Keywords
MRSA
Screening
PCR
Hospital-acquired infection
Hygieneorder
Hospital information system
Combined swab

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Experiences with a new MRSA management regime in the Clinic Combine Southwest

Summary

Background: In 2006 the Hospital Group „Klinikverbund Suedwest" introduced a PCR-based method for MRSA detection in order to reduce nosocomial infections and colonization with MRSA. However, this measure was without long-term success. Therefore, in 2009, the overall concept was revised by the Department of Infection Control in collaboration with the CEO and the laboratory.
Methods: A MRSA-checklist was compiled to select those patients who have to undergo mandatory screening. The responsibility for this selection procedure was no longer with the physicians but was transferred to the nurses instead. A pop-up window on the computer screen with the message „Cave" (caution) as implemented in the German Hospital Surveillance System KISS was integrated in the hospital information system. In addition, a new PCR-based assay for MRSA detection was established which permitted the testing of 100 swabs per day. Laboratory results were asked to be available within 24 hours. The MRSA and Hand-KISS results were to be reported on a regular basis.
Results: MRSA colonised/infected patients were more frequently and more rapidly detected following implementation of the more stringent screening protocol. The rate of nosocomial MRSA-infections could be significantly reduced. The evaluation of economic data shows that the screening costs are not compensated by the additional DRG (diagnosis-related groups) proceeds.
Conclusion: As the infection control precautions had remained unchanged since 2006, we infer that it is solely the stringent screening regimen which has led to the significant reduction in nosocomial MRSA-infections/-colonisations, however it was not cost-neutral. With an early detection of MRSA carriers the occurrence of a costly treatment of MRSA infections can be minimized. Additionally the "silent" transmission and therefore the spreading of highly resistant bacteria within the hospital can be reduced.
Hyg Med 2010; 35 [9]: 306–314

Introduction

In 2006, hospital belonging to the districts of Böblingen and Calw and the City Hospital of Sindelfingen merged to form the South-West Clinic Group. This comprises six hospitals within a 50 km radius.

Given the very different approaches to identifying MRSA carriers in the various hospitals of the South-West Clinic Group, a rapid molecular biology test to detect MRSA was introduced in the diagnostic laboratory in 2007. The aim of this was to identify MRSA carriers quickly and isolate them at an early stage.

However, the surveillance figures (MRSA-KISS), collected since 2007 by the Department for Hygiene and Infection Prevention, did not reveal the crucial leap forward for 2007 and 2008. The number of screenings especially, remained clearly behind expectations. MRSA was frequently detected only after 48 hours of hospitalisation. This increased the number of hospital acquired MRSA cases and the risk of a transmission.

For this reason, a new screening process was established in mid 2009. The goal of this measure was to keep the rate of hospital acquired MRSA infections/colonisations per 1,000 patient days below the 25th percentile in the MRSA-KISS [1, 2, 3]. A systematic decontamination procedure prior to elective interventions was introduced with the aim of reducing the

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number of nosocomial MRSA infections.

The South-West Clinic Group is participating as a pilot region in the development of regional networks to combat the spread of antibiotic-resistant bacteria in Baden-Württemberg. This initiative was implemented on 11.05.2009 by the Ministry for Social Affairs in Baden Württemberg. In addition to the hospitals, it encompasses all institutions where people receive medical and/or nursing care.

Methods

The new MRSA screening process was started in August 2009 in all six hospitals of the clinic group (Table 1).

MRSA checklist

Using official instructions it was determined that every newly admitted patient is questioned by means of a checklist (Figure 1: MRSA checklist). The contents of this checklist mirror the "recommendations for prevention and control of MRSA strains in hospitals and other medical establishments" published by the Robert Koch Institute [4]. It provides clear information to identify patients at risk of colonisation with MRSA. Questioning via the checklist was the task of the nursing staff responsible for admission. Any positive response to a question placed the patient in the screening Group. If the patient was allocated to the screening Group, screening took place within the first 24 hours of hospitalisation.

MRSA detection

MRSA screening was performed via swabbing from nose, throat, and perineum using a single collection swab since sensitivity of MRSA detection is known to be highest using a specimen obtained from multiple sites. In this regard, several authors demonstrated that simultaneous swabbing from the nose and throat is more sensitive in detecting MRSA, than nasal swabbing alone [4, 5]. Further optimisation could be achieved through additional swabbing from the perineal region as well as from open wounds [4, 6, 7] (Table 2).

