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Staphylococcal Infection and Mortality Rate in California: Strain Dominancy Trends and Gender difference

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Abstract

Average of 41,900 patients are diagnosed annually with staphylococcus bacterial infection in California, 24,089 patients have Methicillin-resistant Staphylococcus Aureus (MRSA) and 17,810 patients have Methicillin-Sensitive Staphylococcus (MSSA). This paper demonstrates that there is a difference in mortality rate due to staphylococcus infection between males and females (P-value<0.05, CI 95%). Male patient diagnosed with S. aureus has 1.3 chance of mortality incidence than female patient. In addition, MRSA infection rate is 1.4 times MSSA infection (P-value<0.05, CI 95%), but the gap of infection is decreasing; however, mortality of both infections combined are more than threefold greater compared to three decades ago.

Keywords: MRSA, MSSA, Staphylococcus aureus, mortality, gender, Methicillin-resistant Staphylococcus aureus, infectious disease, prevention

Introduction

There were many evidences of increasing staphylococcus infection over past forty years with emphasis on antibiotics overuse as the main cause and healthcare workers as the main route to contract the infection. In addition, reports demonstrated an increment in Methicillin-resistant Staphylococcus Aureus (MRSA). In this paper, we explored whether or not *S*. aureus pose different mortality risk in relation to the gender of the patient, the type of staphylococcus that is dominant and exposure risk areas. We hypothesized that there is a difference in mortality rate due to *Staphylococcus* aureus (*S*. aureus) infection between male and female. In addition, we hypothesized Methicillin-Resistant Staphylococcus Aureus (MRSA) infection are more common than Methicillin-Sensitive Staphylococcus (MSSA). While evidences indicate that healthcare workers risk have more risk of contracting staphylococcus (Datta et al., 2008) [1], other frontiers are emerging as potential risk of exposure to both MRSA and MSSA, recent evidences explored the existence of staphylococcus in beach areas (Goodwin et al., 2012) [2], while others explored antibiotics and zinc role in animals processing facilities (Hatcher et al., 2017; Huijsdens et al., 2006) [3-4] and veterinary personnel (Hanselman et al., 2006; Rosenkranz et al., 2014) [5-6] .

Materials and Methodology

We collected mortality data from Center for Disease Control and Prevention (CDC) Wide-ranging ONline Data for Epidemiologic Research (CDC WONDER) (from 1968-2016) [7-9] and hospital discharge data from Hospital Inpatient - Diagnosis Code Frequency published by California Health and Human Services Agency (CHHS) (from 2012-2016) [10]. Three ICD-8 codes were available and were used [(ICD-8

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Codes: 005.0 (Staphylococcal), 038.1 (Staphylococcal), 482.3 (Staphylococcus)], the codes for ICD-9 were [ICD-9 Codes: 005.0 (Staphylococcal food poisoning), 038.1 (Staphylococcal septicemia), 041.1 (Staphylococcus), 320.3 (Staphylococcal meningitis), 482.4 (Pneumonia due to staphylococcus)], and for ICD-10 Codes were [ICD-10 Codes: A05.0 (Foodborne staphylococcal intoxication), A41.0 (Septicaemia due to Staphylococcus aureus), A41.1 (Septicaemia due to other specified staphylococcus), A41.2 (Septicaemia due to unspecified staphylococcus), A49.0 (Staphylococcal infection, unspecified), G00.3 (Staphylococcal meningitis), J15.2 (Pneumonia due to staphylococcus), L00 (Staphylococcal scalded skin syndrome), M00.0 (Staphylococcal arthritis and polyarthritis), P23.2 (Congenital pneumonia due to staphylococcus), P36.2 (Sepsis of newborn due to Staphylococcus aureus)]. Data were tested by utilizing independent *t*-test. Data were plotted in figures to demonstrate the significance of analyzed data. For comparison and linking data of Staphylococcus infection rate with mortality rates and to calculate case-fatality rate, we used the period from 2012 to 2016. To demonstrate the magnitude and the trend of mortality rate according to gender, we used the period from 1968-2016. In addition, the paper made a comparison using a 10 years periods scale to demonstrate the difference and the change in mortality rate of each gender in California. Independent variables for mortality rate hypothesis are genders: male or female who were diagnosed with S. aureus and dependent variables are means of mortality rate due to staphylococcus infection between two groups. Independent variables for staphylococcus infection rate hypothesis are Methicillin resistance: *S*. aureus either sensitive or resistance to methicillin and dependent variables are means of infections annual incident rate due to MRSA or MSSA. For both hypotheses an independent *t*-test was used and P-value was set to 0.05 and CI to 95%.

