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Staphylococcal Infection in California: Strain Dominancy and Trends, a Good Day Against Superbug

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Abstract

In California, an average of 41,900 patients are diagnosed annually with S*taphylococcus* bacterial infection; out of these, 24,090 patients have methicillin-resistant *Staphylococcus aureus* (MRSA) infection and 17,810 patients have methicillin-sensitive *Staphylococcus aureus* (MSSA) infection. The aim of this paper is to find out whether there is a significant difference in strain dominancy and in what direction. The paper gathered and analyzed data for period of five years of infection rate due to *Staphylococcus aureus.* This study indicates that a significant difference in dominancy exists, the MRSA infection rate (an average of five years period) is 1.35 times higher than the MSSA infection rate (P-value < 0.05, CI: 95%), but the gap between the two infection rates is decreasing. The infection rate of both MRSA and MSSA is in a path of decline.

Keywords: methicillin-resistant *Staphylococcus aureus*; methicillin-sensitive *Staphylococcus aureus*; statistics; superbug; hormone; prevention

Introduction

There is considerable evidence to indicate that *Staphylococcus* infection has been increasing over the past 40 years, with the main cause of the increase being antibiotics overuse and the main contraction route being through healthcare workers [1,2]. The antibiotic resistance of *S. aureus* attributed to its the ability, via genetic mutation, to escape drug action [1,2]. In this study, we examined the type of *Staphylococcus* that is dominant and its trend. We hypothesized that MRSA infection is more common than methicillin-sensitive *Staphylococcus aureus* (MSSA) infection. Although evidence indicates that healthcare workers have a greater risk of contracting *Staphylococcus* infection (Datta et al., 2008) [3], other frontiers are emerging as potential areas of exposure risk to both MRSA and MSSA infections. Some recent studies have explored the existence of *Staphylococcus* in beach areas (Goodwin et al., 2012) [4], whereas others have explored the role of antibiotics and zinc in increasing resistance of *Staphylococcus* infections in animals processing facilities (Hatcher et al., 2017; Huijsdens et al., 2006) [5,6]. In addition, the carrier status of *Staphylococcus* in veterinary personnel has been studied (Hanselman et al., 2006; Rosenkranz et al., 2014) [7,8]. In this study, *Staphylococcus aureus* infection data (of five years period) were gathered and analyzed. Statistical analysis used to find out whether there is a significant difference.

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Materials and Methodology

We collected data the hospital discharge data obtained from the Hospital Inpatient - Diagnosis Code Frequency dataset published by the California Health and Human Services Agency (from 2012 to 2016) [9]. The data were tested by performing an independent *t*-test and were plotted to demonstrate the significance of the analyzed data. For the *Staphylococcus* infection rate hypothesis, the independent variables were the methicillin resistance states (sensitivity or resistance of *S. aureus* to methicillin) and the dependent variables were the means of the annual infection incident rate due to MRSA or MSSA. An independent *t*-test was statistically significant with a P-value of 0.05 and a CI of 95%.

Results

An average of (41,900) patients are diagnosed annually with *Staphylococcus* bacterial infection in California; out of these, (24,090) patients have MRSA infection and (17,810) patients have MSSA infection. The admission rate for MRSA infection has been reported to be higher than that for MSSA infection, in a ratio of (1.35) of MRSA to MSSA. The gap in the ratio between the admission rates for the MRSA to MSSA infections narrowed to (1.1) in 2016 from 2012 (1.5). Both MRSA and MSSA infection rates are decreasing. The incident rate decreased by (34.5%) for MRSA, and lowered by (7.3%) for MSSA between 2012 and 2016.

Discussion

The gap between MRSA and MSSA is substantial, and the current strategy of focusing on the healthcare worker factor should be revised and other variables should be considered. Although the healthcare worker factor was explored and targeted, a probable reason for the significant decrease in MRSA infection rate might be attributed to the focus on prevention of MRSA infection (decrease of 34.5%) but not on MSSA infection (average decrease of 7.3%). The emerging discovery of different sources of exposure, such as slaughterhouses, veterinarian facilities, and sand beaches, may help to elucidate the different ways in which the disease is contracted [4,5,6,7]. Hormonal factors have been investigated from the perspective of disease treatment and have been found to play a significant role in the treatment of infectious diseases; however, the molecular and cellular mechanisms have not been fully elucidated. Araneo et al. (1993) showed that dehydroepiandrosterone (DHEA) enhances the immune system and prevents the growth of *Listeria monocytogenes* [10]. Nathan et al. (1999) suggested that both DHEA, which may inhibit TNF-α, and androstenediol (AED), whose mechanism is independent of TNF, regulate the neuroendocrine system and protect it from lethal bacterial infection [11]. Contraceptive use extends the carrier status in females, which in turn increases the risk of exposure to *Staphylococcus* infection [12]. Further research is warranted to explore the role of hormones in *Staphylococcus* infection. There is a lack of research on the routes of acquiring the clinical infection in California apart from the healthcare worker route. Recent research in different countries has explored the role of animal slaughterhouses and the effect of disposing potentially infected waste in rivers and oceans. Further research is warranted to investigate the route of transmission in California and the reason behind male patients being more vulnerable to death due to *S. aureus* infection than female patients.