Following receipt of the swabs in the central laboratory, MRSA screening was carried out by PCR ("LightCycler MRSA Advanced Test", Roche Diagnostics, Germany) and by culture, on chromogenic selective medium ("Brilliance-MRSA

Table 1: Changes relating to procedures in the South-West Clinic Group.

Procedure January 2007–July 2009	Procedure from August 2009
Preventative isolation of known MRSA patients	As previously
Physician decides on the grouping of the patient and on the necessity of MRSA screening	Mandatory checklist, which is checked off by the care staff for every patient
Analysis by PCR test and propagation on chromogenic selective growth medium on workdays; only with chromogenic media on weekends	Establishment of a PCR method, handling 100 analyses per day; continued use of chromogenic selective growth media on weekends
MRSA positive results are immediately communicated to the ward by telephone	As previously
MRSA positive results are communicated to the hygiene specialists by email	As previously
Contact isolation of MRSA positive patients; continuing hygiene measures	As previously
Decontamination attempt	As previously
Weekly check-up examination	As previously
Number of patients: 177,253	Number of patients: 41,535

Table 2: Sensitivity of MRSA screening (n.a. -not analysed).*

Site	Sensitivity [%]				
	Kunori [6]	Wendt [8]	Batra [7]	Schulz [5]	Charité [8]
Nose	64	53	n.u.	85	80
Perineum	56	39	n.u.	n.u.	32
Throat	15	36	n.u.	42	45
Nose + Throat	86	62	60	100	87
Nose + Perineum	93	67	n.u.	n.u.	n.u.
Nose + Throat + Perineum	98	71	95	n.u.	n.u.
Nose + Throat + Perineum + Wound	100	92	n.u.	n.u.	n.u.

Table 3: Turn-around-time until availability of the screening result.

N=3.406	Entry of sample into lab until result	Electronic requisition until result
Minimum value	2.0 h	2.5 h
50 % (median)	4.6 h	17.8 h
70 %	7.4 h	22.5 h
80 %	17.8 h	23.9 h
90 %	20.2 h	25.5 h
Maximum value	24.8 h	28.3 h

Agar" Oxoid, Germany) on weekdays; on weekends and bank holidays, only culture was performed.

Turn around time

A rigid reporting and infection control regimen for all MRSA results was performed (Figure 2): all positive MRSA results were reported by phone. Infection control team members were informed via email. Patients colonized with MRSA were isolated and treated before elective surgery based on unpublished data from an observational study revealing that transmission of MRSA did not occur within the first 20 hours of admission (personal communication, C. Wendt, University of Heidelberg). To investigate how soon patients colonized with MRSA are detected we documented a) the time between receipt of the sample in the laboratory and the generation of a result, and b) the time between electronic requisition of MRSA screening and receipt of the final result on the ward.

South-West Clinic Group **All wards**	**MRSA checklist**	Klinikverbund Südwest **Version: 1.0** **Lfd. Nr.:** **Checkliste_MRSA-Screening.pdf**	
Patient label			
Had the patient previously been colonised with MRSA?	☐ no	☐ yes →	**Admission screening**
Had the patient spent more than 3 days in the hospital in the past 12 month?	☐ no	☐ yes →	**Admission screening**
Had the patient been transferred to us from a region with a high MRSA prevalence? (e. g. Frankreich, Spain, Portugal, Italy, Greece, Serbia, Croatia, Albania, Eastern Europe, Great Britain, USA, Japan)	☐ no	☐ yes →	**Admission screening**
Does the patient come from an establishment with a high MRSA prevalence? (Care home, Neurosurgery department, Intensive care ward of a University Clinic)	☐ no	☐ yes →	**Admission screening**
Does the patient have direct contact with animals in agricultural animal husbandry through his/her profession? (e. g. vets, farmers, abattoir personnel)	☐ no	☐ yes →	**Admission screening**
Does the patient have 2 of the following risk factors: ☐ Antibiotic therapy in the past 6 months ☐ Long-term requirement for care ☐ Indwelling catheter (bladder catheter, PEG, etc.) ☐ Requirement for dialysis ☐ Skin ulcer, gangrene, chronic wounds, soft tissue infection ☐ Burn injury ☐ Diabetes	☐ no	☐ yes →	**Admission screening**
Admission screening carried out	on:	by:	
Created on: 20.07.2009	Checked on: 23.07.2009		Revision: 2011
Created by: Care Administration	Checked by: Dr. Rünz		Page: 1 of 1

Figure 1: MRSA screening checklist.

