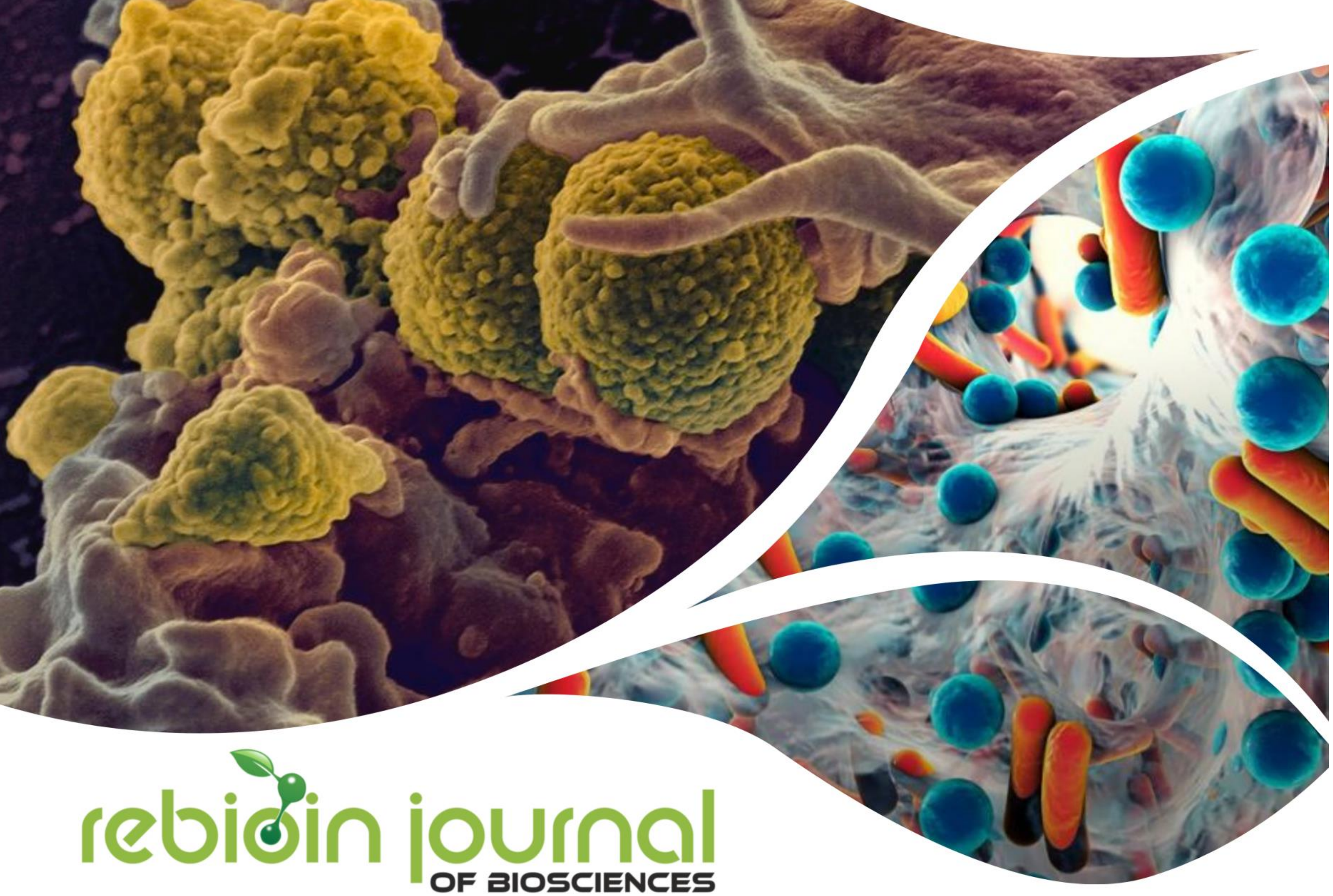

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# FIGHTING BACK Fighting Back Against MRSA: Strategies For Surveillance And Public Awareness in INDIA

# FIGHTING BACK AGAINST MRSA: STRATEGIES FOR SURVEILLANCE AND PUBLIC AWARENESS IN INDIA

**Asteek Kumar Pandey[1], Devanshi Shrivastava[1] and Vinod Kumar Gupta[2*]**

[1]Govt. Thakur Ranmat Singh College, Rewa, Madhya Pradesh, India-486001
[2]Rapture Biotech International Pvt. Ltd., Noida, Uttar Pradesh, India-201301