Results

Average of 41,900 patients are diagnosed annually with staphylococcus bacterial infection in California, 24,089 patients have Methicillin-resistant Staphylococcus Aureus (MRSA) and 17,810 patients have Methicillin-Sensitive Staphylococcus (MSSA). Male mortality rate due to *S*. aureus was significantly higher than female mortality rate (P-value<0.05, CI 95%). Male patient diagnosed with S. aureus has 1.3 chance of mortality than female patient. 131 patients die annually in California due to *S*. aureus between 2012-2016, and eighty-four female patients die annually in the same period. Over forty years period [1968 to 2007] using 10 years scale, the mortality has raised to more than threefold between 1970s to 2000s in male patients, and it has raised to fourfold in the same period in female patients (figure 3 and 4), we believe that the low rate of recorded death happened partly because ICD-8 lacks a code that identify the role of staphylococcus in septicaemia. However, both male and female patients' mortality rate showed noticeable decrement that started in 2007; but females mortality rate is decreasing noticeably; while the male patients' mortality is fluctuating and conservatively high (figure 1 and 2). Further researches are warranted to investigate the etiology which causing the gap to widen. MRSA reported higher admission than MSSA, which may explain high rate of mortality due to *S*. aureus infection between (2012 and 2015), but it might also explain the small decline in mortality rate between (2016-2017) (figure 2 and 5) where the gap between MRSA and MSSA is narrowing. Further researches are warranted to investigate the route of transmission in California and why male patients are more vulnerable to death due to *S*. aureus infection than female patients. There is lack of researches that investigate routes of acquiring the clinical infection in California in addition to healthcare worker contact. Recent researches in different countries explored the role of animals slaughtering houses and the effect of disposing potentially infected waste on rivers and marine water.

Conclusion

There is a gap between male and female mortality due to staphylococcus infection where males have higher (1.3) risk of mortality compared to females. In addition, the MRSA infection is dominant over MSSA infection. While healthcare workers factor was explored, emerging evidences of other potential risk of exposure to staphylococcus are increasing (Figure 6). Further researches are warranted to investigate the association of exposure risks with clinical infection and carrier statuses.

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Table 1 demonstrate absolute infection numbers and incident rates for MRSA and MSSA.

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: MSSA, MRSA, MSSA incident rate, MRSA incident rate

Variable	N	Mean	SE Mean	StDev	Variance	CoefVar	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 rate.

μ_1: mean of Sample 1

μ_2: mean of Sample 2

Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics

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

Estimation for Difference

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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Table 4 Descriptive Statistics of Mortality due to Staphylococcal infection for male, female and total.

Statistics

Variable	N	Mean	SE Mean	StDev	Variance	CoefVar	Minimum
Male Deaths	49	95.98	6.70	46.89	2198.23	48.85	26.00
Male Population	49	14798679	459769	3218380	1.03580E+13	21.75	9639658
Male Mortality Rate	49	0.6151	0.0298	0.2085	0.0435	33.90	0.2565
Female Deaths	49	73.51	5.17	36.17	1308.05	49.20	12.00
Female Population	49	14978561	452860	3170019	1.00490E+13	21.16	9938072
Female Mortality Rate	49	0.4668	0.0253	0.1773	0.0314	37.97	0.1181
Total Death	49	169.5	11.7	81.6	6657.1	48.14	41.0
Total Population	49	29777240	912508	6387556	4.08009E+13	21.45	19577730
Total Mortality Rate	49	0.5405	0.0266	0.1864	0.0348	34.49	0.2042

Variable	Maximum
Male Deaths	207.00
Male Population	19493361
Male Mortality Rate	1.1609
Female Deaths	141.00
Female Population	19756656
Female Mortality Rate	0.8153
Total Death	347.0
Total Population	39250017
Total Mortality Rate	0.9685

Table 5 Two-Sample T-Test and CI for Male and Female Mortality Rates

Method

μ_1: mean of Sample 1

μ_2: mean of Sample 2

Difference: μ_1 - μ_2

Equal variances are not assumed for this analysis.

