

Methicillin-resistant *Staphylococcus aureus* transmission

Unrecognised patient MRSA carriage

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ABSTRACT

INTRODUCTION: Even though methicillin-resistant *Staphylococcus aureus* (MRSA) is a common cause of nosocomial infections, it may often be difficult to evaluate the exact route of transmission.

METHODS: In this study, we describe four cases of nosocomial transmission of MRSA in a hospital with a low MRSA incidence.

RESULTS: In one case, a multi-traumatic patient arrived from a hospital in a foreign country and the primary surveillance swaps were negative for MRSA. The second case was a child with burn wounds who was referred from a Danish hospital. The third case was a multi-traumatic patient from Denmark. The fourth case was a new-born child in the neonate unit.

CONCLUSION: In none of the cases, the index patient was known to have MRSA on admission and no specific precautions were taken to prevent transmission. In all cases there was intensive contact between the patient and the staff which may increase the risk of contaminating hands, arms and the front of the uniform. Hand hygiene is therefore essential, but the use of protection gowns with long sleeves is also important in order to prevent transmission of MRSA. After culture of MRSA and implementation of specific precautions to prevent transmission of MRSA, no further transmissions were observed.

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TRIAL REGISTRATION: The data in this study are included in the routine surveillance of MRSA at Rigshospitalet and do not form part of a trial.

In recent years, methicillin-resistant *Staphylococcus aureus* (MRSA) has emerged worldwide as an important health care-associated pathogen, mainly because of its increased occurrence in the community [1, 2]. MRSA is endemic in many hospitals accounting for up to 50% of all nosocomial *S. aureus* cases, and transmission of MRSA may be difficult to trace when the incidence of MRSA is high [3]. Knowledge about the mode of transmission and identification of factors that increase the risk of transmission are the key to identifying which infection control precautions are necessary in different situations. Outbreaks of MRSA have been reported in a number of settings including in athletic teams, military

recruits and nursing homes [3-6]. Several risk factors have been identified. These factors include underlying disease, close contact with persons colonised with MRSA, patients who have been in hospitals located in high-incidence areas, patients with wounds, patients with foreign bodies and persons performing contact sports [5, 6].

Even though Denmark has seen an increase in the incidence of MRSA, Denmark remains a low-incidence country with less than 2% of the isolated *S. aureus* being MRSA. Therefore, it is possible to follow single cases of MRSA in the hospital, and the mode of transmission of MRSA in nosocomial outbreaks can be identified with great certainty. The policy for infection control precautions differs from one country to the next. For more than 30 years, the infection control policy in Denmark has included contact precautions and active surveillance cultures of patients and personnel who have had contact to hospitals in high-incidence areas as well as isolation of patients transferred from high-incidence areas and patients with known MRSA [7]. This restrictive policy is probably the reason for the low incidence of MRSA in Denmark, and such a policy has been shown to be cost-effective [8, 9].

The aim of this study was to describe the transmission of MRSA between patients and staff in nosocomial outbreaks and to identify factors that may influence the choice of infection control precautions in these situations.

METHODS

Rigshospitalet is a tertiary university hospital with about 1,150 beds. About 70,000 in-house patients are admitted to Rigshospitalet every year, and there are about 450,000 out-patient visits annually.

All patients and staff who have been in hospitals outside of Scandinavia and the Netherlands with contact to hospitals were screened for MRSA by nasal, throat and perineum swaps. The majority of patients admitted to Rigshospitalet had several routine samples taken for microbiological examination during their stay.

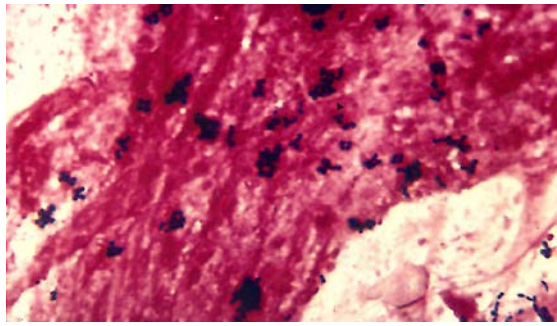
If MRSA was found in routine samples, surveillance swaps from the nose, throat and perineum were taken from the patients. The same surveillance swaps were

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Methicillin-resistant *Staphylococcus aureus* in tracheal secretion from a patient.



taken from other patients who had stayed in the same room, and nose and throat swabs were taken from staff members who had come into close contact with the patient without using protection gown during nursing.

