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Prevalence and risk factors of MRSA colonisations among personnel in outpatient care settings in Hamburg, Germany

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ABSTRACT

Objectives

Healthcare workers frequently come into contact with infected individuals and are at a greater risk of infection than the general population due to their occupation. Multidrug-resistant organisms (MDROs) also pose a significant challenge for personnel and medical facilities. Currently, little is known about the occupational risk of MRSA in outpatient care settings. Therefore, a cross-sectional study was conducted in Hamburg to investigate MRSA colonisation among outpatient nursing staff.

Methods

MRSA screening with nasal swabs was carried out, the known risk factors for colonisation were determined and information on infection control was inquired. Where tests were positive, a control swab was taken; if this confirmed a positive result, decolonisation was offered. A molecular biological examination of the MRSA samples was performed. The occupational MRSA exposure and risk factors were compared with the situation for personnel in inpatient geriatric care.

Results

A total of 39 outpatient services participated in the study and 579 employees were tested. The MRSA prevalence was 1.2% in all and 1.7% in nursing staff. Most of the employees that tested positive had close or known contact with MRSA patients. Health personnel frequently reported personal protective measures and their application. Compared to outpatient staff, inpatient care staff were older and had worked in their profession for a longer time.

Conclusion

This study marks the first time that data has been made available on the occupational MRSA risk of outpatient care personnel in Hamburg. The MRSA prevalence is low and indicates a somewhat low risk of infection.

Strengths and limitations of this study

- Little is known to date about the occupational risk for MDROs among health personnel in outpatient care.
- Most studies on MDROs in healthcare settings focused solely on the patient.
- This is the first project to research the prevalence of MRSA in a large number of health personnel in outpatient care.
- Good infection control and the distribution of in-depth knowledge of infection prevention and hygiene measures helped to keep the MRSA prevalence in HCWs in outpatient care at a moderate rate.

INTRODUCTION

Healthcare workers frequently come into contact with infected individuals and are at a greater risk of infection than the general population due to their occupational activities. Multidrug-resistant organisms (MDROs) are increasingly becoming a public health problem. Meticillin-resistant *Staphylococcus aureus* (MRSA), which is prevalent worldwide, is the best known MDRO. This pathogen also poses a significant challenge for employees in various medical settings.

An MRSA prevalence of 0.7% was found for the general population in Germany.[1] Data on the frequency of MRSA colonisation among personnel in non-outbreak scenarios in Europe and in the US showed prevalence rates of between 0.2% and 15%[2] and average prevalence rates of 4.6%[3] and 5%.[4] For Germany, studies of employees at medical facilities revealed MRSA colonisation rates of 0.4% to 4.5%.[5]

In 2015, 2.9 million people were in need of care in Germany. Nearly three-quarters of them were cared for in their home, of which 66% were cared for by relatives and outpatient care services or solely by outpatient care services. In the same year, 356,000 people were employed in outpatient care in Germany. The majority of employees were women (87%), worked part-time and nearly 40% were aged 50 and older.[6] According to the population trend for Germany, the number of people in need of care is expected to rise steadily, reaching 3.4 million by 2030.[7] An increasing number of patients are being discharged early from hospital, who then require either outpatient or inpatient care.[8] As a result, the need for care on an outpatient basis will also continue to grow.

Little is currently known about the occupational exposure to MRSA among nursing staff in outpatient care settings. Against this backdrop, a study was performed in which the point prevalence of MRSA colonisations among employees in outpatient care facilities was investigated. Occupational exposure and known risk factors were compared with the situation of personnel in inpatient geriatric care settings, based on an earlier study conducted in Hamburg.[9]

METHODS

The cross-sectional study of employees in outpatient care facilities in Hamburg was conducted from June 2015 to March 2016. A total of 403 facilities for outpatient geriatric and/or nursing care were contacted. The MRSA screening was planned to take place on-site at the facilities. In addition, screening appointments were offered at the study centre. All outpatient services personnel were invited to participate. An age range of 18 to 65 years was set as an inclusion criterion.

Swabs from the nasal vestibules of employees were taken for the purpose of screening. Potential risk factors for MRSA colonisation were identified using a questionnaire. Occupational risk factors such as the nature and duration of their work, contact with MRSA patients in a nursing capacity and influential factors such as taking a course of antibiotics, their own hospital stays and contact with animals were explored alongside socio-demographic data. In addition, questions about infection control were asked.

Where MRSA findings were positive, the employees were first given the option of a control swab. If the result was still positive, a non-antibiotic decolonisation kit was provided, consisting of oral, nasal

and hand disinfectant and antimicrobial hair and body wash. A further control swab was offered to check whether the decolonisation efforts had been successful.

Results of a previous study were used for the comparison of occupational risks for personnel in outpatient care and inpatient geriatric care. The MRSA screening was performed from 2014 to 2015 in 19 geriatric care facilities in Hamburg and 759 employees were tested. Further details of the study were described by Peters et al.[9]

The study was conducted in accordance with the requirements of data protection legislation. The Hamburg Ethics Commission gave its approval.

Microbiological methods

Cotton wool swabs were used for the nasal swab examinations. The swab sample was taken by swabbing both anterior nares in a rotating motion for around five seconds and was then sealed in a transport container. In the laboratory, the swab was first streaked on an MRSA-selective plate (Biomerieux) and then put into a Brain Heart Infusion enrichment broth (Becton Dickinson). The plate and broth were incubated at 37°C in an ambient atmosphere. The plate was inspected after 24 hours and 48 hours of incubation. Suspicious colonies were further characterised by MALDI-TOF (Bruker Daltonics, MALDI Biotyper) either directly from the MRSA-selective plate when present as a pure culture or after isolation on CNA agar (Becton Dickinson). The presence of PBP2A was confirmed by an immunochromatographic assay (Alere, PBP2a SA test). After 24 hours of incubation, the enrichment broth was plated on an MRSA-selective plate, which was then incubated for another 48 hours, with inspection after 24 and 48 hours. For positive samples, *S. aureus* protein A (*spa*) typing was performed. PCR amplification of the *spa* gene was performed with the primers 5´-TAA AGA CGA TCC TTC GGT GAG C-´3 and 5´-CAG CAG TAG TGC CGT TTG CTT-´3 using the Hot StartTaq Master Mix (Qiagen).[10] Sequencing of the PCR product was carried out with the BigDye Terminator v3.1 (ThermoFisher) reagent. The sequencing reaction was then purified on Sephadex G-50 DNA Grade (ThermoFisher) columns and subsequently analysed in the ABI 3130xl Genetic Analyser. Resulting sequence data were interpreted with the Ridom tool (http://www.spaserver.ridom.de/).

The univariate analyses were performed using chi-square tests based on Pearson, or where cell frequency was low, using Fisher's exact test. For the multivariate analysis logistic regression was used. The analyses were performed using IBM SPSS Statistics 23.

RESULTS

A total of 39 outpatient care facilities participated in the study (Table 1). They mostly provided basic care and treatment, while four facilities were intensive care services. The size of the care services ranged from 6 to 170 employees per facility; the median was 32 employees. The number of patients who received care from the individual services was between 8 and 280. Care services were provided by 26 employees per facility.

