

Nasal colonization of methicillin resistant *staphylococcus aureus* among slaughterhouse workers in Dar es salaam, Tanzania

Abstract

Introduction: Methicillin resistant *Staphylococcus aureus* (MRSA) is a zoonotic pathogen that is associated with serious and sometimes fatal infections in humans. The pathogen has ability to acquire resistance to most antibiotics. Working in slaughterhouses increase the chance of workers to contract this pathogen. This study aimed to determine the prevalence of MRSA and its associated factors among slaughterhouse workers in Dar es Salaam, Tanzania.

Methods: A cross-sectional study was conducted from June-July 2018 involving workers from 4 registered slaughterhouses. Social demographics and other information was collected using a semi-structured questionnaire. Swabs were collected and inoculated in Mannitol salt agar for *S. aureus* isolation. The isolates were tested for antimicrobial susceptibility using 10µg Oxacillin discs implanted on Muller Hinton Agar plates. Binary logistic regression was employed to determine the association between prevalence of MRSA and independent variables.

Results: MRSA was isolated from 39,2% of the 258 enrolled slaughterhouse workers. MRSA colonization was more likely in persons who have been working for more than 21 years ($p=0,014$) and smokers ($p=0,02$). On-job training ($\text{adjOR}=0,417$; 95% CI: 0,202-0,858, $p=0,018$) was protective against MRSA nasal colonization.

Conclusion: Our study has demonstrated the occurrence of MRSA in slaughterhouse workers in Dar es salaam, Tanzania. It is more prevalent in persons who have been working for a long time in slaughterhouses. In addition, provision of on-job training is protective against MRSA nasal colonization. More studies are required to confirm whether the MRSA detected were livestock-associated.

Keywords: methicillin resistant *staphylococcus aureus*, nasal colonization, slaughterhouse workers, MRSA, Tanzania

Volume 6 Issue 2 - 2022

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Received: April 05, 2022 | **Published:** April 26, 2022

Abbreviations: MRSA, methicillin resistant *staphylococcus aureus*; CDC, centers for disease control and prevention; PPE, personal protective equipment

Introduction

Antimicrobial agents are used to prevent, treat and control diseases in human and farm animals. Improper use of antimicrobial agents in human and farm animals has created a selective pressure for the emergence and dissemination of antimicrobial-resistant bacteria particularly in developing countries.¹ Methicillin Resistant *Staphylococcus aureus* (MRSA) is a gram-positive bacterium that has shown resistance to methicillin and other antibiotics.^{2,3} When a strain of *Staphylococcus aureus* acquires the *mecA* gene it confers resistance to methicillin and the other β -lactams that widely used in both human and veterinary medicine.¹ MRSA infections range from minor skin and soft tissue infections to rapidly fatal, necrotizing pneumonia and devastating sepsis.⁴ Studies have reported the presence of MRSA in human, poultry, pigs, cattle.³ Infections with MRSA – when compared to methicillin-sensitive *S. aureus* – are more difficult to treat and tend to have a poorer outcome.^{5,6}

Occupational exposure to MRSA is eminent. The Centers for Disease Control and Prevention (CDC) provides that, about 1% of

the population is colonized with MRSA and workers who are in frequent contact with MRSA and animals are at risk of infection.⁷ Therefore, infection with MRSA can occur to farmers, slaughterhouse workers, transporters of animals, veterinarians and their families are at high risk of contracting MRSA.^{2,8} MRSA transmissibility from an index person to household contacts occurs in about half the cases.⁹ The use of personal protective equipment (PPE), intensity of animal contact, gender, age, awareness, and smoking have been reported to be associated with the spread of MRSA, among slaughterhouse workers.¹⁰⁻¹³

There are several studies conducted to address MRSA in Tanzania. They looked at patients attending regional hospitals,^{14,15} MRSA contamination and distribution in patient's care environment,¹⁶ health care workers in tertiary and regional hospitals.^{14,17} In animals, the available studies focused on detection of MRSA in animal products and their environment.^{18,19} Whereas these studies focus on MRSA in the hospital patients, health care workers, patients care environment, animals, animal products, and their surroundings, they didn't provide information about workers in ruminant slaughterhouses. Using antimicrobial susceptibility testing protocol for *S. aureus* resistance to oxacillin, we determined the prevalence of MRSA nasal colonization and its associated factors among workers in the ruminant slaughterhouses of Dar es Salaam, Tanzania.