S. aureus with decreased susceptibility to cefuroxime was tested for susceptibility to ceftiofloxacin by the agar diffusion method. If the susceptibility for ceftiofloxacin was decreased, the diagnosis of MRSA was confirmed by polymerase chain reaction (PCR) for the gene *mecA*. The gene *spa* was sequenced in another laboratory.

The general infection control precautions included hand hygiene before clean procedures, after patient contacts, after dirty procedures and after use of gloves. Protection gowns were used during dirty procedures, and masks were used during tracheal suction.

The specific infection control precautions included isolation of the patient in a single person room, hand hygiene, use of gloves and protection gowns with long sleeves during all patient contact. If the patients were catarrhal, the staff wore surgical masks.

Trial registration: Data in this study are included in the routine surveillance of MRSA at Rigshospitalet and do not form part of a trial.

RESULTS

From January 2002 to December 2007, about 450,000 patients were admitted to Rigshospitalet; and MRSA was identified in 172 (0.0004%) patients. MRSA was only cultured from 34 (20%) patients at other hospitals before admission to Rigshospitalet, and MRSA could be cultured both at other hospitals before admission to Rigshospitalet and at Rigshospitalet from 24 (41%) of 58 patients admitted from other hospitals (Table 1). Twenty (14%) of 138 patients with MRSA were found by surveillance screening after transfer from a hospital outside of Scandinavia and the Netherlands. Additionally, five (4%) of 138 persons with MRSA were found by screening because they were involved in outbreaks. Thus, MRSA was found in 25 patients by surveillance screening. The remaining 96 (70%) patients with MRSA were established by coincidence in routine samples from patients without

known risk factors. Eighty-eight (51%) of patients with MRSA or prior MRSA were outpatients and 84 (49%) were in-patients (Table 2).

MRSA was cultured from six staff members of whom four were involved in outbreaks. One staff member was colonised with MRSA at work outside Rigshospitalet, and one had a *spa* type of MRSA from Pakistan that has not been seen in any other person at Rigshospitalet. During the six years of observation, four outbreaks involving 15 (11%) persons with MRSA were observed. Thus, four (5%) of 85 patients with unknown MRSA at admission caused an outbreak.

Outbreak 1

A patient was transferred from a hospital in Thailand with a cervical spine injury after a traffic accident. MRSA was not found at the surveillance swabs. Two weeks later, the same *spa* type of MRSA was found on the patient and his roommate in routine swabs. Infection control precautions were established, and no further spread of MRSA was seen.

Outbreak 2

A multi-traumatic patient was admitted after a traffic accident in Denmark. The patient had no risk factors for MRSA, and surveillance swabs were not performed. Three weeks later, MRSA were found in routine swabs from the wounds. MRSA was found in several surveillance swabs. Surveillance swabs from the staff revealed that a nurse and a nursing assistant who both took care of the patient were colonised with the same MRSA *spa* type as the patient. Infection control precautions were established, and no further spread of MRSA was seen.

Outbreak 3

A three-year-old child with burns was admitted from another Danish hospital together with his mother. Neither the child nor the mother had risk factors for MRSA, and surveillance swabs were not performed. One week later, MRSA was found in routine swabs from the wounds of the child. Surveillance swabs from the mother and the staff revealed that the mother and one nurse were colonised with the same MRSA *spa* type as the child. Infection control precautions were established, and no further spread of MRSA was seen.

Outbreak 4

MRSA was found in a routine blood culture from a three-week-old child in the neonatal unit. Surveillance swabs from all children in the same unit, their parents and the staff revealed that five other children and one nurse were colonised with the same type of MRSA as the first child. Most likely, the MRSA originated from a child born in another Nordic country and not from the first child.

Infection control precautions were established, and no further spread of MRSA was seen.

DISCUSSION

A combination of active surveillance culture, preemptive use of isolation for patients at high risk and contact precautions have been key elements in the policy for controlling MRSA transmission for more than 30 years [7] in Denmark. During the six-year-period that was included in this study, no nosocomial transmission was observed from patients with known MRSA colonisation/infection before admission to the hospital. The generally low rates of MRSA transmission in countries that have implemented aggressive and sustained infection control interventions is a strong indication of the effectiveness of this policy [10-12].