Table 1: Characteristics of the outpatient care facilities (n=39) and employees (n=579)

Outpatient facilities*		
Type of service provided[+]	Basic care Treatment care Intensive care	30 (76.9%) 31 (79.5%) 4 (10.3%)
Number of patients	Range Mean/SD Median	8 – 280 99.0/65.6 86.0
Total personnel	Range Mean/SD Median	6 – 170 41.1/5.7 31.5
Nursing staff	Range Mean/SD Median	5 – 163 34.3/31.1 25.5
Health personnel		**n (%)**
Age in years	< 30 30 to 39 40 to 49 50 to 59 > 60 Unknown	76 (13.1) 114 (19.7) 158 (27.3) 174 (30.1) 47 (8.1) 10 (1.7)
Sex	Female Male Unknown	460 (79.4) 106 (18.3) 13 (2.2)
Mainly nursing activities		423 (73.1)
Care predominantly provided[+]	Basic care Treatment care Intensive care	368 (63.6) 313 (54.1) 113 (19.5)

* not responded n=4 facilities; [+] Multiple answers possible; SD – standard deviation

Health personnel

579 employees participated in the study. The overall participation rate was 40.5%; in the individual facilities, the response rate varied between 8 and 81%. The median age of the employees was 46 and one-third were over 50. Most of the participants were female and 45% had been working in outpatient care for more than ten years. In terms of professional background, 29% were qualified general nurses, 24% were trained geriatric nurses and 19% had received training as nursing assistants. 22% did not have any nursing qualifications; these included social workers, housekeeping staff, office workers and medical assistants. Three out of four employees were mainly entrusted with patient care. Of these, 64% said they performed basic care, including personal hygiene and assistance with excretion and nutrition, 54% dealt with treatment-related activities such as changing dressings, injections and drug administration, and 20% provided intensive care involving ventilation treatment, feeding tubes and port/catheter care. No statistically significant differences showed in the comparison of persons who tested positive for MRSA with those who tested negative.

MRSA

A total of seven employees tested positive for MRSA during screening, putting the prevalence at 1.2% (95% CI 0.5–2.5). These employees were all involved in care activities, resulting in an MRSA

colonisation rate among nursing staff of 1.7% (95% CI 0.7–3.4). In the four weeks prior to screening, 77% of all personnel and 93% of the nursing staff had close contact with patients requiring care with activities like personal hygiene, mobilisation or dressing changes. Known contact with patients infected with a MDRO was reported by 52% of all employees and 61% of the nursing staff. In terms of personal risk factors, one-quarter of the respondents said they had used antibiotics in the last six months. Hospitalisation or a surgical procedure, chronic respiratory illnesses or skin conditions and home care of relatives were mentioned less frequently. Since the multivariate analysis on the risk of MRSA colonisation did not lead to any statistically significant results, this representation is not included.

The offer for a control swab was taken up by all seven subjects who tested positive, resulting in six still positive MRSA findings. The participants who tested positive after the control swab underwent decolonisation treatment, which was not successful for four employees. These employees were referred to the responsible occupational physician.

The genotyping of MRSA samples showed epidemic strains commonly occurring (t032, t005) and less prevalent (t379, t613, t10535) in Germany.

Infection control

Questions concerning health protection in outpatient care were directed at persons in charge at the facilities (mainly nursing management). They first addressed the sharing of information regarding MDROs/MRSA when transferring patients (Table 2). The information from hospitals about colonisation or infection was transmitted in most cases; however, in 10% of the facilities, this information was not shared. On the other hand, 39% of the facilities reported receiving information from the primary care physician (yes / usually), whereas 46% did not receive this information. The most frequent difficulties were reported for the communication with primary care physicians, hospitals and family members. This mainly applied to missing, insufficient or delayed information regarding a positive MRSA result or a decolonisation treatment of the patient. In addition, it was repeatedly reported that this information is often only mentioned in the physician's letter and never reaches the nursing staff.

Table 2: Infection control regarding MDROs for facilities (n=39) and all employees (n=579) compared to nursing staff (n=423)

Outpatient facilities*		**N (%)**
MDROs information from hospitals	*yes* *no* *usually* *unknown*	11 (28.2) 4 (10.3) 20 (51.2) 4 (10.3)
MDROs information from general practitioners	*yes* *no* *usually* *unknown*	5 (12.8) 18 (46.2) 10 (25.6) 6 (15.4)
Problems in communication with[+]	*General practitioners* *Hospitals* *Relatives*	25 (64.1) 22 (56.4) 15 (38.5)

	Patient transport staff	11 (28.2)	
Health personnel	**N_{all} (%)**	**N_{np} (%)**	**p-value**
Instructions at work on MRSA/MDROs	534 (92.2)	408 (96.5)	< 0.01
Protective clothing provided by employer	526 (90.8)	404 (95.5)	< 0.01
Wearing work clothes	216 (37.3)	189 (44.7)	0.02
Hand disinfection...			
when starting work	459 (79.3)	366 (86.5)	< 0.01
after contamination	407 (70.3)	330 (78.0)	< 0.01
after patient contact	515 (88.9)	400 (94.6)	< 0.01
when finished working	469 (81.0)	365 (86.3)	0.03
never	11 (1.9)	0 (0.0)	

* not responded n=4 facilities; [+] multiple answers possible; np – nursing personnel

The employees were also asked about infection control at their workplace and reported that virtually everywhere work instructions on how to deal with multi-resistant pathogens were available and protective clothing was provided by the employer. The wearing of work clothes was reported by 37% of all employees and 45% of the nursing staff. The majority of staff carried out hand hygiene; it was reported more often by the nursing staff than by personnel as a whole.

Comparison of outpatient and inpatient geriatric care

Table 3 compares the characteristics and risk factors for employees in outpatient and inpatient geriatric care settings in Hamburg. It shows that the outpatient care employees in the study were older, that a higher proportion had worked in outpatient care for more than ten years and 73% (versus 62%) had carried out nursing activities in the inpatient sector. Most of the outpatient employees came from the nursing profession (29%), followed by geriatric care (24%). In inpatient settings, 32% were trained geriatric nurses and 8% were qualified general nurses. Other significant differences can be seen at a personal level with regard to the use of antibiotics, caring for relatives and contact with animals.

Table 3: Comparison of outpatient (n=579) and inpatient (n=759) geriatric care staff who underwent MRSA screening in Hamburg

Variable		**$N_{outpatient}$ (%)**	**$N_{inpatient}$ (%)**	**p-value**
Age in years	Mean/SD Median	44.5/11.8 46.0	41.8/12.4 43.0	< 0.01
		n (%)	n (%)	
Positive MRSA results		7 (1.2)	12 (1.6)	0.65
Time spent in	< 1 year	76 (13.1)	79 (10.4)	< 0.01

outpatient or inpatient care	1 – 5 years 6 – 10 years > 10 years Unknown	152 (26.3) 80 (13.8) 259 (44.7) 12 (2.1)	157 (20.7) 147 (19.4) 248 (32.6) 128 (16.9)	
Level of training	Geriatric nurse Care assistant/auxiliary nurse General nurse Without nursing qualification Other/unknown	137 (23.7) 110 (19.0) 167 (28.8) 127 (21.9) 38 (6.6)	241 (31.8) 110 (14.5) 58 (7.6) 78 (10.3) 272 (35.8)	< 0.01
Nursing activities		423 (73.1)	471 (62.1)	< 0.01
Close contact with patients		447 (77.2)	553 (72.9)	0.075
Use of antibiotics		140 (24.2)	261 (34.4)	< 0.01
Care of relatives		60 (10.4)	38 (5.0)	< 0.01
Contact with animals		343 (59.2)	396 (52.2)	< 0.01

DISCUSSION

The current study marks the first time that data on the occupational risk of MRSA in employees of outpatient care facilities in Hamburg could be made available. The MRSA prevalence is low and at 1.2%, it is below the colonisation rate of 1.6% found among staff of geriatric nursing homes in Hamburg (Peters 2017). Compared to other studies of personnel in medical facilities in Germany, the results are on the lower end of the spectrum [5]. Studies on the frequency of MRSA in outpatient care have mainly focused on patients. They report MRSA colonisation rates of 3.7%,[11] 4.7%[12] and 2.1%[13] for Germany. An American study[14] investigated paediatric healthcare personnel in different outpatient settings. The survey of 227 paediatric healthcare workers in outpatient settings revealed a prevalence of 3.1%. In terms of risk factors, only prior surgery was shown to be associated with MRSA colonisation. In our study, however, no correlation with the known risk factors was found for the entire study population. It was only after differentiation of the nursing staff that close contact, MDRO contact and infection control measures demonstrated statistical significance. These differences can be explained by the fact that all MRSA colonisations were identified in the nursing area – due to their profession, nursing staff have the closest contact with patients and are better informed about protective measures than care support staff and therapists.