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean

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Male Mortality Rate	49	0.615	0.208	0.030
Female Mortality Rate	49	0.467	0.177	0.025

Estimation for Difference

Difference	95% Lower Bound for Difference
0.1483	0.0833

Test

Null hypothesis H_0: $\mu_1 - \mu_2 = 0$

Alternative hypothesis H_1: $\mu_1 - \mu_2 > 0$

T-Value	DF	P-Value
3.79	93	0.000

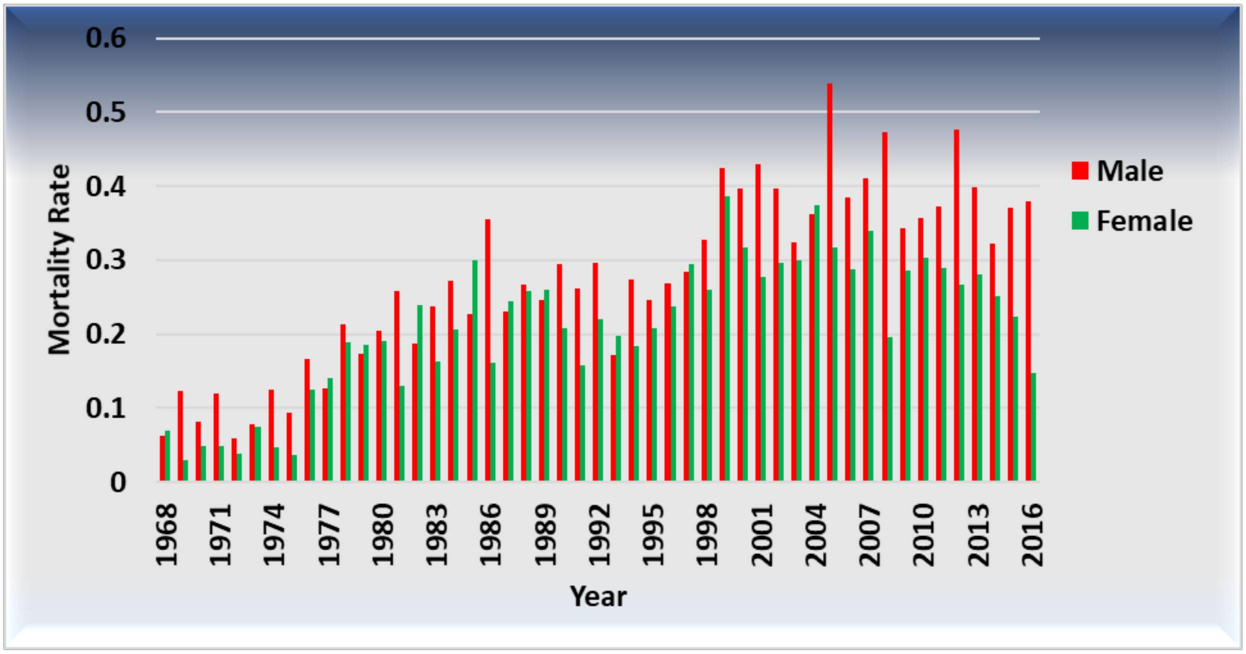

Figure 1 Graph shows male and female mortality rate differences due to *Staphylococcus* aureus infection in California