Screening rates, MRSA prevalence and incidence

The new MRSA screening process was established to determine whether a reduction in the number of nosocomial MRSA infections could be achieved within a 7-month period. For this reason the files of patients were reviewed in regard to the presence of infection with MRSA. Characteristics of nosocomial infection with MRSA before and after implementation of the new MRSA screening process were compared using Chi-Suare-Tests.

The Patient Clinical Complexity Level (PCCL) assigns each patient with an integer value between 0 and 4, calculated from a mathematical formula. It denotes the overall patient-related severity level in the medico-economic classification system, called Diagnosis Related Groups (DRG).

The Case Mix Index (CMI, "case severity index in the DRG system") describes the average severity of patient cases measured against a scale corresponding to the overall resource expenditure. It represents a measure for the relative economical resource expenditure of all treated hospital cases. Thus, the CMI is of considerable significance in the DRG system.

Length of Stay (LOS) indicates the time that the patient spent in hospital receiving inpatient treatment. The German DRG system allocates patients into case group based on their diagnoses, treatments, and demographic characteristics (age, gender, weight ad admission in children under the age of 1) for reimbursement. Main criteria for allocation into a diagnosis-related case group are:

a) Main diagnosis (ICD-10 code)
b) Procedures performed in the hospital (OPS codes)
c) Secondary diagnoses and complications that severly impact the patient management
d) Time of assisted ventilation
e) Patient-specific factors (age, gender, weight at birth in newborns)

Processing of data to determine the specific case group is performed by a certified software package.