Infection control

Other studies dealt with infection control due to the organisational characteristics of outpatient care. A study of the public health service in Bavaria[15] showed that smaller facilities in particular (with fewer than ten patients) achieved poor results in infection control, knowledge about relevant recommendations for action and the availability of work aids. In the large facilities, on the other hand, personnel conditions were less favourable.

Outpatient care poses a particular challenge for infection control due to the fact that it is provided in the patient's home environment. In this scenario as well, however, the recommendations emphasise the need for basic hygiene, such as hand hygiene, barrier measures and surface disinfection.[5]

What stands out in the analysis of the study results is the insufficient communication between the various actors in the healthcare sector in some cases. Hospitals often do not share information about a positive MDRO test result with the outpatient facilities or there is no information regarding decolonisation/control swabs. Primary care physicians also rarely make the nursing staff aware of such findings. Moreover, MRSA carriers themselves are not always and sufficiently informed and experience stigmatisation at times.[16] In terms of infection prevention, however, sharing information about MDROs is important for everyone concerned, in order to ensure optimal patient care and employee protection. Similar results regarding risk communication were also obtained by other authors[17] and these problems were also reported with regard to inpatient geriatric care.[18]

Comparison of outpatient and inpatient geriatric care

In comparing the employees in geriatric outpatient and inpatient settings in Hamburg, differences can be seen. The participants from the outpatient setting were older and had worked in their profession longer, came predominantly from the nursing and geriatric care professions and took care of family members at home twice as often. A more self-determined work environment and flexible hours may be an advantage in outpatient care. The better compatibility of family and career for women returning to work after having children also seems to be a long-term alternative for nursing staff compared to a hospital setting.

Limitations

The study encountered problems in terms of willingness to participate. This was especially evident when recruiting facilities. Despite repeated contact, motivating those in charge to participate was difficult. We can only speculate about the reasons. The reluctance of employers to agree to the MRSA screening is mainly attributable to the fear of numerous positive results. The worry that employees who test positive for MRSA would increasingly take sick leave underscores the problem of the pre-existing shortage of personnel in this sector. In addition, the fear of reputational damage due to a high MRSA prevalence as well as the greater organisational effort required may also be partly responsible for the refusal to participate. It is therefore likely that the results were distorted due to a selection bias. Coupled with low participation rates, an underestimation of the actual MRSA risk cannot be ruled out.

In our study only point prevalence was investigated, hence a differentiation between transient and persistent MRSA carriage was not possible. For a complete depiction of the occupational exposition, data are missing of the patients' MRSA prevalence, their MRSA's genetic strains, and of transmission routes. Statements on the success of decolonisation are unreliable due to the small number of cases.

CONCLUSION

This study made it possible to determine the rate of MRSA among outpatient care staff in Hamburg for the first time and it describes the occupational risk of exposure to health personnel in outpatient

care. The MRSA prevalence is low and known risk factors did not show any correlation with MRSA colonisation. Achievements could be gained by improving information and communication of the infection status of the patient. A good infection control at the facilities is highly recommendable and the employees should acquire in-depth knowledge of infection prevention to improve the compliance with basic hygiene measures such as hand disinfection and personal protective measures.

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Contributors: CP was involved in designing the study, made the statistical analysis and interpretation of the data and drafted the manuscript. OK participated in the design of the study, performed data collection and has been involved drafting the manuscript. AN participated in the design of the study and helped to draft the manuscript. AS participated in the design of the study and has been involved drafting the manuscript. All authors read and approved the final version of the manuscript.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3-4
Bias	9	Describe any efforts to address potential sources of bias	*3*
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3-4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and interactions	4
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4-5
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	5
Outcome data	15*	Report numbers of outcome events or summary measures	5-6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5-8
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Prevalence and risk factors of MRSA colonisations: a cross sectional study among personnel in outpatient care settings in Hamburg, Germany

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ABSTRACT

Objectives

Healthcare workers frequently come into contact with infected individuals and are at a greater risk of infection than the general population due to their occupation. Multidrug-resistant organisms (MDROs) also pose a significant challenge for personnel and medical facilities. Currently, little is known about the occupational risk of MRSA in outpatient care settings. Therefore, a cross-sectional study was conducted in Hamburg to investigate MRSA colonisation among outpatient nursing staff.

Methods

MRSA screening with nasal swabs was carried out, the known risk factors for colonisation were determined and information on infection control was inquired. Where tests were positive, a control swab was taken; if this confirmed a positive result, decolonisation was offered. A molecular biological examination of the MRSA samples was performed. The occupational MRSA exposure and risk factors were compared with the situation for personnel in inpatient geriatric care.

Results

A total of 39 outpatient services participated in the study and 579 employees were tested. The MRSA prevalence was 1.2% in all and 1.7% in nursing staff. Most of the employees that tested positive had close or known contact with MRSA patients. Health personnel frequently reported personal protective measures and their application. Compared to outpatient staff, inpatient care staff were older and had worked in their profession for a longer time.

Conclusion

This study marks the first time that data has been made available on the occupational MRSA risk of outpatient care personnel in Hamburg. The MRSA prevalence is low and provides a good basis for describing the MRSA risk of occupational exposure by health personnel in outpatient care.

Strengths and limitations of this study

- First report of MRSA prevalence in health personnel in outpatient care in Germany on a large scale.
- Epidemic strains of detected MRSA colonisations are provided by genotyping.
- Point prevalence investigation did not allow any differentiation between transient and persistent carriage.

INTRODUCTION

Healthcare workers frequently come into contact with infected individuals and are at a greater risk of infection than the general population due to their occupational activities. Multidrug-resistant organisms (MDROs) are increasingly becoming a public health problem. Meticillin-resistant *Staphylococcus aureus* (MRSA), which is prevalent worldwide, is the best known MDRO. This pathogen also poses a significant challenge for employees in various medical settings.

An MRSA prevalence of 0.7% was found for the general population in Germany.[1] Data on the frequency of MRSA colonisation among health personnel in non-outbreak scenarios in Europe and in the US showed prevalence rates of between 0.2% and 15%[2] and average prevalence rates of 4.6%[3] and 5%.[4] For Germany, studies of employees at medical facilities revealed MRSA colonisation rates of 0.4% to 4.5%.[5]

In 2015, 2.9 million people were in need of care in Germany. Nearly three-quarters of them were cared for in their home, of which 66% were cared for by relatives and outpatient care services or solely by outpatient care services. In the same year, 356,000 people were employed in outpatient care in Germany. The majority of employees were women (87%), worked part-time and nearly 40% were aged 50 and older.[6] According to the population trend for Germany, the number of people in need of care is expected to rise steadily, reaching 3.4 million by 2030.[7] An increasing number of patients are being discharged early from hospital, who then require either outpatient or inpatient care.[8] As a result, the need for care on an outpatient basis will also continue to grow.

