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PREVALENCE AND CLINICAL SPECIMEN DISTRIBUTION OF METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS (MRSA) AT JEMURSARI ISLAMIC HOSPITAL SURABAYA IN 2020

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Abstract:

Background: Methicillin-Resistant Staphylococcus aureus (MRSA) represents a critical pathogen responsible for healthcare-associated infections (HAIs), posing formidable therapeutic challenges due to acquired resistance against nearly all β-lactam antibiotics via PBP2a production. Routine microbiological surveillance in secondary and tertiary referral hospitals is imperative to formulate institutional antibiograms and guide rational empirical antimicrobial regimens.

Objective: To determine the prevalence of MRSA among clinical Staphylococcus aureus isolates and analyze its distribution across specimen types and patient age brackets at Jemursari Islamic Hospital Surabaya during 2020. Methods: A descriptive retrospective cross-sectional study was conducted utilizing secondary laboratory culture databases and medical records from the Clinical Pathology Laboratory of Jemursari Islamic Hospital Surabaya between January and December 2020. All confirmed Staphylococcus aureus isolates fulfilling inclusion criteria were analyzed. Variables evaluated encompassed methicillin-resistance phenotypes (MSSA vs. MRSA), clinical specimen origins, and patient age strata. Data were synthesized using frequency distributions and relative percentages.

Results: A total of 23 non-duplicate Staphylococcus aureus isolates were identified across the one-year surveillance window. Methicillin-Sensitive Staphylococcus aureus (MSSA) accounted for 17 isolates (73.9%), while Methicillin-Resistant Staphylococcus aureus (MRSA) comprised 6 isolates, establishing an overall institutional MRSA prevalence of 26.1%. Stratified by clinical specimen type, MRSA isolates were predominantly recovered from pus/wound exudates (66.7%, n = 4), followed by sputum specimens (33.3%, n = 2). Age-stratified analysis revealed that MRSA was most frequently recovered from older adult patients aged 51–60 years (33.3%, n = 2), with single isolates (16.7% each) identified in age groups 11–20, 21–30, 31–40, and 61–70 years.

Conclusion: The prevalence of MRSA at Jemursari Islamic Hospital Surabaya in 2020 was 26.1%, predominantly originating from purulent soft tissue and respiratory specimens in older adult inpatients. Continuous microbiological surveillance, implementation of strict antimicrobial stewardship programs (ASP), and rigorous infection prevention and control (IPC) protocols are vital to curb the transmission of resistant clones.

Keywords: Antimicrobial resistance; Hospital infection; Inpatient care; Methicillin-Resistant Staphylococcus aureus (MRSA); Pus specimen; Surveillance

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1. INTRODUCTION

Staphylococcus aureus is an ubiquitous Gram-positive bacterium that colonizes human cutaneous and mucosal membranes, yet functions as a virulent opportunistic pathogen responsible for a broad spectrum of human infectious pathologies (Boswihi & Udo, 2018). Clinical manifestations range from superficial skin and soft-tissue infections (SSTIs)—such as folliculitis, furuncles, and postoperative wound abscesses—to invasive, life-threatening systemic diseases including necrotizing pneumonia, osteomyelitis, bacteremia, septic shock, and infective endocarditis (Alni et al., 2018; Boswihi & Udo, 2018). In hospital settings, S. aureus exhibits extraordinary genomic plasticity and adaptive evolutionary mechanisms against conventional antibiotic selective pressures, solidifying its status as one of the leading causative agents of healthcare-associated infections (HAIs) and community-acquired sepsis worldwide (Chineko et al., 2021; Garoy et al., 2019).