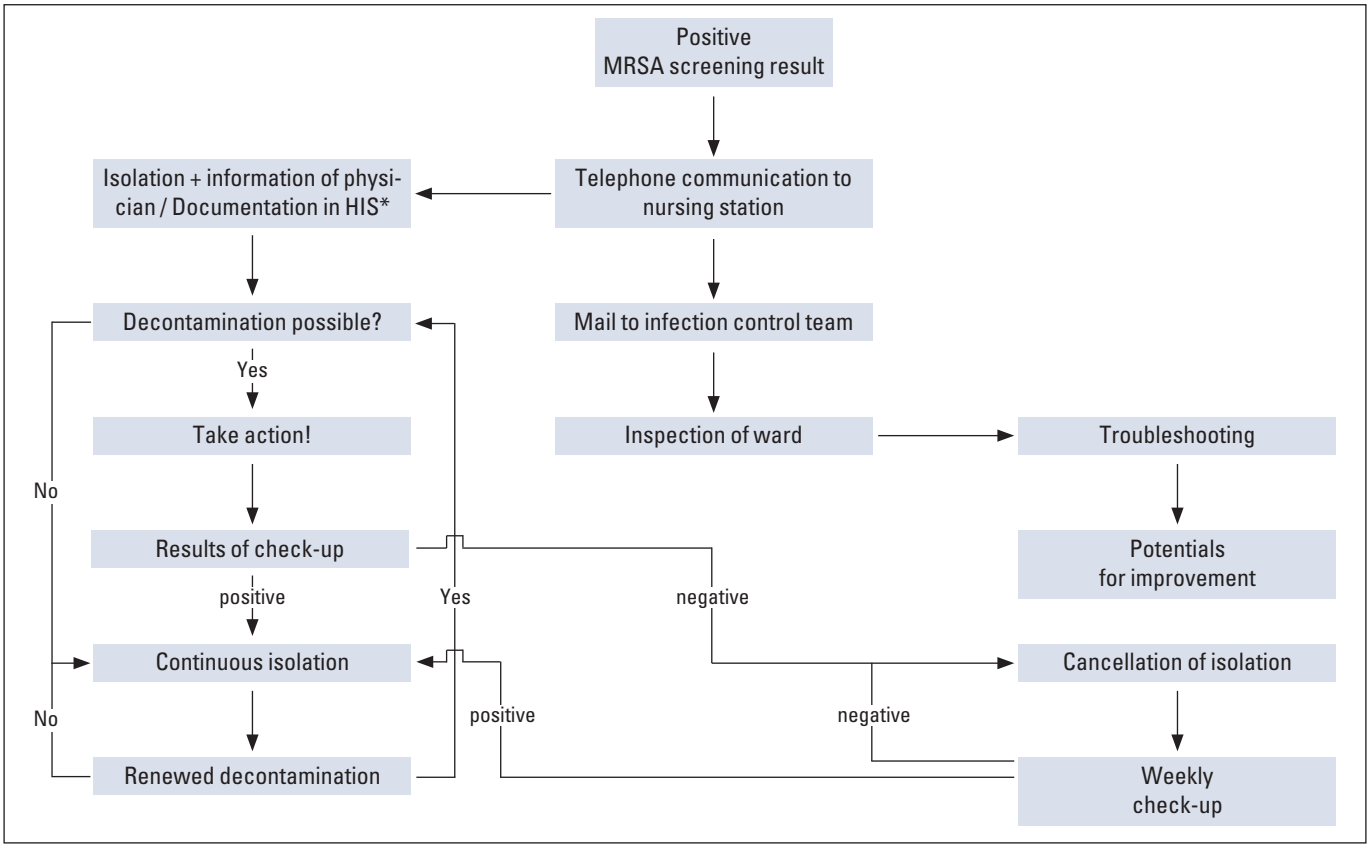

*Figure 2: Flowchart in case of MRSA detection (*HIS = hospital information system).*

Results

1. Turn around time

Evaluation of the "turn-around-time", from "receipt in the laboratory to availability of the result on the ward" on the one hand, and from the "electronic requisition to availability of the result on the ward" on the other, clearly showed that, taking the local situation into account, all results typically were available on the wards within 24 hours. First results were available after 2.0 to 2.5 hours, 50 % of all results were available after 4.6 to 17.8 hours (Table 3, Figure 3).

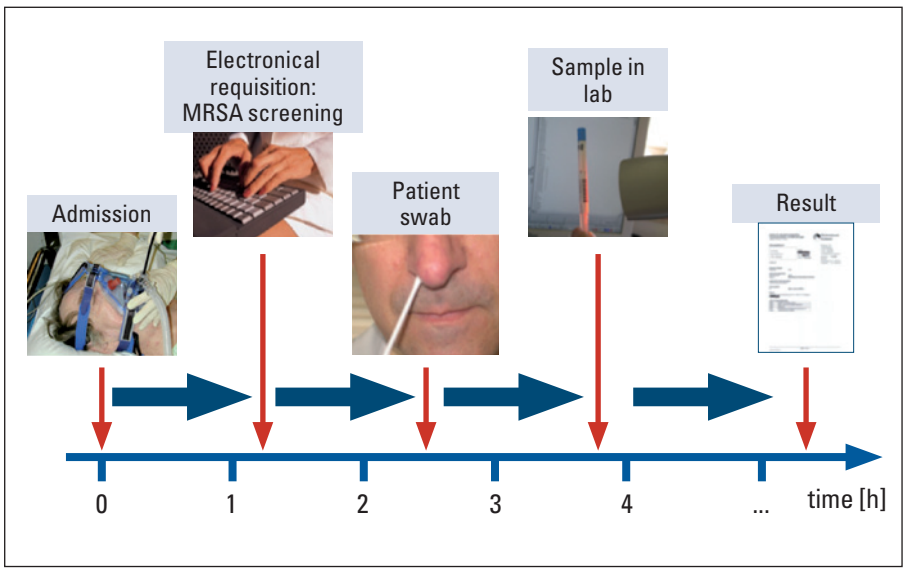

Figure 3: Chronological process from inpatient admission to availability of the screening result.

2. Screening rate

Expanding the MRSA screening following the guidelines of the Robert Koch Institute resulted in a marked increase in the screening rate from 10–15 % (2008–2009) to 28–31 % (2010). The number of PCR tests performed increased to 1490 tests/month (Table 4).