Little is currently known about the occupational exposure to MRSA among nursing staff in outpatient care settings. Against this backdrop, a study was performed in which the point prevalence of MRSA colonisations among employees in outpatient care facilities was investigated. Occupational exposure and known risk factors were compared with the situation of personnel in inpatient geriatric care settings, based on an earlier study conducted in Hamburg.[9]

METHODS

Study population

The cross-sectional study of employees in outpatient care facilities in Hamburg was conducted from June 2015 to March 2016. A total of 403 facilities for outpatient geriatric and/or nursing care were contacted. The MRSA screening was planned to take place on-site at the facilities. In addition, screening appointments were offered at the study centre. All outpatient services personnel were invited to participate. An age range of 18 to 65 years was set as an inclusion criterion. The screening procedure was anonymised. For the dissemination of the study results to the participants, an identification code was issued which was not linked to any identifying data. The code made it possible to transmit the results of the laboratory test to the participants.

Swabs from the nasal vestibules of employees were taken for the purpose of screening. Potential risk factors for MRSA colonisation were identified using a questionnaire. Occupational risk factors such as the nature and duration of their work, contact with MRSA patients in a nursing capacity and influential factors such as taking a course of antibiotics, their own hospital stays and contact with

animals were explored alongside socio-demographic data. In addition, questions about infection control were asked.

Where MRSA findings were positive, the employees were first given the option of a control swab. If the result was still positive, a non-antibiotic decolonisation kit was provided, consisting of oral, nasal and hand disinfectant and antimicrobial hair and body wash. A further control swab was offered to check whether the decolonisation efforts had been successful.

Results of a previous study were used for the comparison of occupational risks for personnel in outpatient care and inpatient geriatric care. The MRSA screening was performed from 2014 to 2015 in 19 geriatric care facilities in Hamburg and 759 employees were tested. Further details of the study were described by Peters et al.[9]

The study was conducted in accordance with the requirements of data protection legislation. The Hamburg Ethics Commission gave its approval (WF-019/15).

Patient and Public Involvement

Patients and public were not involved in this study.

Microbiological methods

Cotton wool swabs were used for the nasal swab examinations. The swab sample was taken by swabbing both anterior nares in a rotating motion for around five seconds and was then sealed in a transport container. In the laboratory, the swab was first streaked on an MRSA-selective plate (Biomerieux) and then put into a Brain Heart Infusion enrichment broth (Becton Dickinson). The plate and broth were incubated at 37°C in an ambient atmosphere. The plate was inspected after 24 hours and 48 hours of incubation. Suspicious colonies were further characterised by MALDI-TOF (Bruker Daltonics, MALDI Biotyper) either directly from the MRSA-selective plate when present as a pure culture or after isolation on CNA agar (Becton Dickinson). The presence of PBP2A was confirmed by an immunochromatographic assay (Alere, PBP2a SA test). After 24 hours of incubation, the enrichment broth was plated on an MRSA-selective plate, which was then incubated for another 48 hours, with inspection after 24 and 48 hours. For positive samples, *S. aureus* protein A (*spa*) typing was performed. PCR amplification of the *spa* gene was performed with the primers 5´-TAA AGA CGA TCC TTC GGT GAG C-´3 and 5´-CAG CAG TAG TGC CGT TTG CTT-´3 using the Hot StartTaq Master Mix (Qiagen).[10] Sequencing of the PCR product was carried out with the BigDye Terminator v3.1 (ThermoFisher) reagent. The sequencing reaction was then purified on Sephadex G-50 DNA Grade (ThermoFisher) columns and subsequently analysed in the ABI 3130xl Genetic Analyser. Resulting sequence data were interpreted with the Ridom tool (http://www.spaserver.ridom.de/).

The univariate analyses were performed using chi-square tests based on Pearson, or where cell frequency was low, using Fisher's exact test. For the multivariate analysis logistic regression was used. The analyses were performed using IBM SPSS Statistics 23.

RESULTS

A total of 39 (9.7%) outpatient care facilities participated in the study (Table 1). They mostly provided basic care and treatment, while four facilities were intensive care services (multiple answers possible). The size of the care services ranged from 6 to 170 employees per facility; the median was 32 employees. The number of patients who received care from the individual services was between 8 and 280. Care services were provided by 26 employees in median per facility.

Table 1: Characteristics of the outpatient care facilities (n=39) and employees (n=579)

Outpatient facilities*		
Type of service provided[+]	Basic care Treatment care Intensive care	30 (76.9%) 31 (79.5%) 4 (10.3%)
Number of patients	Range Mean/SD Median	8 – 280 99.0/65.6 86.0
Total personnel	Range Mean/SD Median	6 – 170 41.1/5.7 31.5
Nursing staff	Range Mean/SD Median	5 – 163 34.3/31.1 25.5
Health personnel		**n (%)**
Age in years	< 30 30 to 39 40 to 49 50 to 59 > 60 Unknown	76 (13.1) 114 (19.7) 158 (27.3) 174 (30.1) 47 (8.1) 10 (1.7)
Sex	Female Male Unknown	460 (79.4) 106 (18.3) 13 (2.2)
Mainly nursing activities		423 (73.1)
Care predominantly provided[+]	Basic care Treatment care Intensive care	368 (63.6) 313 (54.1) 113 (19.5)
Level of training	Geriatric nurse Care assistant/auxiliary nurse General nurse Without nursing qualification Other/unknown	137 (23.7) 110 (19.0) 167 (28.8) 127 (21.9) 38 (6.6)
Time spent in outpatient care	≤ 10 years > 10 years Unknown	308 (53.2) 259 (44.7) 12 (2.1)

* not responded n=4 facilities; [+] Multiple answers possible; SD – standard deviation

Health personnel

579 employees participated in the study. The overall participation rate was 40.5%; in the individual facilities, the response rate varied between 8 and 81%. The median age of the employees was 46 and one-third were over 50. Most of the participants were female (Table 1). Three out of four employees were mainly entrusted with patient care. Of these, 64% said they performed basic care, including personal hygiene and assistance with excretion and nutrition, 54% dealt with treatment-related activities such as changing dressings, injections and drug administration, and 20% provided intensive care involving ventilation treatment, feeding tubes and port/catheter care (multiple answers possible). In terms of professional background, 29% were qualified general nurses, 24% were trained geriatric nurses and 19% had received training as nursing assistants. 22% did not have any nursing qualifications; these included social workers, housekeeping staff, office workers and medical assistants. 53% of the personnel had been working in outpatient care for less than ten years. No statistically significant differences showed in the comparison of persons who tested positive for MRSA with those who tested negative.

MRSA

A total of seven employees tested positive for MRSA during screening, putting the prevalence at 1.2% (95% CI 0.5–2.5). These employees were all involved in care activities, resulting in an MRSA colonisation rate among nursing staff of 1.7% (95% CI 0.7–3.4). In the four weeks prior to screening, 77% of all personnel and 93% of the nursing staff had close contact with patients requiring care with activities like personal hygiene, mobilisation or dressing changes. Known contact with patients infected with a MDRO was reported by 52% of all employees and 61% of the nursing staff. Five MRSA carriers reported MDRO patient contact and another six even close contact. In terms of personal risk factors, one-quarter of the respondents said they had used antibiotics in the last six months. Hospitalisation or a surgical procedure, chronic respiratory illnesses or skin conditions and home care of relatives were mentioned less frequently. Since the multivariate analysis on the risk of MRSA colonisation did not lead to any statistically significant results, this representation is not included.

The offer for a control swab was taken up by all seven subjects who tested positive, resulting in six still positive MRSA findings. The participants who tested positive after the control swab underwent decolonisation treatment, which was not successful for four employees. These employees were referred to the responsible occupational physician.