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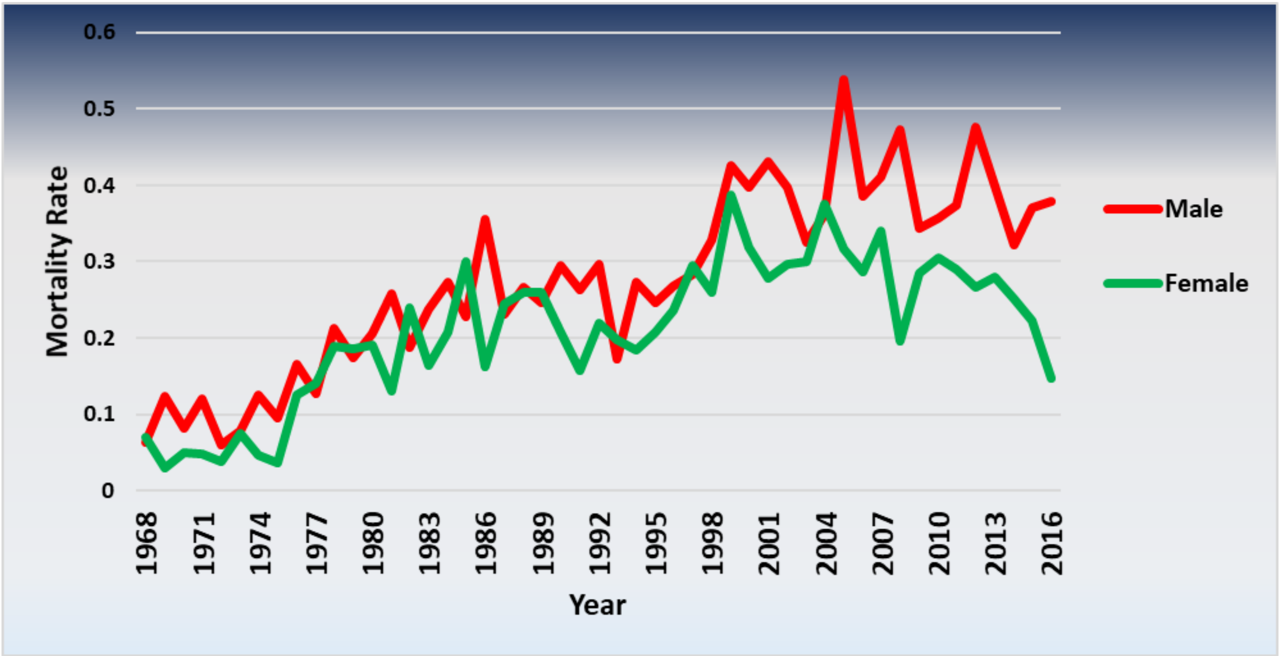
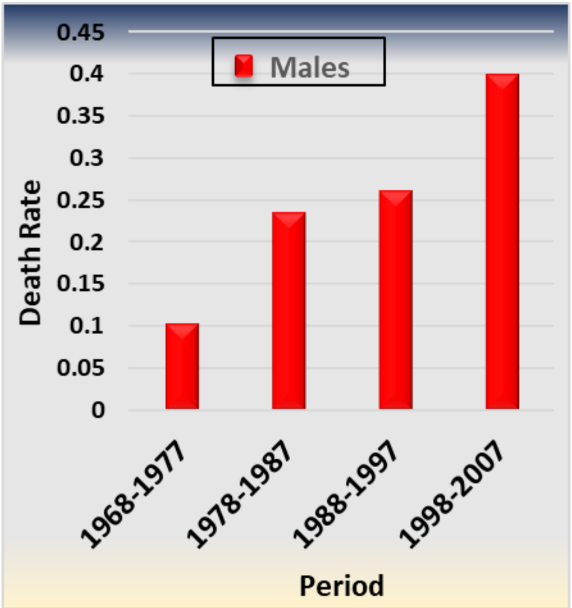


Figure 2 Graph shows mortality rate trend due to *Staphylococcus* aureus infection in California. Male mortality rate conserved at higher rate while female mortality rate decrementing