3. MRSA prevalence

Different figures have been quoted for MRSA prevalence numbers in Germany. The MRSA screening carried out in 2009 in Baden-Württemberg by the State Health Authority in the pilot regions yielded a prevalence of 1.8 %. The prevalence was 1.0 % for normal wards, and 6.5 % for intensive care wards [9].

Experiences in the South-West Clinic Group revealed that prevalence figures differ markedly depending on the region and type of patients (0.7–2.1 %, Table 5). In this regard, hospital 5 serves a region with many nursing homes and a vascular disease center while in hospital 1 encompasses a pediatric and an OB/GYN department. Results also revealed that patients working in animal husbandry or similar professions – at least in our patient population – do not represent a population at increased risk for colonization with MRSA (Table 6). High numbers of MRSA colo-

Table 4: Development of screening rates in the hospital group.

Month	Inpatient admissions	Admission screenings	Screening rate	Screenings per 1,000 pat. days	Number of PCR analyses	Positive-screened patients
08 / 2009	5,343	1,134	21 %	33.9	879	26
09 / 2009	5,543	1,431	26 %	42.8	1,414	62
10 / 2009	5,914	1,721	29 %	37.8	1,396	66
11 / 2009	6,018	1,663	28 %	45.6	1,421	62
12 / 2009	5,544	1,587	29 %	47.9	1,179	49
01 / 2010	5,866	1,595	27 %	43.9	1,190	33
02 / 2010	5,786	1,470	25 %	41.2	1,195	40
03 / 2010	6,545	1,853	28 %	47.2	1,534	66
04 / 2010	5,922	1,803	30 %	51.4	1,492	61
05 / 2010	5,655	1,777	31 %	51.4	1,484	46
06 / 2010	5,757	1,791	31 %	53.3	1,490	66

nization were reported in patients that were a) referred from institutions with high MRSA prevalence, b) had been admitted to the hospital within the last 12 months, and c) had two risk factors. Of interest, highest numbers were reported in patients that had previously been colonized with MRSA (data not shown).

4. MRSA incidence according to KISS

Surveillance data on overall incidence mirror the diverse prevalences in the hospitals of the group (Table 7). Incidence densities of nosocomial MRSA cases as well as MRSA days-associated nosocomial MRSA rates were markedly decreased in the last quarter of 2009. These numbers do not markedly impact the overall numbers for the calendar year but will be fully visible in 2010. The mean daily MRSA load (KISS data set) allowed to investigate the daily need for isolation rooms.

4. Rates of nosocomial MRSA infections/colonizations according to KISS

From a clinical perspective, trends in the numbers of nosocomial MRSA infections and MRSA colonizations are the most important aspect. Figure 4 clearly shows that upon establishment of the new screening process numbers of nosocomial cases of MRSA were reduced to less than 50 %. In three hospitals, there were no cases of nosocomial MRSA infections or colonisations in the 1st and 2nd quarter of 2010.

5. Rate of nosocomial MRSA infections

In the period from 01.09.2008 to 31.03.2009, among 41,563 inpatients 11 nosocomial MRSA infections were observed. In the same time period for the following year, among 41,535 inpatients only 3 nosocomial MRSA infections were observed. MRSA cases that occurred are described in Table 8. All of these were also captured in the KISS system. The assumption that the results of 2010 significantly ($p < 0.05$) differ from those of the reference period 2009 was verified by means of the chi-square test. (Table 9). The number of nosocomial MRSA infections could be reduced significantly ($p < 0.005$) after introduction of the extended screening procedures (Table 9). Of interest, these cases represented diverse infections. It is not a matter of a prolonging nosocomial infections to below the 48h threshold by the KISS definition.

Table 5: Patients, screening rates, prevalence in one month.

Sep. 2009	Hosp 1	Hosp 2	Hosp 3	Hosp 4	Hosp 5	Hosp 6
Inpatient admissions	1.352	1.237	791	682	827	654
Number of screenings	225	320	264	172	190	167
Screening rate	17 %	26 %	33 %	25 %	23 %	26%
MRSA positive patients	9	15	11	9	17	9
MRSA prevalence	0.9 %	1.4 %	1.3 %	2.1 %	1.4 %	1,4%

Table 6: Exemplary distribution of MRSA positive patients in the different risk groups in hospital 2; Time interval: 01.08.2009 – 16.10.2009.