The widespread, unguided clinical consumption of antimicrobial agents over recent decades has accelerated the emergence of multi-drug resistant (MDR) phenotypes, prominent among which is Methicillin-Resistant Staphylococcus aureus (MRSA) (Garoy et al., 2019). Pathophysiologically, methicillin resistance is mediated primarily by the acquisition of the mobile staphylococcal cassette chromosome mec (SCCmec) element carrying the mecA or mecC genes. These structural genes encode an altered transpeptidase known as penicillin-binding protein 2a (PBP2a), which possesses markedly diminished binding affinity for virtually all conventional β-lactam antibiotics, including semi-synthetic penicillins (methicillin, oxacillin), cephalosporins, and carbapenems (Boswihi & Udo, 2018; Garoy et al., 2019). Consequently, therapeutic alternatives are severely narrowed, frequently forcing reliance on glycopeptides (vancomycin), lipopeptides (daptomycin), or oxazolidinones (linezolid). Clinical infections attributable to MRSA are directly associated with prolonged hospitalization, increased intensive care unit (ICU) admissions, escalating healthcare expenditures, higher therapeutic failure rates, and substantially elevated patient morbidity and mortality (Garoy et al., 2019; Kumar et al., 2021).

Recognizing this formidable clinical challenge, the World Health Organization (WHO) has categorized MRSA as a high-priority antibiotic-resistant pathogen requiring urgent surveillance and innovative therapeutics (World Health Organization, 2023). Globally, MRSA prevalence rates exhibit dramatic geographical heterogeneity, influenced by local infection prevention standards, regional hospital sizes, and antibiotic prescription cultures. International surveillance studies have documented MRSA prevalence rates reaching 72.0% in hospital settings in Eritrea (Garoy et al., 2019) and 29.4% in India (Kumar et al., 2021). In Indonesia, national systematic reviews indicate that MRSA prevalence varies widely across tertiary and district facilities, ranging between 0.3% and 52.0% among confirmed S. aureus isolates (Syahniar et al., 2020). Regional investigations report MRSA prevalence rates of 5.9% in Makassar (Nismawati et al., 2018) and 37.5% in the ICU of Abdul Moeloek Hospital in Bandar Lampung (Budiman et al., 2020), while in Surabaya, historic provincial referral data from Dr. Soetomo Hospital documented persistent MRSA detection in intensive care and surgical blood specimens (Sutandhio et al., 2018; Thirafi et al., 2017).

This pronounced inter-hospital variance underscores that national epidemiological estimates cannot replace facility-specific antibiograms. Every clinical hospital environment possesses unique microbiological ecologies shaped by patient demographic comorbidities, invasive device utilization, empirical prescribing habits, and hand hygiene compliance. Jemursari Islamic Hospital Surabaya (Rumah Sakit Islam Jemursari Surabaya) is an accredited private referral general hospital serving dense urban populations in southern Surabaya. Although

managing substantial inpatient volumes with complex surgical, internal medicine, and critical care units, baseline empirical microbiological data delineating local MRSA prevalence and specimen distribution at this institution remain scarce.

Therefore, this study aimed to determine the prevalence of Methicillin-Resistant Staphylococcus aureus (MRSA) among clinical S. aureus isolates and describe its phenotypic distribution across specimen types and patient age brackets at Jemursari Islamic Hospital Surabaya during the full calendar year of 2020. The resulting baseline evidence is intended to inform the hospital's Antimicrobial Stewardship Committee (Komite Pengendalian Resistensi Antimikroba [KPRA]) and Infection Prevention and Control Committee (Komite PPI) in optimizing empirical prescribing guidelines and infection containment strategies.

2. METHODS

2.1 Research Design

This study employed a quantitative descriptive observational research design utilizing a retrospective cross-sectional approach. This design was chosen to determine the prevalence and characterize the distribution of Methicillin-Resistant Staphylococcus aureus (MRSA) among clinical isolates archived over a defined one-year historical surveillance period without active clinical intervention.

2.2 Research Setting and Surveillance Time

The investigation was conducted at the Clinical Pathology and Microbiology Laboratory of Jemursari Islamic Hospital Surabaya, East Java Province, Indonesia. The surveillance window spanned twelve consecutive calendar months, from 1 January 2020 to 31 December 2020.