Conclusions

This paper explored the dominancy of *S. aureus.* MRSA infection is dominant over MSSA infection in the period 2012-2016. There is a significant decrement in the incident of infection rate of *S. aureus.* This marks a turning point in antibiotic resistance era. The healthcare worker factor has already been explored; however, increasing evidence of other potential areas of exposure risk (Figure 2) to *Staphylococcus* infection has emerged. Hormonal factors may play a major role in providing more immunity against the infection. Further research is warranted to investigate the association of exposure risks with clinical infection and carrier status. In addition, further research is warranted to explore the immunological mechanism that provides females more immunity and protection against higher mortality rates.

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Table 1 Absolute numbers and incident rates for MRSA and MSSA infections.

Year	MSSA infection	MRSA infection	MRSA/MSSA ratio	Population	MSSA incident rate	MRSA incident rate
2012	18098	28414	1.570007736	38041430	47.5744471	74.6922500
2013	18045	25931	1.437018565	38332521	47.0749106	67.6475205
2014	18036	24226	1.343202484	38802500	46.4815411	62.4341215
2015	17567	22686	1.291398645	39144818	44.8769490	57.9540311
2016	17305	19192	1.109043629	39250017	44.0891529	48.8967941

Table 2 Descriptive statistics for MSSA, MRSA, MSSA incident rate, and MRSA incident rate.

Variable	N	Mean	SE Mean	St Dev	Variance	Coef Var	Minimum	Median	Maximum
MSSA	5	17810	159	355	125830	1.99	17305	18036	18098
MRSA	5	24090	1550	3466	12016593	14.39	19192	24226	28414
MSSA incident rate	5	4.6019	0.0662	0.1481	0.0219	3.22	4.4089	4.6482	4.7574
MRSA incident rate	5	6.232	0.436	0.976	0.952	15.65	4.890	6.243	7.469

Table 3 Two-sample *t*-test and CI method for MRSA and MSSA infection rates.

μ_1: Mean of Sample 1

μ_2: Mean of Sample 2

Difference: μ_1 - μ_2

Variances are not assumed to be equal for this analysis.

Descriptive statistics

Sample	N	Mean	St Dev	SE Mean
MRSA	5	6.232	0.976	0.44
MSSA	5	4.602	0.148	0.066

Difference estimation

Difference	95% lower bound for difference
1.630	0.689

Test

Null hypothesis	H_0: $\mu_1 - \mu_2 = 0$
Alternative hypothesis	H_1: $\mu_1 - \mu_2 > 0$

T-value	DF	P-value
3.69	4	0.010

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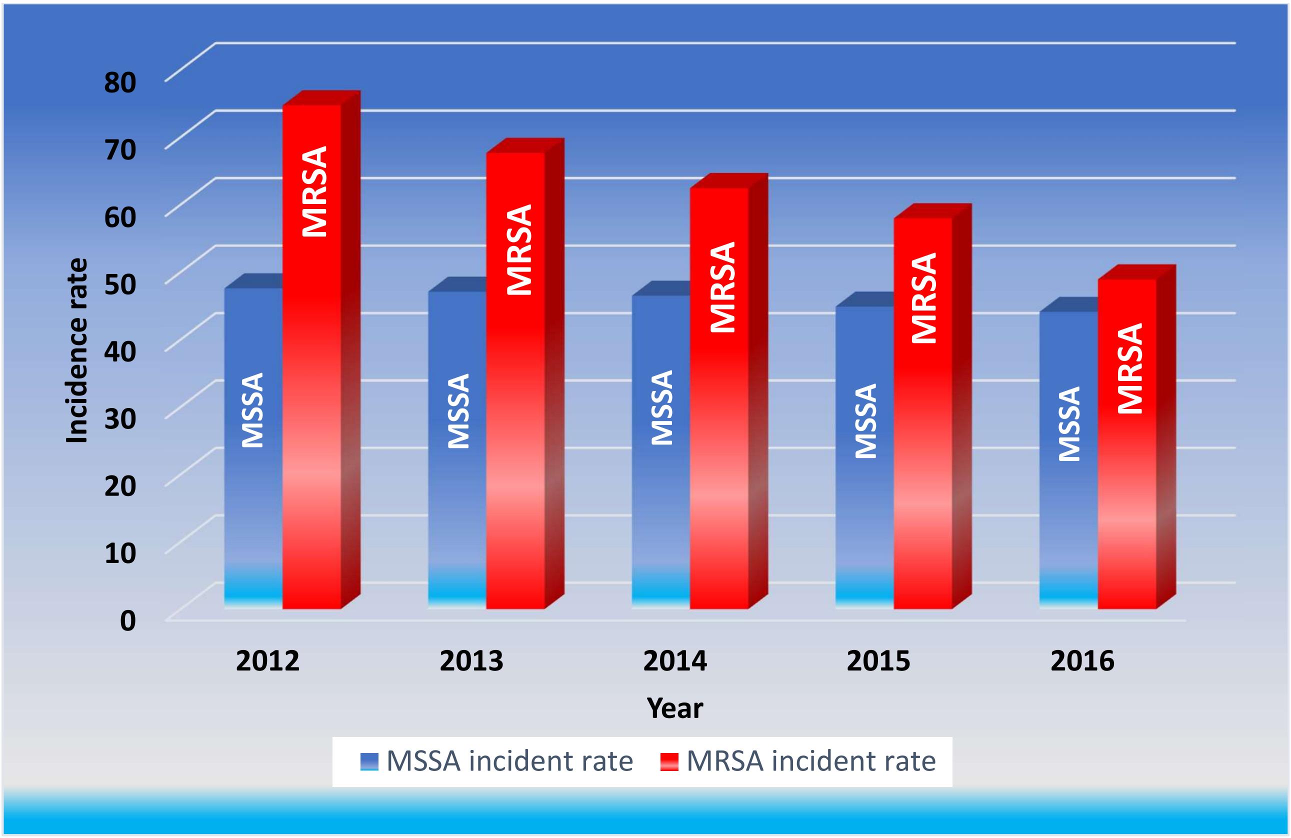