The genotyping of MRSA samples showed as a whole five different epidemic strains: commonly occurring (t032, t005) and less prevalent (t379, t613, t10535) in Germany.

Infection control

Questions concerning health protection in outpatient care were directed at persons in charge at the facilities (mainly nursing management). They first addressed the sharing of information regarding MDROs/MRSA when transferring patients (Table 2). The information from hospitals about colonisation or infection was transmitted in most cases; however, in 10% of the facilities, this information was not shared. On the other hand, 39% of the facilities reported receiving information from the primary care physician (yes / mostly), whereas 46% did not receive this information. The most frequent difficulties were reported for the communication with primary care physicians, hospitals and family members (multiple answers possible). This mainly applied to missing, insufficient or delayed information regarding a positive MRSA result or a decolonisation treatment of the

patient. In addition, it was repeatedly reported that this information is often only mentioned in the physician's letter and never reaches the nursing staff.

Table 2: Infection control regarding MDROs for facilities (n=39) and all employees (n=579) compared to nursing staff (n=423)

Outpatient facilities*		**N (%)**	
MDROs information from hospitals	*yes*	11 (28.2)	
	no	4 (10.3)	
	mostly	20 (51.3)	
	unknown	4 (10.3)	
MDROs information from general practitioners	*yes*	5 (12.8)	
	no	18 (46.2)	
	mostly	10 (25.6)	
	unknown	6 (15.4)	
Problems in communication with+	*General practitioners*	25 (64.1)	
	Hospitals	22 (56.4)	
	Relatives	15 (38.5)	
	Patient transport staff	11 (28.2)	
Health personnel		**N_{all} (%)**	**N_{np} (%)**	**p-value**
Instructions at work on MRSA/MDROs		534 (92.2)	408 (96.5)	< 0.01
Protective clothing provided by employer		526 (90.8)	404 (95.5)	< 0.01
Wearing work clothes		216 (37.3)	189 (44.7)	0.02
Hand disinfection...+				
when starting work		459 (79.3)	366 (86.5)	< 0.01
after contamination		407 (70.3)	330 (78.0)	< 0.01
after patient contact		515 (88.9)	400 (94.6)	< 0.01
when finished working		469 (81.0)	365 (86.3)	0.03
never		11 (1.9)	0 (0.0)	

* not responded n=4 facilities; + multiple answers possible; np – nursing personnel

The employees were also asked about infection control at their workplace and reported that virtually everywhere work instructions on how to deal with multi-resistant pathogens were available and protective clothing was provided by the employer. The wearing of work clothes was reported by 37% of all employees and 45% of the nursing staff. The majority of staff carried out hand hygiene; it was reported more often by the nursing staff than by personnel as a whole.

Comparison of outpatient and inpatient geriatric care

Table 3 compares the characteristics and risk factors for employees in outpatient and inpatient geriatric care settings in Hamburg. It shows that the outpatient care employees in the study were older, that a higher proportion had worked in outpatient care for more than ten years and 73%

(versus 62%) had carried out nursing activities in the inpatient sector. Most of the outpatient employees came from the nursing profession (29%), followed by geriatric care (24%). In inpatient settings, 32% were trained geriatric nurses and 8% were qualified general nurses. Other significant differences can be seen at a personal level with regard to the use of antibiotics, caring for relatives and contact with animals.

Table 3: Comparison of outpatient (n=579) and inpatient (n=759) geriatric care staff who underwent MRSA screening in Hamburg

Variable		**$N_{outpatient}$**	**$N_{inpatient}$**	**p-value**
Age in years	Mean/SD Median	44.5/11.8 46.0	41.8/12.4 43.0	< 0.01
		n (%)	n (%)	
Positive MRSA results		7 (1.2)	12 (1.6)	0.65
Time spent in outpatient or inpatient care	< 1 year 1 – 5 years 6 – 10 years > 10 years Unknown	76 (13.1) 152 (26.3) 80 (13.8) 259 (44.7) 12 (2.1)	79 (10.4) 157 (20.7) 147 (19.4) 248 (32.6) 128 (16.9)	< 0.01
Level of training	Geriatric nurse Care assistant/auxiliary nurse General nurse Without nursing qualification Other/unknown	137 (23.7) 110 (19.0) 167 (28.8) 127 (21.9) 38 (6.6)	241 (31.8) 110 (14.5) 58 (7.6) 78 (10.3) 272 (35.8)	< 0.01
Nursing activities		423 (73.1)	471 (62.1)	< 0.01
Close contact with patients		447 (77.2)	553 (72.9)	0.075
Use of antibiotics		140 (24.2)	261 (34.4)	< 0.01
Care of relatives		60 (10.4)	38 (5.0)	< 0.01
Contact with animals		343 (59.2)	396 (52.2)	< 0.01

DISCUSSION

The current study marks the first time that data on the occupational risk of MRSA in employees of outpatient care facilities in Hamburg could be made available. The MRSA prevalence is low and at 1.2%, it is below the colonisation rate of 1.6% found among staff of geriatric nursing homes in Hamburg (Peters 2017). Compared to other studies of personnel in medical facilities in Germany, the results are on the lower end of the spectrum [5]. Studies on the frequency of MRSA in outpatient

care have mainly focused on patients. They report MRSA colonisation rates of 3.7%,[11] 4.7%[12] and 2.1%[13] for Germany. An American study[14] investigated paediatric healthcare personnel in different outpatient settings. The survey of 227 paediatric healthcare workers in outpatient settings revealed a prevalence of 3.1%. In terms of risk factors, only prior surgery was shown to be associated with MRSA colonisation. In our study, however, no correlation with the known risk factors was found for the entire study population. It was only after differentiation of the nursing staff that close contact, MDRO contact and infection control measures demonstrated statistical significance. These differences can be explained by the fact that all MRSA colonisations were identified in the nursing area – due to their profession, nursing staff have the closest contact with patients and are better informed about protective measures than care support staff and therapists.

Infection control

Other studies dealt with infection control due to the organisational characteristics of outpatient care. A study of the public health service in Bavaria[15] showed that smaller facilities in particular (with fewer than ten patients) achieved poor results in infection control, knowledge about relevant recommendations for action and the availability of work aids. In the large facilities, on the other hand, personnel conditions were less favourable.

Outpatient care poses a particular challenge for infection control due to the fact that it is provided in the patient's home environment. In this scenario as well, however, the recommendations emphasise the need for basic hygiene, such as hand hygiene, barrier measures and surface disinfection.[5]

What stands out in the analysis of the study results is the insufficient communication between the various actors in the healthcare sector in some cases. Hospitals often do not share information about a positive MDRO test result with the outpatient facilities or there is no information regarding decolonisation/control swabs. Primary care physicians also rarely make the nursing staff aware of such findings. Moreover, MRSA carriers themselves are not always and sufficiently informed and experience stigmatisation at times.[16] In terms of infection prevention, however, sharing information about MDROs is important for everyone concerned, in order to ensure optimal patient care and employee protection. Similar results regarding risk communication were also obtained by other authors[17] and these problems were also reported with regard to inpatient geriatric care.[18]

Comparison of outpatient and inpatient geriatric care

In comparing the employees in geriatric outpatient and inpatient settings in Hamburg, differences can be seen. The participants from the outpatient setting were older and had worked in their profession longer, came predominantly from the nursing and geriatric care professions and took care of family members at home twice as often. A more self-determined work environment and flexible hours may be an advantage in outpatient care. The better compatibility of family and career for women returning to work after having children also seems to be a long-term alternative for nursing staff compared to a hospital setting.