2.3 Research Population and Sample

The study population comprised all non-duplicate biological specimens submitted for microbiological culture and antimicrobial susceptibility testing (AST) at the Clinical Pathology Laboratory during the surveillance period. Total sampling (saturated sampling) was applied, enrolling all clinical isolates identified as Staphylococcus aureus that satisfied predefined study eligibility criteria. Inclusion criteria were: (1) positive bacterial culture confirmed as Staphylococcus aureus; (2) complete antimicrobial susceptibility report indicating methicillin susceptibility status (MSSA or MRSA); and (3) verified patient age and clinical specimen documentation. Exclusion criteria were: (1) duplicate isolates recovered from the same patient within the same septic episode; (2) coagulase-negative staphylococcal species (CoNS); and (3) incomplete laboratory records. A total sample of 23 S. aureus isolates fulfilled all eligibility criteria.

2.4 Laboratory Procedures and Microbiological Identification

Microbiological processing was executed in accordance with standard diagnostic protocols. Clinical specimens (pus/wound swabs and sputum) were inoculated onto selective and differential media, including Blood Agar and MacConkey Agar plates, and incubated aerobically at 35–37°C for 24–48 hours. Staphylococcus aureus was identified via characteristic golden-yellow colony pigmentation, beta-hemolysis, Gram-positive staphylococcal microscopic morphology, positive catalase reaction, and positive slide/tube coagulase testing. Antimicrobial susceptibility testing was performed to differentiate MSSA from MRSA based on standardized laboratory guidelines.

2.5 Variables and Data Collection Techniques

Secondary data were systematically extracted from computerized laboratory information systems (LIS) and hospital patient medical record archives. Evaluated variables included: (1)

phenotypic methicillin susceptibility (MSSA vs. MRSA); (2) biological specimen origin (pus/wound exudate, sputum, blood, urine); and (3) patient chronological age stratified into ten-year categorical intervals (0–10, 11–20, 21–30, 31–40, 41–50, 51–60, 61–70, and 71–80 years).

2.6 Data Analysis

Extracted data were verified, coded, and analyzed using SPSS software. Descriptive statistical analysis was conducted, computing absolute frequencies (n) and relative percentages (%) to establish the overall institutional MRSA prevalence (calculated as the proportion of MRSA isolates divided by the total number of S. aureus isolates multiplied by 100%). Cross-tabulations were constructed to illustrate the proportional distribution of MSSA and MRSA across clinical specimen categories and patient age brackets.

2.7 Scope and Limitations

The scope was delimited to archived microbiological isolates from a single private Islamic general hospital in Surabaya over a single calendar year (2020). Methodological limitations include the small total isolate count (n = 23 S. aureus isolates), which limits statistical power for multi-subgroup comparisons, the retrospective reliance on secondary laboratory registers precluding clinical outcome analysis.

2.8 Ethical Considerations

This investigation was conducted using secondary laboratory data that had been completely anonymized prior to analysis. To safeguard absolute patient confidentiality, all personal identifying details were permanently removed and replaced with unique alphanumeric codes. Consequently, the research team possessed no mechanism or key to trace these records back to individual patients. Every dataset handled throughout the evaluation strictly preserved the privacy and integrity of the source subjects. Access to these retrospective clinical archives was formally granted through the authorization of hospital administrative authorities. Furthermore, the handling and evaluation of these records strictly adhered to the institutional oversight established by the governing healthcare facility. This rigorous protocol ensured that all research procedures operated in full compliance with administrative permissions while maintaining uncompromised confidentiality standards.

3. RESULTS AND DISCUSSION

3.1. Result

During the twelve-month surveillance period from January to December 2020, a total of 23 non-duplicate clinical isolates of Staphylococcus aureus were successfully recovered and identified at the Clinical Pathology Laboratory of Jemursari Islamic Hospital Surabaya. Based on standard antimicrobial susceptibility testing, 17 isolates (73.9%, rounded to 74%) were identified as Methicillin-Sensitive Staphylococcus aureus (MSSA), while 6 isolates (26.1%, rounded to 26%) were confirmed as Methicillin-Resistant Staphylococcus aureus (MRSA). Consequently, the overall institutional prevalence of MRSA among S. aureus isolates was 26.1%. Table 1 delineates the phenotypic characteristics and proportional distribution of MSSA and MRSA isolates stratified by anatomical specimen origin and patient chronological age brackets.