Figure 1 Dominance of MRSA infection incident rate over MSSA infection incident rate

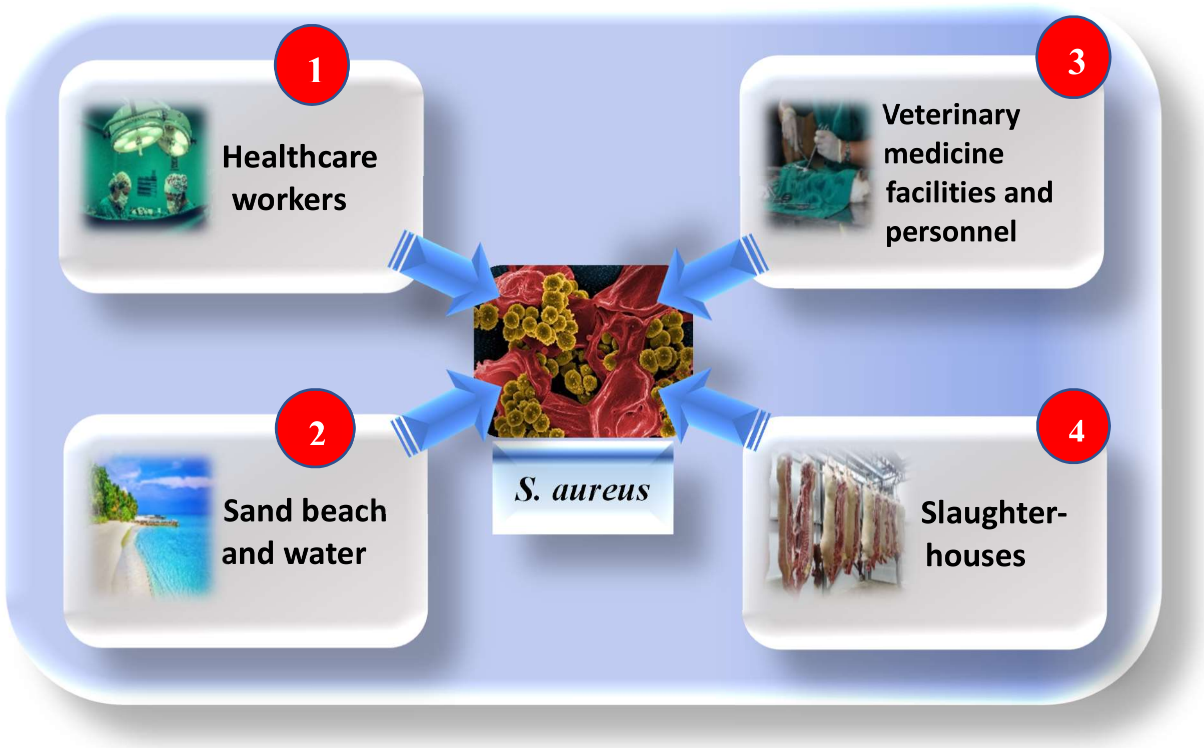

Figure 2 Areas of potential exposure for both MRSA and MSSA infections

Disclosure of interest

The author reports no conflicts of interest.

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