Risk group	Number (Percentage)	MRSA positive (Percentage)
Screening forms	905 (100%)	42 (100%)
Prior MRSA colonisation	27 (2.8%)	2 (4.8%)
From establishment with high MRSA prevalence	183 (20.2%)	11 (26.2%)
From region with high MRSA prevalence	50 (5.5%)	2 (4.8%)
Inpatient stay in the past 12 months	630 (69.6%)	17 (40.5%)
Professional activity in husbandry	37 (4.1%)	0 (0%)
2 risk factors (antibiosis, care requirement, catheter, dialysis, chronic wounds, burn injury, diabetes)	200 (22.1%)	9 (21.4%)

Economical aspects

Since the number of MRSA screening using PCR test increased significantly we investigated whether additional costs for screening tests were compensated for through additional revenues.

The costs per year for personnel and reagents for this quality-assurance measure amount to approx. € 273,000/year. Additional charges, such as costs of personnel, materials and isolation measures for MRSA carriers must be added to this.

In the 2010 DRG system additional costs for the treatment of patients with multi-resistant pathogens are compensated by specific DRGs. In 2010 the DRGs E77B, F77Z, G77Z, J77Z, K25Z, K77Z, L63A and T77Z (Table 10) are covered under OPS 8-987.10 and all subgroups including OPS 8-987.1, OPS 8-987.10 (OPS 8-987*), which means complex treatment for multi-resistant pathogens. Due to the increase in patients with MRSA colonisation or infection, an increase in the corresponding revenue was achieved in the aforementioned DRGs. The rate of DRGs with higher values rose from 2.7 to 5.0 cases per month (Table 11).

Using discharge data we focused our analysis on two time intervals:

– January 2008 to August 2009 = prior to implementation of extended screening
– September 2009 to March 2010 = after implementation ofextended screening

The shortening of the Length of Stay by an average of 2.5 days since September 2009 is considered a result of early treatment of MRSA carriers. The increase in revenue through OPS code 8-987.* is very heterogeneous. In most cases an increase is only to be expected when PCCL 4 is achieved through corresponding secondary diagnoses. Analysis of individual cases revealed mean CMI increasesper DRG depicted in Table 10.

In the period from September 2009 to December 2009 we observed an increase in revenue of 17,187 CM points per quarter. With a standard case value of €2,900, this yields an additional annual revenue of €199,373. The following statement can therefore be made for the observation period: introduction of MRSA screening cannot be refinanced from additional DRG revenue.

We did not evaluate the cost savings through spared MRSA infections at this point. The revenues in cases of nosocomial infections increase in the DRG system by an amount appropriate to the actual costs, so that, from an economical viewpoint, there is no loss of income.

Currently we are working on an improved documentation regimen for complex treatment of multi-resistant pathogens. A current, ongoing detailed analysis will reveal the extent to which the additional costs of materials and personnel in treatment are covered by the additional revenue.

Table 7: Course of the overall incidence density according to MRSA-KISS, aggregated for the whole calendar year (presented in blue: reference data in the group „all hospitals", Q25 = 25th percentile, Q75 = 75th percentile).

Year	Q25	Median	Q75	Hosp 1	Hosp 2	Hosp 3	Hosp 4	Hosp 5	Hosp 6
Overall incidence density									
2007	0.55	0.83	1.25	0.37	0.76	-	-	2.22	0.53
2008	0.54	0.91	1.44	0.70	0.72	0.30	0.51	1.88	0.66
2009	0.66	1.06	1.51	0.65	0.92	0.95	0.75	2.68	1.04
Incidence density of nosocomial MRSA cases									
2007	0.12	0.21	0.34	0.20	0.16	-	-	0.19	0.08
2008	0.13	0.19	0.31	0.22	0.12	0.04	0.12	0.16	0.11
2009	0.11	0.20	0.30	0.09	0.10	0.13	0.21	0.17	0.10

Discussion

The present study results clearly show that, through implementation of systematic screening measures, patients colonised or infected with MRSA are detected more rapidly and in increased numbers [10, 11, 12]. Furthermore, it can be shown that numbers of nosocomial MRSA infections could be significantly ($p < 0.005$) lowered following introduction of the extended screening process. We therefore reduced the risk of silent transmission and spread of multi-resistant nosocomial pathogens.