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Table 1. Distribution of Staphylococcus aureus Isolates (MSSA and MRSA) by Clinical Specimen Type and Patient Age Strata at Jemursari Islamic Hospital Surabaya in 2020 (n = 23)

Clinical & Demographic Variable	MSSA Isolates n (%)	MRSA Isolates n (%)	Total S. aureus n (%)	Proportional MRSA Rate (%)
Specimen Category				
Pus / Wound Exudate	10 (58.8%)	4 (66.7%)	14 (60.9%)	28.6%
Sputum / Respiratory Secretion	7 (41.2%)	2 (33.3%)	9 (39.1%)	22.2%
Total Specimens	**17 (100.0%)**	**6 (100.0%)**	**23 (100.0%)**	**26.1%**
Patient Age Bracket				
0 – 10 years old	4 (23.5%)	0 (0.0%)	4 (17.4%)	0.0%
11 – 20 years old	2 (11.8%)	1 (16.7%)	3 (13.0%)	33.3%
21 – 30 years old	0 (0.0%)	1 (16.7%)	1 (4.3%)	100.0%
31 – 40 years old	1 (5.9%)	1 (16.7%)	2 (8.7%)	50.0%
41 – 50 years old	4 (23.5%)	0 (0.0%)	4 (17.4%)	0.0%
51 – 60 years old	2 (11.8%)	2 (33.3%)	4 (17.4%)	50.0%
61 – 70 years old	1 (5.9%)	1 (16.7%)	2 (8.7%)	50.0%
71 – 80 years old	**3 (17.6%)**	**0 (0.0%)**	**3 (13.0%)**	**0.0%**
Total Age Distribution	17 (100.0%)	6 (100.0%)	23 (100.0%)	26.1%

Source: Secondary microbiological records, Clinical Pathology Laboratory, Jemursari Islamic Hospital Surabaya, 2020.

As detailed in Table 1, purulent wound exudates (pus) represented the primary anatomical source for both MSSA and MRSA isolates, encompassing 60.9% (n = 14) of all confirmed S. aureus isolates. Among MRSA isolates, two-thirds (66.7%, n = 4) were recovered from pus specimens, while 33.3% (n = 2) originated from lower respiratory sputum specimens. In terms of age stratification, MRSA cases were predominantly clustered among older adults aged 51–60 years (33.3%, n = 2), with single isolates identified across age groups 11–20, 21–30, 31–40, and 61–70 years (16.7% each). Conversely, pediatric patients aged 0–10 years and elderly patients aged 71–80 years yielded exclusively MSSA isolates (n = 4 and n = 3, respectively).

3.2 Discussion

The principal empirical finding of this investigation establishes that the prevalence of Methicillin-Resistant Staphylococcus aureus (MRSA) at Jemursari Islamic Hospital Surabaya in 2020 was 26.1% (6 out of 23 S. aureus isolates). This documentation confirms that approximately one in every four clinical S. aureus infections at this facility was resistant to standard β-lactam antimicrobial therapy. Furthermore, the specimen distribution demonstrated that MRSA was heavily localized within pus/wound secretions (66.7%), followed by respiratory sputum (33.3%), with peak vulnerability observed among patients aged 51–60 years (33.3%). These findings establish an essential epidemiological baseline

reflecting the local microbiological resistance landscape during the initial year of the COVID-19 pandemic.

The 26.1% MRSA prevalence identified at RS Islam Jemursari demonstrates notable consistency with regional and international hospital surveillance reports. Nationally, systematic reviews by Syahniar et al. (2020) synthesizing Indonesian hospital data reported MRSA prevalence ranging from 0.3% to 52.0%. Our finding aligns closely with secondary hospital estimates in Java and is substantially lower than specialized critical care reports, such as the 37.5% ICU prevalence documented at Abdul Moeloek Hospital in Bandar Lampung (Budiman et al., 2020). Conversely, it exceeds the 5.9% prevalence reported from general patient cohorts at Hasanuddin University Hospital in Makassar (Nismawati et al., 2018). Internationally, our rate is comparable to tertiary hospital data from India (29.4%) (Kumar et al., 2021), while remaining well below the hyper-endemic 72.0% rate documented in Eritrea (Garoy et al., 2019). The predominance of pus specimens (66.7%) mirrors findings by Chineko et al. (2021) in Banjarmasin and Sutandhio et al. (2018) in Surabaya, affirming that purulent cutaneous and surgical site wounds serve as the principal anatomical niche for MRSA colonization and infection.