***Corresponding author mail id:** astikpandey139@gmail.com

## ABSTRACT

The prevalence and consequences of methicillin-resistant *Staphylococcus aureus (*MRSA) in India between 2015 and 2020 are examined in this study. A major cause of infections worldwide, especially in healthcare settings, *Staphylococcus aureus* is a Gram-positive bacterium that offers serious health hazards. The study emphasizes the concerning increase in MRSA prevalence, which was determined to be 37% overall, with regional differences in India. This underscores the threat that antibiotic-resistant strains pose to public health. The study highlights the epidemiological trends of MRSA and its correlation with elevated infection rates, namely in surgical site infections, bloodstream infections, and skin and soft tissue infections, by means of a methodical literature analysis and data extraction from several studies. To stop the spread of antibiotic resistance and boost healthcare outcomes, the studies recommend more surveillance, more stringent drug stewardship, and public awareness campaigns. The report emphasizes the necessity of all-encompassing approaches to reduce the incidence of MRSA, stressing the value of good hand hygiene and prudent antibiotic use to stop the nation's drug-resistant infection rate from rising further.

**Keywords:** Methicillin-Resistant *Staphylococcus aureus,* Antimicrobial resistance, Meta-analysis, Prevalence, Infection.

## INTRODUCTION

Usually seen in irregular, grape-like clusters, Staphylococcus aureus is a facultative anaerobic, heterotrophic, non-motile, non-spore-forming, Gram-positive cocci with a diameter of 0.5 to 1.5 µm. Only a few of the at least 47 species of the genus Staphylococcus, which belongs to the family Staphylococcaceae, infect humans and animals [1]. Methicillin-resistant S *aureus* (MRSA) was projected to be responsible for 52% of multidrug-resistant infections in hospitalized patients in the United States in 2017 [2]. Infection rates involving implantable foreign bodies have grown, despite the fact that the rate of endocarditis in US patients with S *aureus* bacteremia has decreased from over 50% [3]. Between 1954 to about 12% in 2017 [4]. The 90-day death rate for individuals with S *aureus* bacteremia is 27.0% (95% CI, 21.5%-33.3%), despite advancements in detection and treatment [5]. Increased global mortality is linked to *Staphylococcus aureus* bacteria growing resistance to antibiotics. Surgical site infections (SSIs) are closely linked to the perioperative spread of *S. aureus*. Up to 11% of healthy patients having elective surgery experience SSIs, and they are linked to higher rates of death, length of stay in the hospital, readmission, and medical expenses. The strategic attenuation of more pathogenic *S. aureus* strain features should be prompted by this evidence [6]. It is unknown how common *S. aureus* colonization is in humans. A more comprehensive explanation of *S. aureus 's* prevalence colonization both *within* and between low- and middle-income countries (LMIC) is necessary, as there is bias towards high-income countries (HIC) despite the availability of rigorous *S. aureus* colonization surveillance data and international publications. These findings may point to significant epidemiological patterns and open the door to techniques for preventing and limiting the spread of infections locally. *S. aureus* , for instance, is extremely clonal, and some strains show unique virulence profiles (such as antimicrobial resistance [AMR]) and establish themselves in particular environmental or geographic niches [7].

### ***Staphylococcus aureus* spread**

*Staphylococcus aureus* is a Gram-positive bacterium, and it is a crucial pathogen in humans and animals, causing a wide variation of illnesses ranging from skin and soft tissue infections is to life dangerous unwanted diseases. The pathogenesis of a particular *S. aureus* strain is assign to the combined influence of extracellular factors and toxins, associated with the intrusive qualities of the strain such as compliance, biofilm formation, and resistance to phagocytosis [8].In current years, methicillin-resistant *S. aureus* (MRSA) has become an increasing problem in Southeast Asia, for all improvements in health care and increased Hospitalization rates [9].

### **Overview of Skin Structure**

The structure of the skin is a complex network that acts as the body's first defense against infections, UV rays, toxins, and mechanical harm. The amount of water released into the environment and temperature are also controlled by this organ.