Limitations

The study encountered problems in terms of willingness to participate. This was especially evident when recruiting facilities. Despite repeated contact, motivating those in charge to participate was

difficult. We can only speculate about the reasons. The reluctance of employers to agree to the MRSA screening is mainly attributable to the fear of numerous positive results. The worry that employees who test positive for MRSA would increasingly take sick leave underscores the problem of the pre-existing shortage of personnel in this sector. In addition, the fear of reputational damage due to a high MRSA prevalence as well as the greater organisational effort required may also be partly responsible for the refusal to participate. It is therefore likely that the results were distorted due to a selection bias. Coupled with low participation rates, an underestimation of the actual MRSA risk cannot be ruled out.

In our study only point prevalence was investigated, hence a differentiation between transient and persistent MRSA carriage was not possible. For a complete depiction of the occupational exposition, data are missing of the patients' MRSA prevalence, their MRSA's genetic strains, and of transmission routes. Statements on the success of decolonisation are unreliable due to the small number of cases.

CONCLUSION

This study made it possible to determine the rate of MRSA among outpatient care staff in Hamburg for the first time and it describes the occupational risk of exposure to health personnel in outpatient care. The MRSA prevalence is low but all MRSA colonisations were found in nursing personnel. Known risk factors did not show any correlation with MRSA colonisation. Achievements could be gained by improving information and communication of the infection status of the patient. A good infection control at the facilities is highly recommendable and the employees should acquire in-depth knowledge of infection prevention to improve the compliance with basic hygiene measures such as hand disinfection and personal protective measures.

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Contributors: CP was involved in designing the study, made the statistical analysis and interpretation of the data and drafted the manuscript. OK participated in the design of the study, performed data collection and has been involved drafting the manuscript. AN participated in the design of the study and helped to draft the manuscript. AS participated in the design of the study and has been involved drafting the manuscript. All authors read and approved the final version of the manuscript.

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Ethics approval: The Ethics Committee of the General Medical Council for the city of Hamburg.

Data sharing statement: No additional data sharing available.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3-4
Bias	9	Describe any efforts to address potential sources of bias	*3*
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3-4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and interactions	4
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4-5
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	5
Outcome data	15*	Report numbers of outcome events or summary measures	5-6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5-8
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Prevalence and risk factors of MRSA colonisations: a cross sectional study among personnel in outpatient care settings in Hamburg, Germany

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ABSTRACT

Objectives

Healthcare workers frequently come into contact with infected individuals and are at a greater risk of infection than the general population due to their occupation. Multidrug-resistant organisms (MDROs) also pose a significant challenge for personnel and medical facilities. Currently, little is known about the occupational risk of MRSA in outpatient care settings. Therefore, a cross-sectional study was conducted in Hamburg to investigate MRSA colonisation among outpatient nursing staff.

Methods

MRSA screening with nasal swabs was carried out, the known risk factors for colonisation were determined and information on infection control was inquired. Where tests were positive, a control swab was taken; if this confirmed a positive result, decolonisation was offered. A molecular biological examination of the MRSA samples was performed. The occupational MRSA exposure and risk factors were compared with the situation for personnel in inpatient geriatric care.

Results

A total of 39 outpatient services participated in the study and 579 employees were tested. The MRSA prevalence was 1.2% in all and 1.7% in nursing staff. Most of the employees that tested positive had close or known contact with MRSA patients. Health personnel frequently reported personal protective measures and their application. Compared to outpatient staff, inpatient care staff were older and had worked in their profession for a longer time.

Conclusion

This study marks the first time that data has been made available on the occupational MRSA risk of outpatient care personnel in Hamburg. The MRSA prevalence is low and provides a good basis for describing the MRSA risk of occupational exposure by health personnel in outpatient care.

Strengths and limitations of this study

- First report of MRSA prevalence in health personnel in outpatient care in Germany on a large scale.
- Epidemic strains of detected MRSA colonisations are provided by genotyping.
- Point prevalence investigation did not allow any differentiation between transient and persistent carriage.

INTRODUCTION

Healthcare workers frequently come into contact with infected individuals and are at a greater risk of infection than the general population due to their occupational activities. Multidrug-resistant organisms (MDROs) are increasingly becoming a public health problem. Meticillin-resistant *Staphylococcus aureus* (MRSA), which is prevalent worldwide, is the best known MDRO. This pathogen also poses a significant challenge for employees in various medical settings.

An MRSA prevalence of 0.7% was found for the general population in Germany.[1] Data on the frequency of MRSA colonisation among health personnel in non-outbreak scenarios in Europe and in the US showed prevalence rates of between 0.2% and 15%[2] and average prevalence rates of 4.6%[3] and 5%.[4] For Germany, studies of employees at medical facilities revealed MRSA colonisation rates of 0.4% to 4.5%.[5]

In 2015, 2.9 million people were in need of care in Germany. Nearly three-quarters of them were cared for in their home, of which 66% were cared for by relatives and outpatient care services or solely by outpatient care services. In the same year, 356,000 people were employed in outpatient care in Germany. The majority of employees were women (87%), worked part-time and nearly 40% were aged 50 and older.[6] According to the population trend for Germany, the number of people in need of care is expected to rise steadily, reaching 3.4 million by 2030.[7] An increasing number of patients are being discharged early from hospital, who then require either outpatient or inpatient care.[8] As a result, the need for care on an outpatient basis will also continue to grow.

Little is currently known about the occupational exposure to MRSA among nursing staff in outpatient care settings. Against this backdrop, a study was performed in which the point prevalence of MRSA colonisations among employees in outpatient care facilities was investigated. Occupational exposure and known risk factors were compared with the situation of personnel in inpatient geriatric care settings, based on an earlier study conducted in Hamburg.[9]

METHODS

Study population

The cross-sectional study of employees in outpatient care facilities in Hamburg was conducted from June 2015 to March 2016. A total of 403 facilities for outpatient geriatric and/or nursing care were contacted. The MRSA screening was planned to take place on-site at the facilities. In addition, screening appointments were offered at the study centre. All outpatient services personnel were invited to participate. An age range of 18 to 65 years was set as an inclusion criterion. The screening procedure was anonymised. For the dissemination of the study results to the participants, an identification code was issued which was not linked to any identifying data. The code made it possible to transmit the results of the laboratory test to the participants.

Swabs from the nasal vestibules of employees were taken for the purpose of screening. Potential risk factors for MRSA colonisation were identified using a questionnaire. Occupational risk factors such as the nature and duration of their work, contact with MRSA patients in a nursing capacity and influential factors such as taking a course of antibiotics, their own hospital stays and contact with

animals were explored alongside socio-demographic data. In addition, questions about infection control were asked.

Where MRSA findings were positive, the employees were first given the option of a control swab. If the result was still positive, a non-antibiotic decolonisation kit was provided, consisting of oral, nasal and hand disinfectant and antimicrobial hair and body wash. A further control swab was offered to check whether the decolonisation efforts had been successful.

Results of a previous study were used for the comparison of occupational risks for personnel in outpatient care and inpatient geriatric care. The MRSA screening was performed from 2014 to 2015 in 19 geriatric care facilities in Hamburg and 759 employees were tested. Further details of the study were described by Peters et al.[9]

The study was conducted in accordance with the requirements of data protection legislation. The Hamburg Ethics Commission gave its approval (WF-019/15).

Patient and Public Involvement

Patients and public were not involved in this study.