As the entire hygiene regimen was continued unchanged, it can be concluded

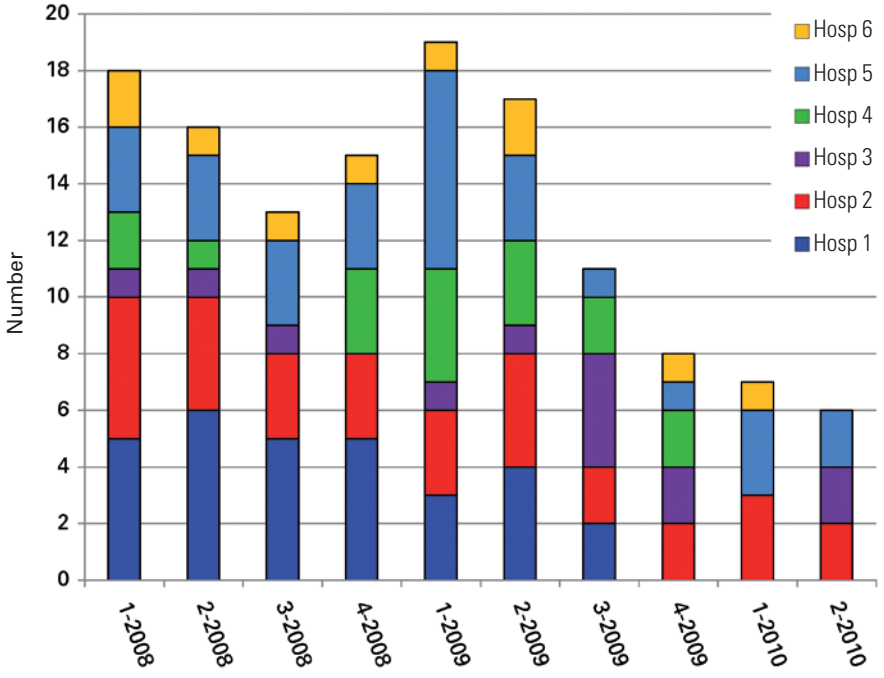

Figure 4: Summary of the course of the number of nosocomial MRSA infections/colonisations per quarter.

Table 8: MRSA infections before and after introduction of the new screening regimen.

Age of patient	MRSA detection	nosocomial according to KISS	nosocomial according to file	Type of infection	LOS [d]
Old screening regimen		**01.09.2008 to 31.03.2009**			
50	Tracheal secretion	Yes	Yes	Sepsis	24
82	Drainage secretion	Yes	Yes	Wound infection	46
60	Aspiration secretion	Yes	Yes	Pneumonia	64
36	Tracheal secretion	Yes	Yes	Pneumonia	31
87	Tracheal secretion	Yes	Yes	Pneumonia	28
79	Tracheal secretion	Yes	Yes	Pneumonia	12
68	Wound swab	Yes	Yes	Urinary tract infection	50
78	Blood culture	Yes	Yes	Sepsis	52
69	Wound swab	Yes	Yes	Sepsis	94
75	Wound swab	Yes	Yes	Wound infection	34
63	Wound swab	Yes	Yes	Sepsis	46
				Mean LOS	47,6
New screening regimen		**01.09.2009 to 31.03.2010**			
67	Wound swab	Yes	Yes	Osteomyelitis	14
59	Abdominal swab	Yes	Yes	Wound infection	44
76	Wound swab	Yes	Yes	Wound infection	67
				Mean LOS	41,7

Table 9: Four-field table for nosocomial MRSA infections.

Time frame	Case number of nosocomial MRSA infections	Overall number of inpatient cases
Old screening regimen: 01.09.2008 to 31.03.2009	11	41,563
New screening regimen: 01.09.2009 to 31.03.2010	3	41,535

that the introduction of the systematic screening process alone contributed to the significant reduction in nosocomial MRSA infections [10, 13]. Rapid detection of patients colonized or infected with MRSA allows for decontamination prior to elective interventions. Major efforts are currently undertaken to decontaminate patients prior to elective surgery, even in an outpatient setting.