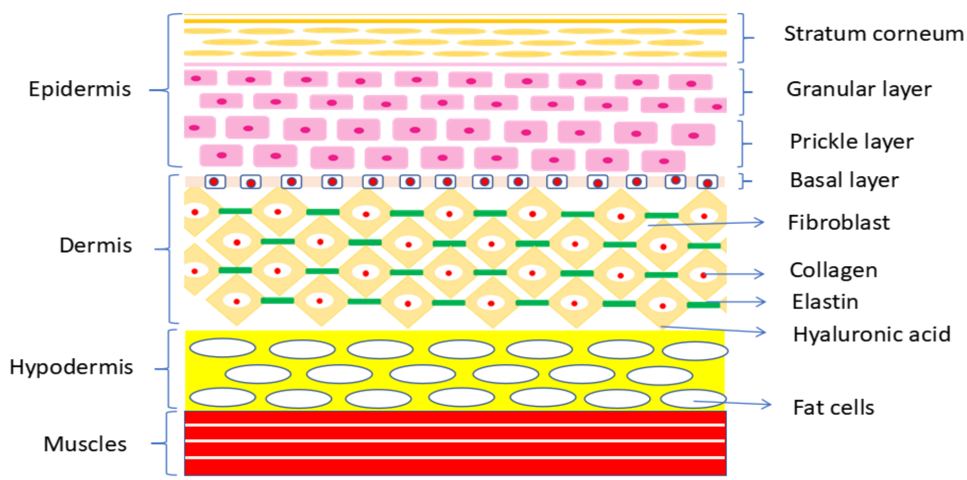


**Fig 1:-** layer of skin.

**Layers of Skin:-** The three layers that make up the skin each have unique anatomical features and purposes.

A. Epidermis
B. Dermis
C. hypodermis

**Epidermis:-** The epidermis, the Skin's outermost layer,is composed of several strata and various cell types crucial for its function.

**Layers of the epidermis**:

A. Stratum Basale
B. Stratum Spinosum
C. Stratum Granulosum
D. Stratum Lucidum
E. Stratum Corneum

**Dermis**

The basement membrane connects the dermis to the epidermis [10]. At one time drug molecule is through the stratum corneum, it may pass through from top to bottom epidermal tissues and enter into the dermis. It is 1-2 mm thick and mostly composed of fibrous tissues. The medication is absorbed into the systemic circulation through the dermis' abundant blood vessel supply. [11]. Sebaceous glands, sweat glands, and hair follicles playing a role in supporting, protecting and sensing the skin [12]. The skin surface of human is contain an average 10-70 hair follicles and 200-250 sweat glands on every $cm^2$ of the skin area [13]. The dermis is made up of two layers:

A. Papillary layer (thinner, upper layer)
B. Reticular layer (thicker, lower layer)

**Hypodermis**

The hypodermis, sometimes referred to as subcutaneous tissue, is the lowest layer of skin that connects the skin to muscles and bones, stores energy as fat, and protects and insulates the body [14]. Together with the outer layer (epidermis) and middle layer (dermis), the hypodermis is one of the three layers of human skin [15].

**Structure of hypodermis**

The hypodermis is a difficult structure composed of different cells, tissues, glands, and vessels that collaborate to defend the body and secure that it functions normally**.**
The components of the hypodermis include:-

**Function of the Hypodermis**

In the human body, the hypodermis serves a number of vital purposes.These include[16].

❖ Fat and energy storage
❖ Protecting the body
❖ Regulating body temperature
❖ Connecting the skin to bone and muscle

**Skin Microbiota's Function in Skin Health and Illness:**

Skin represents a shield against the enviromental pollutants, chemical and microorganisms [17]. The main microorganisms of skin microbiota belongs to Staphylococcus, Corynebacterium, Staphylococcus and propionibacterium genera. Among Staphylococcus species the main isolates species are coagulase- negative Staphylococci (CoNS) in particular S.epidermidis is the most

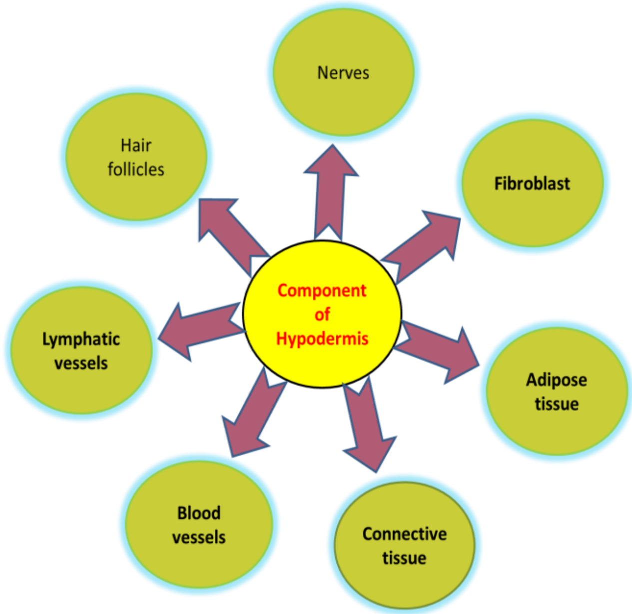

**Fig 2:-** Component of hypodermis.

reported strain CoNS play a vital role in the skin microbial stabilization, through the inhibition of pathogen [18]. The metabolism of S. epidermidis produces butyric acid, a short-chain fatty acid that inhibits *S. aureus* from growing both in vitro and in vivo [19].