Microbiological methods

Cotton wool swabs were used for the nasal swab examinations. The swab sample was taken by swabbing both anterior nares in a rotating motion for around five seconds and was then sealed in a transport container. In the laboratory, the swab was first streaked on an MRSA-selective plate (Biomerieux) and then put into a Brain Heart Infusion enrichment broth (Becton Dickinson). The plate and broth were incubated at 37°C in an ambient atmosphere. The plate was inspected after 24 hours and 48 hours of incubation. Suspicious colonies were further characterised by MALDI-TOF (Bruker Daltonics, MALDI Biotyper) either directly from the MRSA-selective plate when present as a pure culture or after isolation on CNA agar (Becton Dickinson). The presence of PBP2A was confirmed by an immunochromatographic assay (Alere, PBP2a SA test). After 24 hours of incubation, the enrichment broth was plated on an MRSA-selective plate, which was then incubated for another 48 hours, with inspection after 24 and 48 hours. For positive samples, *S. aureus* protein A (*spa*) typing was performed. PCR amplification of the *spa* gene was performed with the primers 5´-TAA AGA CGA TCC TTC GGT GAG C-´3 and 5´-CAG CAG TAG TGC CGT TTG CTT-´3 using the Hot StartTaq Master Mix (Qiagen).[10] Sequencing of the PCR product was carried out with the BigDye Terminator v3.1 (ThermoFisher) reagent. The sequencing reaction was then purified on Sephadex G-50 DNA Grade (ThermoFisher) columns and subsequently analysed in the ABI 3130xl Genetic Analyser. Resulting sequence data were interpreted with the Ridom tool (http://www.spaserver.ridom.de/).

The univariate analyses were performed using chi-square tests based on Pearson, or where cell frequency was low, using Fisher's exact test. For the multivariate analysis logistic regression was used. The analyses were performed using IBM SPSS Statistics 23.

RESULTS

A total of 39 (9.7%) outpatient care facilities participated in the study (Table 1). They mostly provided basic care and treatment, while four facilities were intensive care services (multiple answers possible). The size of the care services ranged from 6 to 170 employees per facility; the median was 32 employees. The number of patients who received care from the individual services was between 8 and 280. Care services were provided by 26 employees in median per facility.

Table 1: Characteristics of the outpatient care facilities (n=39) and employees (n=579)

Outpatient facilities*		
Type of service provided[+]	Basic care Treatment care Intensive care	30 (76.9%) 31 (79.5%) 4 (10.3%)
Number of patients	Range Mean/SD Median	8 – 280 99.0/65.6 86.0
Total personnel	Range Mean/SD Median	6 – 170 41.1/5.7 31.5
Nursing staff	Range Mean/SD Median	5 – 163 34.3/31.1 25.5
Health personnel		**n (%)**
Age in years	< 30 30 to 39 40 to 49 50 to 59 > 60 Unknown	76 (13.1) 114 (19.7) 158 (27.3) 174 (30.1) 47 (8.1) 10 (1.7)
Sex	Female Male Unknown	460 (79.4) 106 (18.3) 13 (2.2)
Mainly nursing activities		423 (73.1)
Care predominantly provided[+]	Basic care Treatment care Intensive care	368 (63.6) 313 (54.1) 113 (19.5)
Level of training	Geriatric nurse Care assistant/auxiliary nurse General nurse Without nursing qualification Other/unknown	137 (23.7) 110 (19.0) 167 (28.8) 127 (21.9) 38 (6.6)
Time spent in outpatient care	≤ 10 years > 10 years Unknown	308 (53.2) 259 (44.7) 12 (2.1)

* not responded n=4 facilities; [+] Multiple answers possible; SD – standard deviation

Health personnel

579 employees participated in the study. The overall participation rate was 40.5%; in the individual facilities, the response rate varied between 8 and 81%. The median age of the employees was 46 and one-third were over 50. Most of the participants were female (Table 1). Three out of four employees were mainly entrusted with patient care. Of these, 64% said they performed basic care, including personal hygiene and assistance with excretion and nutrition, 54% dealt with treatment-related activities such as changing dressings, injections and drug administration, and 20% provided intensive care involving ventilation treatment, feeding tubes and port/catheter care (multiple answers possible). In terms of professional background, 29% were qualified general nurses, 24% were trained geriatric nurses and 19% had received training as nursing assistants. 22% did not have any nursing qualifications; these included social workers, housekeeping staff, office workers and medical assistants. 53% of the personnel had been working in outpatient care for less than ten years. No statistically significant differences showed in the comparison of persons who tested positive for MRSA with those who tested negative.

MRSA

A total of seven employees tested positive for MRSA during screening, putting the prevalence at 1.2% (95% CI 0.5–2.5). These employees were all involved in care activities, resulting in an MRSA colonisation rate among nursing staff of 1.7% (95% CI 0.7–3.4). In the four weeks prior to screening, 77% of all personnel and 93% of the nursing staff had close contact with patients requiring care with activities like personal hygiene, mobilisation or dressing changes. Known contact with patients infected with a MDRO was reported by 52% of all employees and 61% of the nursing staff. Five MRSA carriers reported MDRO patient contact and another six even close contact. In terms of personal risk factors, one-quarter of the respondents said they had used antibiotics in the last six months. Hospitalisation or a surgical procedure, chronic respiratory illnesses or skin conditions and home care of relatives were mentioned less frequently. Since the multivariate analysis on the risk of MRSA colonisation did not lead to any statistically significant results, this representation is not included.

The offer for a control swab was taken up by all seven subjects who tested positive, resulting in six still positive MRSA findings. The participants who tested positive after the control swab underwent decolonisation treatment, which was not successful for four employees. These employees were referred to the responsible occupational physician.

The genotyping of MRSA samples showed as a whole five different epidemic strains: commonly occurring (t032, t005) and less prevalent (t379, t613, t10535) in Germany. The *spa* type t10535 was found three times in two facilities, other strains were only analysed in single employees in individual facilities.

Infection control

Questions concerning health protection in outpatient care were directed at persons in charge at the facilities (mainly nursing management). They first addressed the sharing of information regarding MDROs/MRSA when transferring patients (Table 2). The information from hospitals about colonisation or infection was transmitted in most cases; however, in 10% of the facilities, this information was not shared. On the other hand, 39% of the facilities reported receiving information from the primary care physician (yes / mostly), whereas 46% did not receive this information. The most frequent difficulties were reported for the communication with primary care physicians, hospitals and family members (multiple answers possible). This mainly applied to missing, insufficient

or delayed information regarding a positive MRSA result or a decolonisation treatment of the patient. In addition, it was repeatedly reported that this information is often only mentioned in the physician's letter and never reaches the nursing staff.

Table 2: Infection control regarding MDROs for facilities (n=39) and all employees (n=579) compared to nursing staff (n=423)

Outpatient facilities*		**N (%)**	
MDROs information from hospitals	*yes* *no* *mostly* *unknown*	11 (28.2) 4 (10.3) 20 (51.3) 4 (10.3)	
MDROs information from general practitioners	*yes* *no* *mostly* *unknown*	5 (12.8) 18 (46.2) 10 (25.6) 6 (15.4)	
Problems in communication with+	*General practitioners* *Hospitals* *Relatives* *Patient transport staff*	25 (64.1) 22 (56.4) 15 (38.5) 11 (28.2)	
Health personnel	**N_{all} (%)**	**N_{np} (%)**	**p-value**
Instructions at work on MRSA/MDROs	534 (92.2)	408 (96.5)	< 0.01
Protective clothing provided by employer	526 (90.8)	404 (95.5)	< 0.01
Wearing work clothes	216 (37.3)	189 (44.7)	0.02
Hand disinfection...+			
when starting work	459 (79.3)	366 (86.5)	< 0.01
after contamination	407 (70.3)	330 (78.0)	< 0.01
after patient contact	515 (88.9)	400 (94.6)	< 0.01
when finished working	469 (81.0)	365 (86.3)	0.03
never	11 (1.9)	0 (0.0)	

* not responded n=4 facilities; + multiple answers possible; np – nursing personnel

The employees were also asked about infection control at their workplace and reported that virtually everywhere work instructions on how to deal with multi-resistant pathogens were available and protective clothing was provided by the employer. The wearing of work clothes was reported by 37% of all employees and 45% of the nursing staff. The majority of staff carried out hand hygiene; it was reported more often by the nursing staff than by personnel as a whole.

