–5.7%). This finding is comparable to the most recent research.[23]

It was revealed that 9 studies reported on the MRSA acquisition among burn patients. A

random effect model was used as substantial heterogeneity was determined (I^2 = 97%, P =.000). The overall acquisition rate of MRSA ranged from

2.2% to 24%, with the pooled estimate being 8.6% (95% CI: 0.048 – 0.150).

The lowest MRSA colonization (2.2%) was reported in a study from the USA by Haith et al.[10] reflecting the higher hygiene and infection control level in burn ICU, while the highest prevalence (89.8%) was reported in a Brazilian study by Rodrigues et al.[7] reflecting lower hygiene practices, may be due to the higher overcrowding of patients.

Kalligeros et al. conducted a meta-analysis, which revealed that the acquisition of MRSA in trials that did not include a decontamination process was 21.2% (95% confidence interval: 13.2%–30.5%), with a statistically significant decrease trend over the course of recent years. The MRSA acquisition incidence rate was found to be 4.5 percent in studies that utilized a decontamination approach, with a 95% confidence interval ranging from 0.9% to 10.6%. MRSA acquisition was shown to be greater amongst individuals who had suffered from inhalation injuries (odds ratio: 3.96, 95% confidence interval: 2.51–6.23), flame burns (odds ratio: 1.85, 95% confidence interval: 1.25–2.73), or admission to the intensive care unit (odds ratio: 3.12, 95% confidence interval: 2.18–4.47).[23]

MRSA acquisition in the ICU is associated with untrained medical staff, contaminated items and equipment, and unplanned measures when dealing with cases and carriers, so early detection of the acquisition is the most important issue in decreasing and hindering the spread of infection.

Many factors determine outcomes of MRSA, such as length of hospital stay, length of ICU stay, intubation, duration of intubation, number of operations, onset of active infection, and Mortality.

Regarding length of hospital stay, the current meta-analysis found five studies that examined the effect of MRSA on hospital stay. Following the identification of considerable heterogeneity (I2 = 89%, P <.001), we opted to conduct the analysis using the random-effect model. The value of the combined mean 95% confidence interval was 22.6 (13.7 to 31.6). The combined result suggested that MRSA-positive patients are associated with longer hospital stays (Z = 4.97, P <.001).

Emaneini et al. said in their meta-analysis that individuals with burns who are infected with MRSA had a higher risk of morbidity, Mortality, duration of hospital stay, and expenses. This finding is in accordance with what they said.[22]

These data show a reciprocal association between MRSA hospital stays. Hospital stay is associated with an increased chance of MRSA infection, and MRSA infection is associated with an increased duration of hospital stay. A severe sickness, the use of medical devices, and chronic and continuous exposure to healthcare professionals and/or individuals who may be colonized or infected with MRSA are all factors that may lead to infection in individuals who have been hospitalized for an extended period of time.

Regarding the length of ICU stay, the current meta-analysis found four studies that examined the effect of MRSA on ICU stay. Following the identification of considerable heterogeneity (I2 = 91%, P <.001), we opted to conduct the analysis using the random effect model. A combined mean 95% confidence interval was found to be 2.79 (-2.21 to 7.8). The combined result suggested that MRSA-positive patients are not associated with longer ICU stays (Z = 1.09, P =.27).

In the meta-analysis that Kalligeros et al. conducted, they found that the acquisition of MRSA was greater among individuals who had been admitted to the intensive care unit (OR 3.12, 95% CI: 2.18–4.47). However, they did not investigate the impact that MRSA acquisition had on the duration of stay.[23]

However, the duration of stay at ICU, if regular swabs from the wound and nose, hygiene precautions, isolation of new cases, and regular policy of antibiotic use are done, will decrease risks of infections, duration of stay, and costs for treatments and operations.

Regarding Mortality, four studies examined the effect of MRSA on mortality rate. No significant heterogeneity was detected. Therefore, a fixed effect model was used for analysis (I^2 = 0%, P =.56). The total odds ratio 95% confidence intervals came out at 1.28 (0.69 to 1.40). Based on the compilation of findings, it was determined the individuals who tested positive for MRSA did not have a higher death rate (Z = 0.78, P =.44). The integrity of this barrier is compromised as a consequence of burns, which also lead to immunosuppression on both the local & systemic levels. Concurrently, burn wounds may serve as a microenvironment for bacteria due to the presence of necrotic tissue, which has significant levels of protein and does not have any vascularization. The individual who has suffered a burn is at a significant risk of experiencing significant morbidity & death as a result of infection, which is one of the most damaging consequences.[23]

This comes in agreement with Emaneini et al., who, in their meta-analysis, stated that Individuals with burns who are infected with MRSA have a higher risk of morbidity and

death.22 Also, according to the systematic review by Shuping et al., burn patients infected with MRSA have a significantly higher rate of Mortality due to many factors (as the leading cause of Mortality is deaths caused by burns, ICU is multi-organ failure).[24]

4. Conclusion

The study found 14.7% MRSA infections in burn patients admitted to burn ICUs, with 3.8% colonization and 8.6% acquisition. Risk factors include age, burn surface area, male gender, inhalational injury, and burn cause.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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