**Skin microbiota in skin health:**

1) **Barrier function:-** The skin microbiota provides a physical barrier that helps prevent pathogenic bacteria colonizing and infecting the skin. [20].
2) **Immune Modulation :-** Commensal microbes play a significant role in regulating the immune system, sustain in the development of immune tolerance, particularly in the early stages of life [21].
3) **Antimicrobial production :-** Certain skin microbiota members produce antibacterial substances, contributing to the skin's defense against potential pathogens [22].
4) **Hydration and pH Balance :-** The microbiome also plays a major role in maintaining skin hydration levels and pH both significant for skin barrier function [23].
5) **Influence on skin conditions :-** A balanced microbiota can help to control inflamation, reducing the risk of skin disorders like acne, eczema and psoriasis [24].

**Skin microbiota in disease**

**1) Dysbiosis :-** Dysbiosis refers to an polarity in microbiota composition, contributing to skin diseases.

**2) Acne:-** C. acnes can proliferates in choke pores ,leading to inflammation and acne lesions.

**3) Eczema:-** Atopic dermatitis can worsen due to dysbiosis in the skin microbiota, which is frequently indicated by an increase in *S. aureus* .

## Epidemiology

**Increasing rates of *S. aureus* bacteremia**

Overall, SAB is becoming more common. Between 1980 and 1989, SAB rates reported to the National Nosocomial Infections Surveillance System (NNIS) increased by 283% in non-teaching hospitals and 176% in big teaching hospitals [25]. *S. aureus* was the second most prevalent bloodstream isolate by 1998, accounting for 16% of all hospital-acquired bacteremia cases [26]. Between 2011 and 2014, 13.2% of nosocomial bacteremia in the USA was caused by *S. aureus* [27-28]. In the industrialized world, it also affects 10 to 30 persons per 100,000 each year [29]. The development of new treatments and medical procedures has been a significant influence in the rising incidence of SAB. A significant number of patients are at risk for staphylococcal bloodstream infections as a result of the growing use of invasive procedures, prosthetic devices, and intravascular catheters. According to a recent study by Emory University, 70% of recorded increases in hospital-acquired *S. aureus* bloodstream infections during a 10-year study period were attributable to intravascular device-associated SAB [30].

A new patient category has formed as a result of the move of acute medical care to outpatient settings and the rise in long-term intravascular device use in patients with chronic illnesses (such as cancer and end-stage renal disease): People who get SAB linked to catheters in the community [31].

For instance, according to a recent prospective analysis, 22% of community-acquired SAB episodes between 1990 and 1993 were caused by intravascular devices [30]. Another study found that community-acquired infections were present in about one-third of individuals with catheter-associated SAB [32]. It is unclear how much of these healthcare-related factors contribute to community-acquired SAB. Traditional at-risk groups are still susceptible to *S. aureus* bloodstream infections, even though healthcare-associated infections account for an increasing percentage of all SAB cases. Injection drug use (IDU) continues to be a major cause of SAB in many large metropolitan referral hospitals, but classic, community-acquired illnesses still account for a sizable portion of SAB cases in other locations [33].

**Increasing rate of *S. aureus* endocarditis**

The most common cause of infective endocarditis (IE) worldwide is *S. aureus* , which was once believed to be caused by viridians streptococci [34]. Furthermore, because of its tendency to cause serious illnesses and frequent antibiotic resistance, The threat posed by *S. aureus* to IE has increased. In recent decades, *S. aureus* prosthetic valve endocarditis (PVE), one of the most serious bacterial infections, has become more common due to methicillin-resistant *S. aureus* (MRSA) [35]. The rising incidence of *S. aureus* linked to healthcare The increasing use of implanted devices and interventional treatments may be partially reflected in IE. For instance, a recent analysis of 329 consecutive patients with definite or possible IE at the authors' institution from 1993 to 1999 showed that while infection rates from viridans group streptococci decreased (P ¼ 0.007), the number of cases linked to hemodialysis dependence (P ¼ 0.04), immune suppression (P ¼ 0.008), and The research period saw an increase in *S. aureus* (P < 0.001).