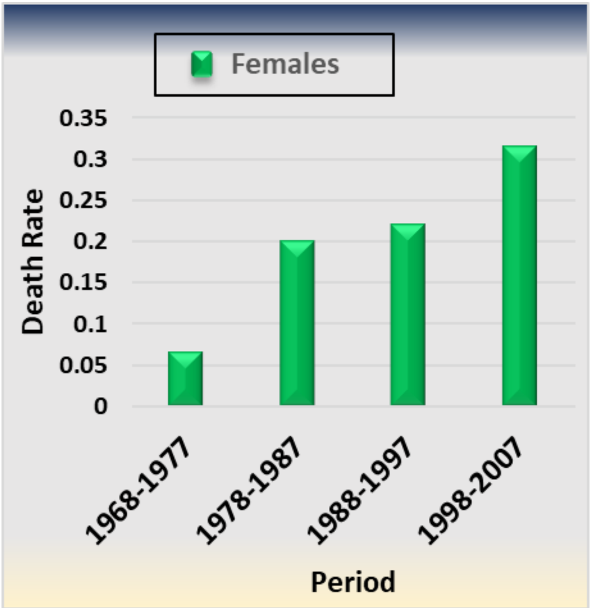


Figure 3 Graph shows male mortality rate 2000s is more than threefold than 1970s

Figure 4 Graph shows female mortality rate 2000s is fourfold than 1970s

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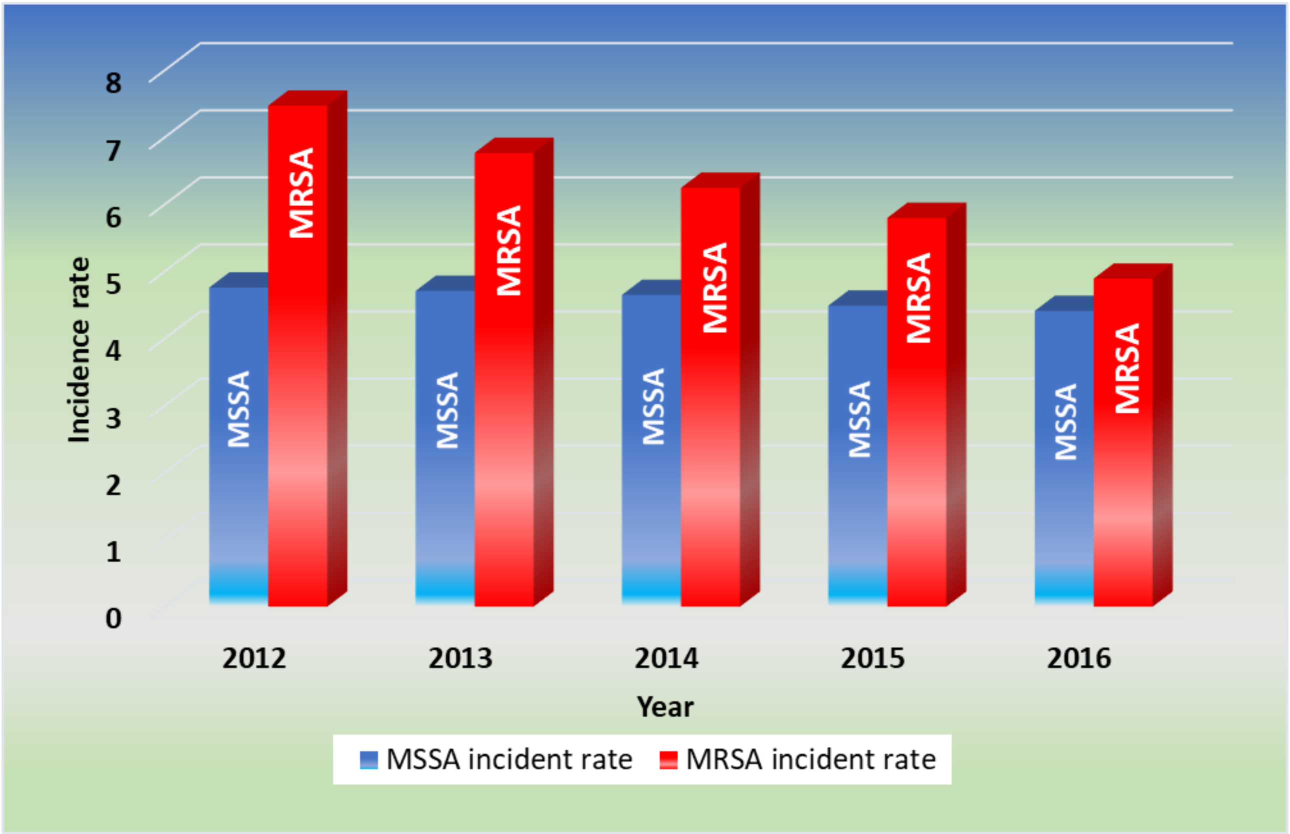