The biological mechanisms underpinning MRSA persistence and its anatomical tropism for purulent exudates are intimately linked to staphylococcal virulence factors and biofilm physiology (Boswihi & Udo, 2018). S. aureus produces an extensive armamentarium of surface adhesins (microbial surface components recognizing adhesive matrix molecules [MSCRAMMs]), hemolysins, and extracellular enzymes (coagulase, hyaluronidase, nucleases) that facilitate rapid attachment to traumatized epithelial surfaces and damaged surgical tissue (Alni et al., 2018). Upon colonization, MRSA strains form dense extracellular polysaccharide biofilms on open wounds and medical catheters, shielding bacterial colonies from host phagocytic clearance and impairing antibiotic penetration (Chineko et al., 2021; Garoy et al., 2019). Production of PBP2a via the mecA gene preserves bacterial peptidoglycan cell wall cross-linking despite therapeutic concentrations of oxacillin or cefoxitin, leading to extensive tissue necrosis, pus formation, and persistent local suppuration (Boswihi & Udo, 2018; Garoy et al., 2019).

The clustering of MRSA cases among mature adult and elderly patients aged 51–60 years is pathophysiologically attributed to immunosenescence, high prevalence of chronic metabolic comorbidities (such as Type 2 diabetes mellitus and chronic kidney disease), peripheral vascular disease, and increased exposure to healthcare environments (Syahniar et al., 2020). Diabetic microangiopathy compromises cutaneous perfusion, creating chronic, poorly healing lower extremity ulcers that serve as ideal portals for resistant staphylococcal colonization. Furthermore, older inpatients frequently undergo invasive catheterizations and receive broad-spectrum empirical antibiotics, which disrupts commensal microflora and exerts selective pressure favoring resistant clones (Budiman et al., 2020; Garoy et al., 2019).

A critical appraisal of the empirical data requires contextualizing the 2020 surveillance timeframe, which coincided with the onset of the global COVID-19 pandemic. During 2020, hospital infection prevention and control practices were intensely altered: widespread personal protective equipment (PPE) utilization and intensified surface disinfection may have curtailed cross-transmission, whereas widespread empirical prescription of broad-spectrum antibiotics (such as azithromycin, fluoroquinolones, and cephalosporins) for suspected respiratory coinfections may have paradoxically increased selective resistance pressure. Furthermore, elective surgical procedures and non-emergency outpatient visits

were drastically curtailed, explaining the relatively low absolute number of S. aureus isolates (n = 23) recovered over the year. Because the secondary dataset lacked individual inpatient clinical charts, whether the isolated MRSA strains represented healthcare-associated (HA-MRSA) or community-acquired (CA-MRSA) infections, and whether patients received prior antibiotic therapy or had invasive devices, cannot be mathematically partitioned.

This study bridges an important institutional empirical gap by providing the maiden baseline prevalence documentation of MRSA at Jemursari Islamic Hospital Surabaya. Establishing that 26.1% of staphylococcal infections are methicillin-resistant provides the Hospital Antimicrobial Stewardship Committee (KPRA) and Clinical Pathology Laboratory with crucial evidence: standard empiric therapy with cefazolin, ampicillin-sulbactam, or second/third-generation cephalosporins carries a 26% failure probability in severe staphylococcal sepsis, justifying the rational positioning of vancomycin or linezolid in hospital formulary guidelines.

3.3 Implications

The findings carry urgent practical implications for hospital clinicians and administration: (1) Mandatory screening of purulent surgical wounds via rapid cefoxitin disc or automated phenotypic methods prior to step-down therapy; (2) Strict enforcement of contact precautions, patient isolation, and hand hygiene compliance for confirmed MRSA cases; and (3) Integration of annual hospital-wide antibiograms into electronic clinical decision support systems to prevent empiric overuse of broad-spectrum carbapenems and glycopeptides.