Independently, hemodialysis was linked to *S. aureus* -induced IE (OR ¼ 3.1, 95% CI: 1.6–5.9) [36].These results suggest a connection between evolving medical procedures and *S. aureus* IE epidemiology. The rising incidence of *S. aureus* IE linked to healthcare is probably caused, at least in part, by the increased use of intravascular devices. For instance, an intravascular device was suspected of being the source of infection in more than 50% of patients in a report of 59 *S. aureus* IE cases that were prospectively identified between 1994 and 1998 [37]. An infected intravenous catheter was the most frequent cause of bacteremia in a recent prospective cohort of 22 individuals with hospital-acquired IE (17 of which were caused by *S. aureus* happening in half of the cases [38].

**Skin and soft tissue infections (SSTIs) caused by *S. aureus* are becoming more common**

The Gram-positive cocci-shaped bacteria Staphylococcus aureus belongs to the Staphylococcaceae family. It is frequently present on healthy skin and mucosal membranes, as well as in the environment and the normal human microbial system [39].*S aureus* is primarily harmless and is found in the noses of about 30% of people. However, by entering the bloodstream and moving to interior tissues, it can result in problems and serious infections in the intestines and local organs, includingSkin and soft tissue infections caused by *S. aureus* [40] Methicillin-resistant *S. aureus* (MRSA) and other antibiotic-resistant strains have emerged, despite the fact that *S. aureus* frequently contributes to the commensal microbiome has become a major issue in clinical medicine worldwide. The *S. aureus* strain known as MRSA has become resistant to β-lactam drugs [41]. MecA, an antibiotic resistance gene, enables MRSA strains to prevent β-lactam drugs from deactivating enzymes essential for the formation of cell walls [42]. In recent decades, MRSA, a community-associated methicillin-resistant Staphylococcus aureus (CA-MRSA), has become the main culprit behind skin and soft-tissue infections (SSTIs). However, at first, it was a hospital-acquired infection [43]. The US saw 3.4 million ED visits for SSTIs in 2005, up from 1.2 million in 1993, according to recent studies [44].

**Increasing rate of *S. aureus* food poisoning**

The intoxication known as Staphylococcal food poisoning (SFP) is brought on by eating foods that contain adequate levels of one or more preformed enterotoxins [45-46]. Abdominal cramps, nausea, and forceful vomiting, with or without diarrhea, are among the symptoms of SFP that appear quickly (2–8 hours) [47]. The illness normally goes away 24 to 48 hours after it first appears and is self-limiting. Sometimes it can be severe enough to require hospitalization, especially in cases involving infants, the elderly, or individuals with disabilities [48].

The primary cause of food contamination is thought to be food handlers who have enterotoxin-producing *S. aureus* in their hands or nostrils, either from respiratory secretions or personal touch. With estimates of 20–30% for persistent colonization and 60% for intermittent colonization, *S. aureus* is actually a frequent commensal of human skin and mucosal membranes. Contamination is primarily linked to incorrect handling of cooked or processed foods, followed by storage under circumstances that allow the growth of *S. aureus* and the production of the enterotoxin or toxins, as *S. aureus* does not compete well with the native microbiota in raw foods [49].