Comparison of outpatient and inpatient geriatric care

Table 3 compares the characteristics and risk factors for employees in outpatient and inpatient geriatric care settings in Hamburg. It shows that the outpatient care employees in the study were

older, that a higher proportion had worked in outpatient care for more than ten years and 73% (versus 62%) had carried out nursing activities in the inpatient sector. Most of the outpatient employees came from the nursing profession (29%), followed by geriatric care (24%). In inpatient settings, 32% were trained geriatric nurses and 8% were qualified general nurses. Other significant differences can be seen at a personal level with regard to the use of antibiotics, caring for relatives and contact with animals.

Table 3: Comparison of outpatient (n=579) and inpatient (n=759) geriatric care staff who underwent MRSA screening in Hamburg

Variable		**$N_{outpatient}$**	**$N_{inpatient}$**	**p-value**
Age in years	Mean/SD Median	44.5/11.8 46.0	41.8/12.4 43.0	< 0.01
		n (%)	n (%)	
Positive MRSA results		7 (1.2)	12 (1.6)	0.65
Time spent in outpatient or inpatient care	< 1 year 1 – 5 years 6 – 10 years > 10 years Unknown	76 (13.1) 152 (26.3) 80 (13.8) 259 (44.7) 12 (2.1)	79 (10.4) 157 (20.7) 147 (19.4) 248 (32.6) 128 (16.9)	< 0.01
Level of training	Geriatric nurse Care assistant/auxiliary nurse General nurse Without nursing qualification Other/unknown	137 (23.7) 110 (19.0) 167 (28.8) 127 (21.9) 38 (6.6)	241 (31.8) 110 (14.5) 58 (7.6) 78 (10.3) 272 (35.8)	< 0.01
Nursing activities		423 (73.1)	471 (62.1)	< 0.01
Close contact with patients		447 (77.2)	553 (72.9)	0.075
Use of antibiotics		140 (24.2)	261 (34.4)	< 0.01
Care of relatives		60 (10.4)	38 (5.0)	< 0.01
Contact with animals		343 (59.2)	396 (52.2)	< 0.01

DISCUSSION

The current study marks the first time that data on the occupational risk of MRSA in employees of outpatient care facilities in Hamburg could be made available. The MRSA prevalence is low and at 1.2%, it is below the colonisation rate of 1.6% found among staff of geriatric nursing homes in Hamburg (Peters 2017). Compared to other studies of personnel in medical facilities in Germany, the

results are on the lower end of the spectrum [5]. Studies on the frequency of MRSA in outpatient care have mainly focused on patients. They report MRSA colonisation rates of 3.7%,[11] 4.7%[12] and 2.1%[13] for Germany. An American study[14] investigated paediatric healthcare personnel in different outpatient settings. The survey of 227 paediatric healthcare workers in outpatient settings revealed a prevalence of 3.1%. In terms of risk factors, only prior surgery was shown to be associated with MRSA colonisation. In our study, however, no correlation with the known risk factors was found for the entire study population. It was only after differentiation of the nursing staff that close contact, MDRO contact and infection control measures demonstrated statistical significance. These differences can be explained by the fact that all MRSA colonisations were identified in the nursing area – due to their profession, nursing staff have the closest contact with patients and are better informed about protective measures than care support staff and therapists.

Infection control

Other studies dealt with infection control due to the organisational characteristics of outpatient care. A study of the public health service in Bavaria[15] showed that smaller facilities in particular (with fewer than ten patients) achieved poor results in infection control, knowledge about relevant recommendations for action and the availability of work aids. In the large facilities, on the other hand, personnel conditions were less favourable.

Outpatient care poses a particular challenge for infection control due to the fact that it is provided in the patient's home environment. In this scenario as well, however, the recommendations emphasise the need for basic hygiene, such as hand hygiene, barrier measures and surface disinfection.[5]

What stands out in the analysis of the study results is the insufficient communication between the various actors in the healthcare sector in some cases. Hospitals often do not share information about a positive MDRO test result with the outpatient facilities or there is no information regarding decolonisation/control swabs. Primary care physicians also rarely make the nursing staff aware of such findings. Moreover, MRSA carriers themselves are not always and sufficiently informed and experience stigmatisation at times.[16] In terms of infection prevention, however, sharing information about MDROs is important for everyone concerned, in order to ensure optimal patient care and employee protection. Similar results regarding risk communication were also obtained by other authors[17] and these problems were also reported with regard to inpatient geriatric care.[18]

Comparison of outpatient and inpatient geriatric care

In comparing the employees in geriatric outpatient and inpatient settings in Hamburg, differences can be seen. The participants from the outpatient setting were older and had worked in their profession longer, came predominantly from the nursing and geriatric care professions and took care of family members at home twice as often. A more self-determined work environment and flexible hours may be an advantage in outpatient care. The better compatibility of family and career for women returning to work after having children also seems to be a long-term alternative for nursing staff compared to a hospital setting.

Limitations

The study encountered problems in terms of willingness to participate. This was especially evident when recruiting facilities. Despite repeated contact, motivating those in charge to participate was difficult. We can only speculate about the reasons. The reluctance of employers to agree to the MRSA screening is mainly attributable to the fear of numerous positive results. The worry that employees who test positive for MRSA would increasingly take sick leave underscores the problem of the pre-existing shortage of personnel in this sector. In addition, the fear of reputational damage due to a high MRSA prevalence as well as the greater organisational effort required may also be partly responsible for the refusal to participate. It is therefore likely that the results were distorted due to a selection bias. Coupled with low participation rates, an underestimation of the actual MRSA risk cannot be ruled out.

In our study only point prevalence was investigated, hence a differentiation between transient and persistent MRSA carriage was not possible. For a complete depiction of the occupational exposition, data are missing of the patients' MRSA prevalence, their MRSA's genetic strains, and of transmission routes. Statements on the success of decolonisation are unreliable due to the small number of cases.

CONCLUSION

This study made it possible to determine the rate of MRSA among outpatient care staff in Hamburg for the first time and it describes the occupational risk of exposure to health personnel in outpatient care. The MRSA prevalence is low but all MRSA colonisations were found in nursing personnel. Known risk factors did not show any correlation with MRSA colonisation. Achievements could be gained by improving information and communication of the infection status of the patient. A good infection control at the facilities is highly recommendable and the employees should acquire in-depth knowledge of infection prevention to improve the compliance with basic hygiene measures such as hand disinfection and personal protective measures.

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Contributors: CP was involved in designing the study, made the statistical analysis and interpretation of the data and drafted the manuscript. OK participated in the design of the study, performed data collection and has been involved drafting the manuscript. AN participated in the design of the study and helped to draft the manuscript. AS participated in the design of the study and has been involved drafting the manuscript. All authors read and approved the final version of the manuscript.

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Provenance and peer review: Not commissioned; externally peer reviewed.

Ethics approval: The Ethics Committee of the General Medical Council for the city of Hamburg.

Data sharing statement: No additional data sharing available.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3-4
Bias	9	Describe any efforts to address potential sources of bias	*3*
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3-4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and interactions	4
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4-5
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	5
Outcome data	15*	Report numbers of outcome events or summary measures	5-6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5-8
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.