Figure 5 Graph shows the dominancy of Methicillin Resistant *S*. aureus (MRSA) over Methicillin Sensitive S. aureus (MSSA)

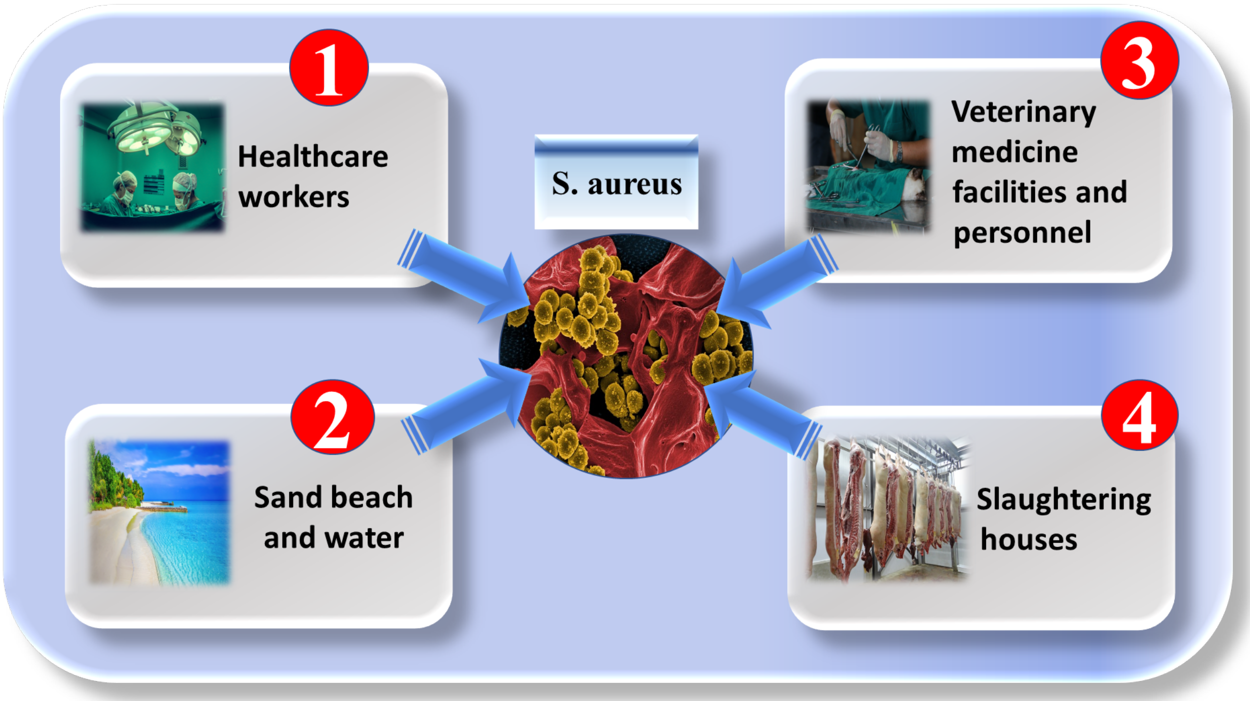

Figure 6 shows areas of potential exposure of both Methicillin Resistant *S.* aureus (MRSA) and Methicillin Sensitive S. aureus (MSSA)

Disclosure of interest

The authors report no conflicts of interest.

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