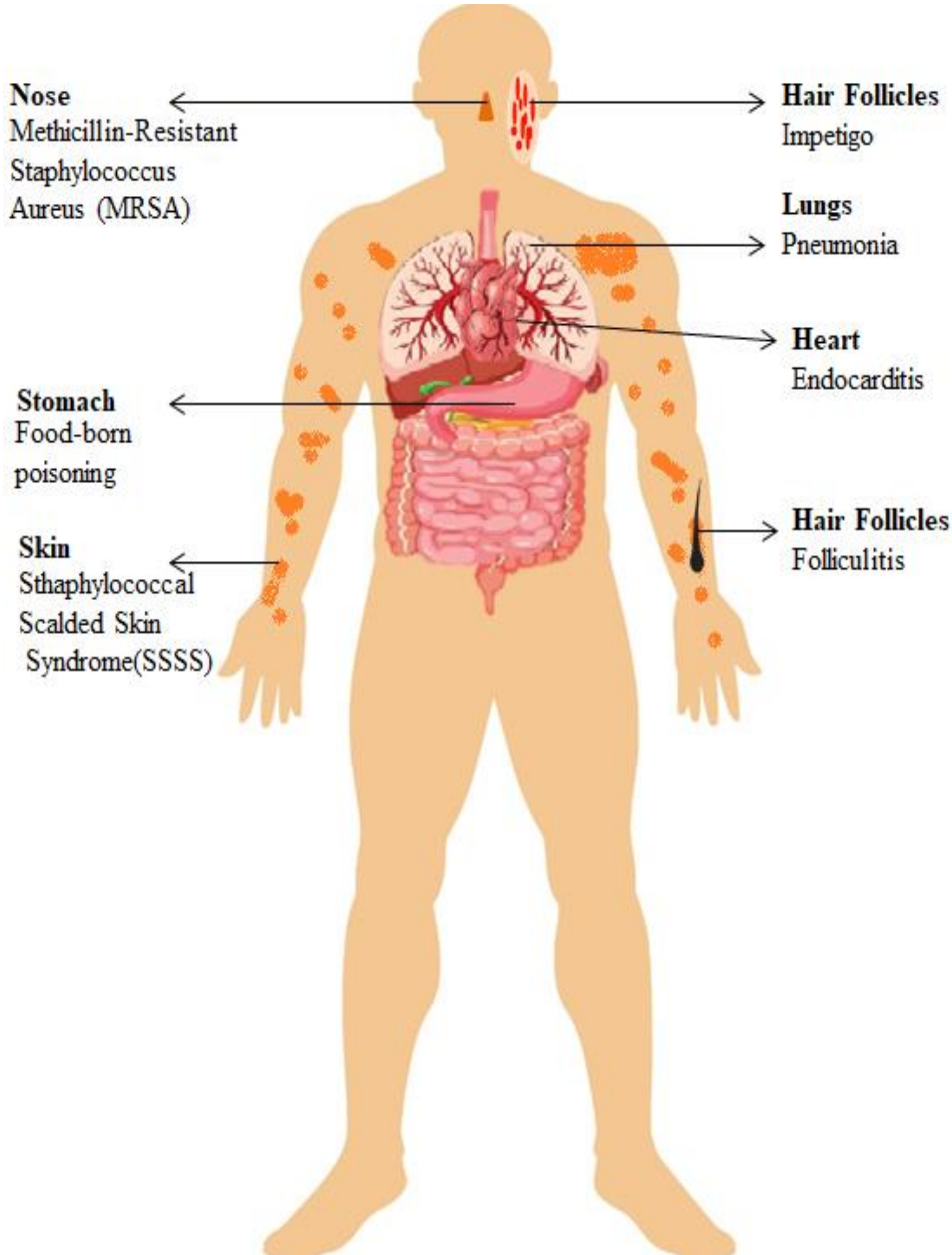


**Fig :- 3 Infection caused by *Staphylococcus aureus* [50].**

## METHODS

### Literature search

Using the following keywords in different combinations, we conducted a systematic search for articles: "*Staphylococcus aureus*," "*S. aureus* ," "MRSA," "prevalence," "India," and "Humans." We searched a number of sites, including Indian journals, PubMed, Google Scholar, and J-Gate Plus. Only publications published between 2015 and 2020 were included in the search. Furthermore, manual searches were conducted on citations obtained from review papers and original investigations. Lastly, the papers were selected by applying the inclusion and exclusion criteria to assess the titles and abstracts for relevancy. Plus. Only publications published between 2015 and 2020 were included in the search. Furthermore, manual searches were conducted on citations obtained from review papers and original investigations. Finally, the papers were chosen by evaluating the titles and abstracts for relevance using the inclusion and exclusion criteria.

### Study selection criteria

Following a search, the findings were put into Excel, duplicates were eliminated, and pertinent research was reviewed. We initially limited the papers we included to those published between 2015 and 2020 that had the headline keyword "prevalence of MRSA in India." The synopses of an few chosen papers were screened for titles. They read the whole studies on which they had reported.

(a) the prevalence of MRSA
(b) sample size data
(c) events (positive)
(d) year of study,
(e) geographical location of the study,
(f ) diagnostic procedures that serve as a confirmatory measure for MRSA identification [51].

The study did not include any articles that did not meet the aforementioned screening requirements. The analysis also excluded articles that had a lot of samples or occurrences. Duplicate studies were excluded, as were reviews, reports, editorial articles, and epidemic reports that omitted information on the prevalence of MRSA.

Details extracted from qualified studies included the following: first author, year of publication, research setting/sampling location, number of studied cases, number of MRSA isolates, isolate sources, diagnostic procedures utilized for confirmation, antibiogram results, and consideration for meta-analysis. To stratify the studies by state, zone, and year of publication, we also wanted to know the location of the research environment and the year of publication**.**

### Data extraction

### Risk of bias and quality assessment

A set rating scale was used to evaluate the quality of various investigations. [52]. An evaluation of the author and study year, the repressiveness of the sample utilized in the study, exposure

determination, comparability, and outcome were all included in the rating, which ranged from zero to five.
95% CI was used to express as a percentage. The importance of the heterogeneity in the studies was examined by subgroup analysis. The studies were categorized by state, year of publication, and national zones. The stratified prevalence of MRSA in various countries, research periods, sample sizes, and diagnostic tests was determined using subgroup meta-regression analysis.