In the four outbreaks of MRSA, transmission was only observed before the MRSA carriage status was revealed. As soon as MRSA was cultured from routine samples, nurses and doctors who had contact with the patient and patients in the same room were screened for MRSA, the specific contact precautions were implemented by isolation regimes, specific infection control precautions and surveillance screening of patients and staff were implemented and no further transmission was observed. MRSA carriage status was not revealed in the four outbreaks, either because no MRSA were found by the primary surveillance swaps or because the patients had no risk factors for MRSA that indicated surveillance swaps. Studies have shown that a higher MRSA recovery rate (97% versus 76%) is obtained when surveillance swaps are done three times within 24 hours compared to a single time [13]. However, with a relatively high number of admissions from hospitals outside the Nordic countries and the Netherlands and given that spreading was only observed in one other patient (case 1) in the course of the six-year study period, this would not be cost effective. Two patients had wounds (outbreaks 2 and 3), which may be regarded as a risk factor, but in a six-year period more than 100,000 patients with wounds are admitted to the hospital. It would therefore not be cost-effective to prevent two cases of nosocomial MRSA.

It is well-documented that *S. aureus* is mainly transferred through direct hand/skin contact from patient to staff to other patients or from patient to patient [14]. There is ample evidence that health-care workers spread microbes from patient to patient via contaminated hands [15, 16]. Hands are easily contaminated during nursing or from contact with environmental surfaces in close proximity to the patient. Intensive close contact increases the risk for transmission of *S. aureus* not only in health-care units but also in nursing homes [17]. In the study period, nursing staff usually used short-sleeved

TABLE 1

Numbers of patients with MRSA at Rigshospitalet in 2002-2007.

	2002	2003	2004	2005	2006	2007	Total
With MRSA, total	10	22	33	29	42	36	172
With MRSA found in other hospitals, but not at Rigshospitalet	1	1	3	8	11	10	34
With MRSA found in other hospitals and at Rigshospitalet	1	2	8	6	6	1	24
With MRSA only found at Rigshospitalet	8	19	22	15	25	25	114

MRSA = methicillin-resistant *Staphylococcus aureus*.

TABLE 2

Numbers of different types of patients with MRSA at Rigshospitalet in 2002-2007.

	2002	2003	2004	2005	2006	2007	Total
With MRSA, total	10	22	33	29	42	36	172
With MRSA found at Rigshospitalet	9	21	30	21	31	26	138
With MRSA from other Danish hospitals	2	3	11	14	17	11	58
With MRSA from hospitals in high incidence areas outside of Scandinavia and the Netherlands	1	5	4	2	2	6	20
With MRSA in out-patient clinics	5	13	17	16	19	18	88
With MRSA involved in nosocomial outbreaks	0	2	0	2	8	0	12
With MRSA found by active surveillance screening	4	7	2	3	9	0	25

MRSA = methicillin-resistant *Staphylococcus aureus*.

gowns, whereas doctors and patients often used long-sleeved gowns. The increased area of free skin associated with the use of short sleeves may increase the risk of transmitting MRSA between patients as staphylococci probably adhere better to skin than to the gown [18, 19].

In all four outbreaks of MRSA, there was intensive close contact between the patients and the staff, either because the patients were heavy and immobile (outbreaks 1 and 2) or because they were children who were often held and carried by the staff (outbreaks 3 and 4). In all cases, the hands, arms and uniforms of the staff came into close contact with the patients. General infection control precautions (hand hygiene, protection gowns and gloves for dirty procedures) were used. Specific infection control precautions (gloves and protection gowns at all contacts with patients, and disinfection of medical equipment, and isolation of patients) were not done. In all four cases, the spread might have been prevented through use of protection gowns at all contacts with patients combined with careful hand hygiene. Using protection gowns at all patient contacts will make the daily work more difficult and with only four outbreaks in six years, it would not be cost-effective to use protection gowns at all patient contacts. However, it is important for the staff to follow hand hygiene precau-

tions which includes regular disinfection of all free skin and daily changing of the uniform.

Several infection control precautions could have been effective in preventing these four outbreaks, but none of them seem to be cost-effective in a hospital with a low MRSA incidence. Since it is difficult to make randomised controlled prospective clinical studies in this area, data are often based on more or less casuistic observations. Therefore, mathematic modelling studies have been performed to estimate the impact of active surveillance culture and isolation for control of MRSA. Such a study has predicted that isolating colonised/infected patients on the basis of clinical culture results alone is unlikely to be successful at controlling MRSA, whereas a combination of an active surveillance culture and isolation may lead to successful control of MRSA even in a setting with a high MRSA incidence [20].

In the four outbreaks of MRSA, the index patient was not known to carry MRSA, and there was intensive and close contact between the patient and the staff. In all four cases, the outbreak was easily stopped when the specific infection control precautions (protection gown and gloves worn at all patient contacts) were used after the MRSA was known. Thus, it seems that both the general and specific infection control precautions in place to prevent the spreading of MRSA in our hospital are sufficient and cost-effective – well knowing that small limited outbreaks of MRSA may occur from time to time.

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