Material and methods

Antimicrobial agents are used to prevent, treat and control diseases in human and farm animals. Improper use of antimicrobial agents in human and farm animals has created a selective pressure for the emergence and dissemination of antimicrobial-resistant bacteria particularly in developing countries.¹ Methicillin Resistant *Staphylococcus aureus* (MRSA) is a gram-positive bacterium that has shown resistance to methicillin and other antibiotics.^{2,3} When a strain of *Staphylococcus aureus* acquires the *mecA* gene it confers resistance to methicillin and the other β -lactams that widely used in both human and veterinary medicine.¹ MRSA infections range from minor skin and soft tissue infections to rapidly fatal, necrotizing pneumonia and devastating sepsis.⁴ Studies have reported the presence of MRSA in human, poultry, pigs, cattle.³ Infections with MRSA – when compared to methicillin-sensitive *S. aureus* – are more difficult to treat and tend to have a poorer outcome.^{5,6}

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Results

Socio-demographic characteristics of slaughterhouse workers

The study involved 258 workers from four registered slaughterhouses. The age of workers ranged from 17 to 66 years. Of these, most were males (98,8%) and married 72,9% (n=188). About 65,0% of workers had been working in the slaughterhouses for more than two years. Approximately, 71% of the workers had primary school education while 10% of them had incomplete primary schools or no formal education. More than a half of the workers in the slaughterhouses were skinners/eviscerators (55,4%; n=143) and about two-third were not using PPE. 16,0% of the workers (n=42) were current smokers and only about 25,0% were aware of the source of infections. Some of the workers (37,2%; n=96) were not adhering to slaughterhouses guidelines of not eating in the slaughter halls (Table 1). 95 (36,8%) slaughterhouse workers reported to be sick in the past three months, of them 60,0% had visited a healthcare facility for treatment while the remaining had opted for self-medication.

Table 1 Socio-demographic characteristics of the study population (N=258)

Variable	Description	Frequency(n)	Percent(%)
Age	Range	17 – 66 years	
Sex	Males	255	98,8
	Females	3	1,2
Marital status	Single	70	27,1
	Married	188	72,9
Work duration	<1 year	32	12,4
	2-12	168	65,1
	13-23	47	18,2
	24-33	9	3,5
	34+	2	0,8
Education	Informal	26	10,1
	Primary	184	71,3
	Secondary	48	18,6
Occupation	Vet. Officer	5	1,9
	Slaughter men	8	3,1
	Skinner/ Eviscerators	143	55,4
	Cleaners	6	2,3
	Gut washers	17	6,6
	Supervisors	22	8,5
	Businessmen*	57	22,1
Use of PPE	Yes	85	32,9
	No	173	67,1
Smoking	Yes	42	16,3
	No	216	83,7
Awareness on sources of infections	Yes	71	27,5
	No	187	72,5
Eating in working areas	Yes	96	37,2
	No	162	62,8

*Businessmen included butcher owners, carcass bearers, cow truck driver and meat van driver

Prevalence of MRSA nasal colonization

Nasal swab samples were collected from 258 workers in four slaughterhouses. Of all the isolates collected, 183 tested positive for *S. aureus*, of which 58 (31,7%) of the isolates tested positives were susceptible to oxacillin, 24 (13,1%) were intermediate and the remaining 101 (55,2%) were resistant to oxacillin (MRSA). The overall prevalence of MRSA among all workers in the four registered slaughterhouses was 39,1% (101/258) (Table 2). The only risk factors that had a statistically significant effect on the isolation of MRSA were the working duration (p=0,014) and smoking (p=0,02). Work section, PPE use and education level did not have significant influence on the prevalence of MRSA nasal colonization (Table 3).

Table 2 Variation of *S. aureus* and MRSA among slaughterhouse workers in Dar es salaam (N=258)

Location	Number of workers(N)	<i>S. aureus</i> + n (%)	- n (%)	MRSA*+ n (%)	- n (%)	Prevalence(%)
Ukonga	142	99 (69,7)	43 (30,3)	59 (59,6)	40 (40,4)	V
Kimara	54	31 (57,4)	23 (42,6)	19 (61,3)	12 (38,7)	61,3
Vingunguti	31	28 (90,3)	3 (9,7)	11 (39,3)	17 (60,7)	20,4
Tegeta	31	25 (80,7)	6 (19,3)	12 (48,0)	13 (52,0)	38,7
Total	258	183 (70,9)	75 (29,1)	101(55,2)	82 (44,8)	39,1

*MRSA was not statistically significant among workers in different slaughterhouses (p=0.204)

Table 3 Prevalence of MRSA among slaughterhouse workers by demographic characteristics of the participants

Character	Presence of MRSA		p-value	
	Positive	Negative		
Education level				
Primary education or less	5 (71,4 %)	2 (28,6 %)	0,378	
Secondary education and above?	96 (54,5 %)	80 (45,5 %)		
Occupation				
Veterinary Officer	3 (75,0%)	1 (25,0%)	0,08	
Slaughter man	1 (20,0%)	4 (80,0%)		
Skinners	60 (58,8%)	42 (41,2%)		
Cleaners	3 (50,0%)	3 (50,0%)		
Offal cleaners	3 (23,1%)	10 (76,9%)		
Supervisors	6 (42,9 %)	8 (57,1%)		
Businessmen*	25 (64,1 %)	14 (39,5%)		
<20	91 (52,9 %)	81(47,1 %)		0,014*
>21	10 (90,9)	1 (9,1 %)		
Smoking				
Yes	23 (74,2 %)	8(25,8 %)	0,02*	
No	78 (51,3 %)	74(48,7 %)		
Practices				
PPE use				
Yes	31(50,8 %)	30 (49,2 %)	0,4	
No	70 (57,4 %)	52(42,6 %)		
Hand washing				
Yes	98 (56,0%)	77 (44,0%)	0,304	
No	3 (37,5 %)	5 (62,5%)		