**Table 1. Methicillin-resistant Staphylococcus aureus prevalence in India by year from 2015 to 2020.**

| YEAR | Pooled prevalence, % (95% CI) |
|---|---|
| 2015 | 38 (30 – 45) |
| 2016 | 39 (29 – 50) |
| 2017 | 31 (20 – 44) |
| 2018 | 35 (26 – 43) |
| 2019 | 37 (28 – 46) |
| 2019 | 69 (64 – 74) |

**Table 2:** Methicillin-resistant Staphylococcus aureus prevalence by zone in India from 2015 to 2020.

| Region | Pooled prevalence, % (95% CI) |
|---|---|
| **North** (Uttarakhand Uttar Pradesh, , Jammu and Kashmir, Haryana Himachal Pradesh, Punjab, New Delhi, and Uttar Pradesh) | 41 (33-50) |
| **North East** (Assam, Tripura, and Sikkim) | 40 (23-58) |
| **South** (Telangana, Karnataka, Tamil Nadu, Andhra Pradesh, , Puducherry and Kerala) | 34 (26-42) |
| **East** (Odisha and West Bengal) | 43 (20-68) |
| **West** (Rajasthan, Gujarat , and Maharashtra) | 33 (24-43) |
| **Central** (Madhya Pradesh) | 36 (25-47) |
| **Overall** | 37 (32-41) |