3.4 Research contribution

This study contributes localized epidemiological surveillance data from a major private Islamic referral hospital in East Java, enriching provincial and national antimicrobial resistance tracking registries.

3.5 Limitations

Several limitations must be acknowledged: (1) The retrospective design relied strictly on secondary laboratory records; (2) The absolute isolate volume was small (n = 23 S. aureus isolates; 6 MRSA), precluding multivariable regression modeling.

3.6 Suggestions

Future inquiries should establish prospective, multi-year surveillance tracking longitudinal resistance trends across inpatient wards (ICU vs. surgical vs. pediatric), incorporate molecular typing (SCCmec, spa typing, and Panton-Valentine leukocidin [PVL] toxin detection), assess minimum inhibitory concentrations (MICs) for vancomycin, and evaluate clinical patient outcomes via multivariable logistic regression.

4. CONCLUSION

The institutional prevalence of Methicillin-Resistant Staphylococcus aureus (MRSA) among clinical S. aureus isolates at Jemursari Islamic Hospital Surabaya during 2020 was 26.1% (6 out of 23 isolates), while 73.9% (n = 17) were Methicillin-Sensitive S. aureus (MSSA). MRSA was predominantly isolated from purulent wound exudates (66.7%) and sputum specimens (33.3%), with peak vulnerability documented in patients aged 51–60 years (33.3%). These findings confirm that MRSA represents an active, significant clinical concern in hospital care, mandating institutionalized antimicrobial stewardship programs, culture-guided rational prescribing, and reinforced infection control vigilance.

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AUTHOR CONTRIBUTIONS STATEMENT

MDP: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing—original draft. DRK, YDP, YA: Supervision, Validation, Methodology, Writing—review and editing, Project administration.

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REFERENCES

Alni, R. H., Mohammadzadeh, A., Mahmoodi, P., & Alikhani, M. Y. (2018). Detection of toxic shock syndrome toxin (TSST) gene among Staphylococcus aureus isolated from patients and healthy carriers. Avicenna Journal of Clinical Microbiology and Infection, 5(1), 1–5. https://doi.org/10.34172/ajcmi.2018.01

Boswihi, S. S., & Udo, E. E. (2018). Methicillin-resistant Staphylococcus aureus: An update on the epidemiology, treatment options, and infection control. Current Medicine Research and Practice, 8(1), 18–24. https://doi.org/10.1016/j.cmrp.2018.01.001

Budiman, H. M., Soleha, T. U., Warganegara, E., & Anggraini, D. I. (2020). Prevalence of colonization of methicillin-resistant Staphylococcus aureus (MRSA) in the intensive care unit (ICU) of Abdul Moeloek General Hospital, Bandar Lampung. Majority, 9(1), 19–23.

Chineko, S. I., Pratiwi, D. I. N., Rahmiati, R., Muthmainnah, N., & Yasmina, A. (2021). Antibiotic susceptibility pattern of MRSA in the intensive care unit of Ulin General Hospital Banjarmasin. Indonesian Journal of Clinical Pathology and Medical Laboratory, 27(2), 177–183. https://doi.org/10.24293/ijcpml.v27i2.1702

David, M. Z., & Daum, R. S. (2010). Community-associated methicillin-resistant Staphylococcus aureus: Epidemiology and clinical consequences of an emerging epidemic. Clinical Microbiology Reviews, 23(3), 616–687. https://doi.org/10.1128/CMR.00081-09

Garoy, E. Y., Gebreab, Y. B., Achila, O. O., Tekeste, D. G., Kesete, R., Ghirmay, R., Kiflay, R., & Tesfu, T. (2019). Methicillin-resistant Staphylococcus aureus (MRSA): Prevalence and antimicrobial sensitivity pattern among patients—A multicenter study in Asmara, Eritrea. Canadian Journal of Infectious Diseases and Medical Microbiology, 2019, Article 8321834. https://doi.org/10.1155/2019/8321834