*Note: Bussinessmen included butcher owners/carcass bearer/ cow truck driver/meat van driver

Factors associated with the prevalence of MRSA among slaughterhouse workers

Binary logistic regression analysis of workers and management factors found that, lack of regular infection prevention trainings

increases the likelihood of workers being colonized with MRSA (adjOR=0,417, 95,0% CI (0,202-0,858), p=0,018). Working duration, smoking, periodic medical checkup and provision of PPE to workers did not show significant association with the detection of MRSA colonies (Table 4).

Table 4 Binary logistic regression of factors associated with prevalence of MRSA among slaughterhouse workers (n=101)

Variable	Unadjusted OR	95% CI	p=Value	Adjusted OR	95% CI	p=Value
Working duration						
<20 years	1					
>21 years	0,112	0,014-0,897	0,014	0,301	0,052-1,747	0,181
On job training						
Yes	1					
No	0,522	0,288-0,948	0,032	0,417	0,202-0,858	0,018*
Smoking						
Yes	2,728					
No	1	1,148-6,478	0,02	1,762	0,707-4,391	0,224
Periodic medical checkup						
Yes	1					
No	2,048	1,118-3,752	0,02	1,302	0,632-2,683	0,474
Provided with PPEs						
Yes	1					
No	0,535	0,296-0,967	0,038	0,609	0,312-1,190	0,147
Reporting system						
Yes	1					
No	0,515	0,275-0,966	0,037	0,551	0,270-1,125	0,102

Discussion

This study is the first to report the prevalence of MRSA nasal colonization among ruminant slaughterhouse workers in Dar es Salaam, Tanzania. The study confirm the presence of the MRSA among slaughterhouse workers with the prevalence of nasal colonization ranging from 20,4 to 61,3%. This prevalence is higher when compared to studies conducted in swine slaughterhouses in Italy (5,0% and 7,3%), South Africa (12,0%) and Latvia (21,1%)^{3,24-27} A study by Moon and colleagues²⁷ is the only available study to investigate MRSA colonization in cattle slaughterhouse workers and they did not detect any isolates containing MRSA suggesting that the prevalence obtained in this study is very high. A possible explanation for this finding could be the differences in level of hygiene and the setup of infrastructure between Tanzania and the reported developed countries. Moreover the huge application of antibiotics in livestock can also contributed to the increase in MRSA colonization.²⁸

Several factors related to working in close contact with animals have been found to be associated with the higher MRSA prevalence in slaughterhouse workers. In this study the higher prevalence of MRSA is associated with working duration, smoking and on-job training. Working in the slaughterhouses for more than 21 years is significantly associated with the higher prevalence of MRSA. This finding is supported by a study conducted in Cameroon which indicated that years spent in the pig slaughterhouse was a risk factor for nasal MRSA colonization (p=0.007). The main explanation of this association could be related to time workers spent dealing with animals as it was also reported by Mascaro et al., 2018.²⁵ Our findings differ from a study on workers in pig abattoirs in Trinidad and Tobago, in which, duration of work in the abattoir did not have significant association (p=0.55) with MRSA prevalence.¹

With regard to working environment, training of workers and provision of protective clothing are associated with reduced the odds of being colonized with MRSA. In our study, binary logistic regression analysis found that on-job training of slaughterhouse workers is the only factor that is significantly protective (p=0,018) against MRSA nasal colonization. Smoking, periodic medical check-up and use of PPE are not significantly related to the MRSA nasal colonization. Contrary to this study, Founou et al., 2018 found training of slaughterhouse workers and proper use of PPE to be significantly protective against MRSA nasal colonization.²⁹

To our knowledge, this study is the first to report on MRSA nasal colonization in slaughterhouse workers in the country. It also investigated workers in ruminant slaughterhouses, the rarely studied workplace as compared to workers in swine and poultry slaughterhouses. The limitation of the study is based on its design. The study was conducted using cross-section design whereby exposure and the associated risk factors were simultaneously assessed resulting in a temporal relationship between exposure and risk factors that lack strong evidence. Notwithstanding this, the identified relationships provide an understanding of the MRSA colonization status among slaughterhouse workers.

Conclusion

In conclusion, our study has demonstrated the occurrence of MRSA in slaughterhouse workers in Dar es salaam, Tanzania. It is more prevalent in persons who have been working for a long time in slaughterhouses. In addition, provision of on-job training was found to be protective against MRSA nasal colonization. More studies are required to confirm whether the MRSA detected were livestock-associated.

Acknowledgments

Authors would like to acknowledge the support they received from workers and management of Ukonga, Kimara and Vingunguti slaughterhouses.

Conflicts of interest

The author declares there is no conflict of interest.

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