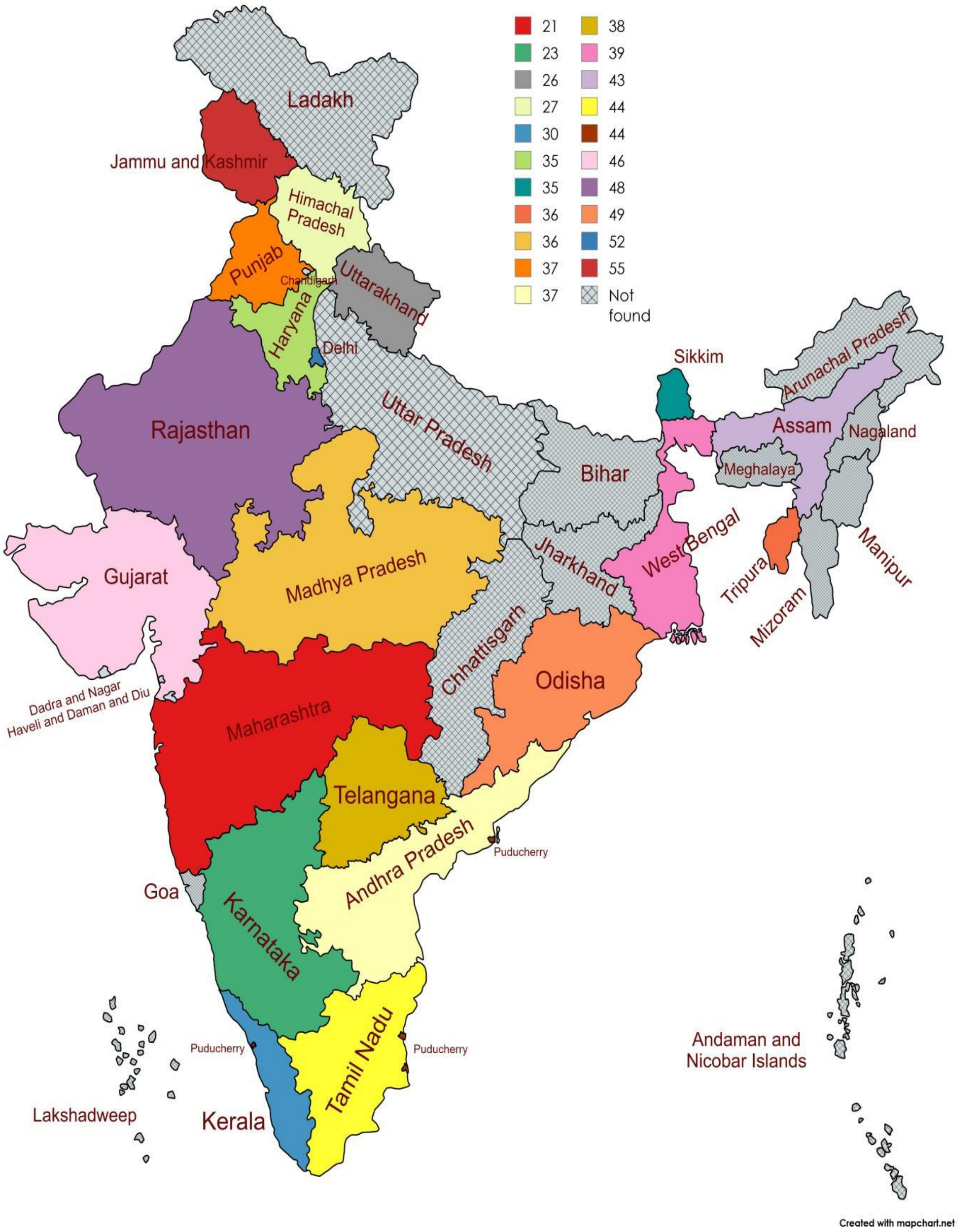


**Fig 4:-** Pooled prevalence of methicillin-resistant *Staphylococcus aureus* in 22 states in India during 2015 – 2020.

## Conclusion

In India, the total pooled prevalence of MRSA was extremely high at 37%. Calculating the frequency of MRSA would be greatly aided by studies using fast tests and big populations in many areas. The necessity of creating stricter guidelines and standards for the use of antibiotics in the human healthcare system is highlighted by the rise in MRSA prevalence. Strict hand cleanliness and the limited use of antibiotics can greatly reduce the prevalence of MRSA. To stop the epidemic growth of drug-resistant bacteria in India, awareness of the careless use of antibiotics and preventative measures should be raised [51].

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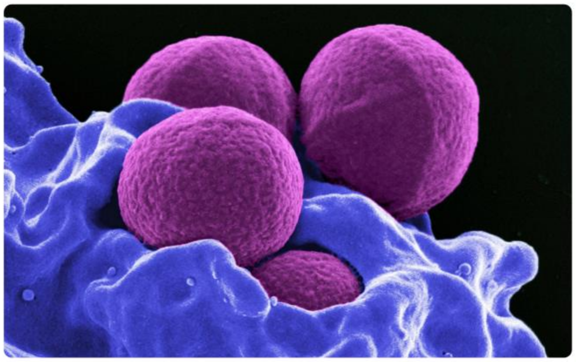
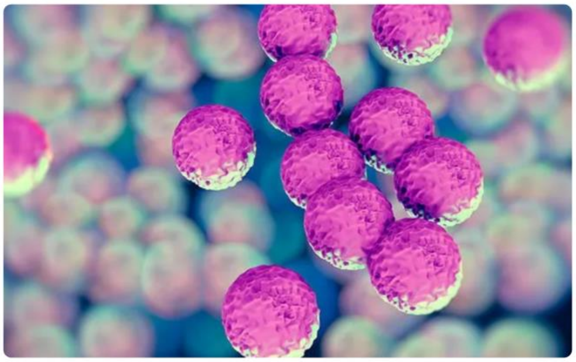
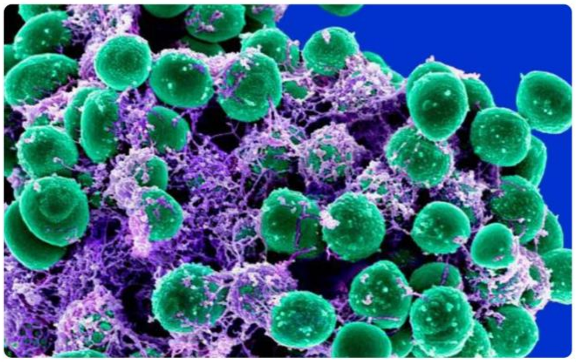
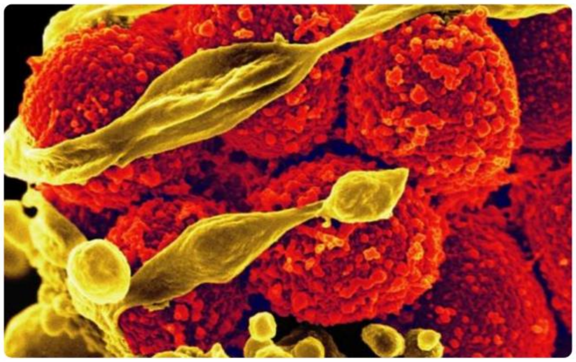
# Stop MRSA Before It Spreads Awareness Is the First Cure









Plot no 977, GMS Road, near Balliwala Flyover, opposite Cubic Plaza, Dehradun, Uttarakhand 248001

admin@reboin.com

www.rebioin.com