Kock, R., Becker, K., Cookson, B., van Gemert-Pijnen, J. E., Harbarth, S., Kluytmans, J., Mielke, M., Peters, G., Skov, R. L., Struelens, M. J., Tacconelli, E., Navarro Torné, A., Witte, W., & Friedrich, A. W. (2010). Systematic literature analysis and review of targeted preventive measures to limit healthcare-associated infections by meticillin-resistant Staphylococcus aureus. Eurosurveillance, 15(41), Article 19688. https://doi.org/10.2807/ese.15.41.19688-en

Kumar, P., Gupta, G., Gupta, G. K., Mishra, V., & Gupta, G. (2021). Prevalence of MRSA and antimicrobial susceptibility of Staphylococcus aureus in clinical samples in the National Capital Region, India. Journal of Pharmaceutical Research International, 33(59A), 209–215. https://doi.org/10.9734/jpri/2021/v33i59A34289

Lakhundi, S., & Zhang, K. (2018). Methicillin-resistant Staphylococcus aureus: Molecular characterization, evolution, and epidemiology. Clinical Microbiology Reviews, 31(4), Article e00020-18. https://doi.org/10.1128/CMR.00020-18

Nismawati, N., Sjahril, R., & Agus, R. (2018). Detection of methicillin-resistant Staphylococcus aureus (MRSA) in patients of Hasanuddin University Hospital using culture methods. Proceedings of the National Seminar on Indonesian Megabiodiversity, 1(1), 112–118.

Sutandhio, S., Widodo, A. D. W., & Wasito, E. B. (2018). Distribution and antibiogram of MRSA from blood specimens in four semesters perspective in Dr. Soetomo General Hospital Surabaya. Jurnal Widya Medika, 4(2), 61–67.

Syahniar, R., Rayhana, R., Swasti, K. D., Khatam, M., & Duarsa, D. B. B. (2020). Methicillin-resistant Staphylococcus aureus among clinical isolates in Indonesia: A systematic review. Biomedical & Pharmacology Journal, 13(4), 1871–1878. https://doi.org/10.13005/bpj/2064

Tacconelli, E., Carrara, E., Savoldi, A., Harbarth, S., Mendelson, M., Monnet, D. L., Pulcini, C., Kahlmeter, G., Kluytmans, J., Carmeli, Y., Ouellette, M., Outterson, K., Patel, J., Cavaleri, M., Cox, E. M., Houchens, C. R., Grayson, M. L., Hansen, P., Singh, N., … Zorzet, A. (2018). Discovery, research, and development of new antibiotics: The WHO priority list of antibiotic-resistant bacteria and tuberculosis. The Lancet Infectious Diseases, 18(3), 318–327. https://doi.org/10.1016/S1473-3099(17)30753-3

Thirafi, S. Z. T., Bramantono, B., & Kuntaman, K. (2017). Susceptibility pattern of methicillin-resistant Staphylococcus aureus (MRSA) bacteria in Dr. Soetomo General Academic Hospital Surabaya, Indonesia (Master's thesis). Universitas Airlangga Repository.

Tong, S. Y., Davis, J. S., Eichenberger, E., Holland, T. L., & Fowler, V. G. (2015). Staphylococcus aureus infections: Epidemiology, pathophysiology, clinical manifestations, and novel

therapeutics. Clinical Microbiology Reviews, 28(3), 603–661. https://doi.org/10.1128/CMR.00134-14

Turner, N. A., Sharma-Kuinkel, B. K., Maskarinec, S. A., Eichenberger, E. M., Shah, P. P., Carugati, M., Holland, T. L., & Fowler, V. G. (2019). Methicillin-resistant Staphylococcus aureus: An overview of basic and clinical research. Nature Reviews Microbiology, 17(4), 203–218. https://doi.org/10.1038/s41579-018-0147-4

Vestergaard, M., Frees, D., & Ingmer, H. (2019). Antibiotic resistance and the MRSA problem. Microbiology Spectrum, 7(2), 1–23. https://doi.org/10.1128/microbiolspec.GPP3-0057-2018

World Health Organization. (2023). Global antimicrobial resistance and use surveillance system (GLASS) report 2022. World Health Organization. https://www.who.int/publications/i/item/9789240062702