At the present point in time, no definite statement can be made on whether MRSA decontamination performed prior to elective surgeries, as reported by McConeghy et al. [14], Sandri et al. [15], and Simor et al. [16], will lead to further decline in the rate of nosocomial MRSA infections.

Further influencing variables are, in our opinion, a) the so-called 'cave' (latin: attention) function in the hospital information system, b) regular reporting of surveillance results (Hand-KISS, MRSA-KISS), and c) the participation in the Multi-Resistant Pathogen Network of Baden-Württemberg as a pilot project. As described by Curran et al. [17] and Gastmeier [18], and confirmed by results of the present study an active surveillance program and functionality features within the hospital information system can minimise the risk of nosocomial infections.

Economical studies, equivalent to those presented here, can not be found in the literature yet. Keshtgar et al. [19] reported that costs for PCR screening are compensated for through the reduction in cases of MRSA bacteremia. Wernitz et al. [20] showed, that effectiveness of screening programs is achieved when approx. 3 hospital associated MRSA cases are prevented. The authors also concluded that a cost deficit of more than € 5,000 must be factored in within the DRG-system for each hospital associated MRSA case. The figures in our study clearly show that the current costs of screening are not covered by the DRG revenue. Major differences of results in the present study to published studies [20] are especially related to the number of screening analyses performed.

This expanded screening process represents represents a major benefit for our patients. Thus we believe the process provides maximum patient by greatly reducing the transmission of MRSA during the hospital stay.

Conclusions

Experience from previous years showed all too clearly that screening performed solely at the individual discretion of the physician, and subsequent strict infection control measures guidelines for MRSA positive patients did not yield the desired success concerning minimizing hospital acquired MRSA infections/colonisations.

With the multimodal approach currently practised that encompasses
- screening of all risk patients,
- availability of the screening result within approx. 24 hours,
- implementation of infection control measures in case of a positive result,
- supervision of implementation by the infection control specialists, and
- preoperative decontamination measures for elective interventions,

in our opinion, will result in successful prevention of infections and fewer transmissions.

Whether this will result in a significant decrease in the rate of overall MRSA incidence density remains to be determined. Possibly, additional measures relating to public health policy have to be initiated

Table 10: Revenue calculation for 2009.

DRG / Text	CMI difference to cases without MRSA	Case number 1st –3rd quarter in 2009	CM 1st –3rd quarter in 2009	Case number 4th quarter in 2009	CM 4th quarter in 2009
E77A Other infections and inflammations of the respiratory organs with congenital malformation syndrome or with compl. diagnosis or extremely difficult CC or with condition following organ transplantation, with complex treatment for multi-resistant pathogens or complex intensive medical treatment in childhood > 72	0.636	6	3.816	7	4.452
F77Z Complex treatment with multi-resistant pathogens for diseases and impairments of the circulatory system	1.102	1	1.102	5	5.510
G77Z Complex treatment with multi-resistant pathogens for diseases and impairments of the digestive organs	0.760	5	3.798	8	6.076
J77Z Complex treatment with multi-resistant pathogens for diseases and impairments of the skin, subcutaneous tissue and breast	0.750	1	0.750	1	0.750
K25Z Complex treatment with multi-resistant pathogens with OR procedure for endocrine, nutritional and metabolic diseases	0.803	1	0.803	1	0.803
K77Z Complex treatment with multi-resistant pathogens with endocrine, nutritional and metabolic diseases	0.876	1	0.876	0	0.000
L63A infections of the urinary organs with extremely severe CC, with complex treatment for multi-resistant pathogens	0.763	1	0.763	1	0.763
T77Z Complex treatment with multi-resistant pathogens for infectious and parasitic diseases	1.201	5	6.005	4	4.804
Total		21	17.912 (3 quarters)	27	23.158 (1 quarter)

Table 11: Development of DRG high value case numbers.

Time period	Mean LOS	Mean case number per month	Cases in the DRGs E77B, F77Z, G77Z, J77Z, K25Z, K77Z, L63A and T77Z
January 2008 to August 2009	18.5	2.7	48
September 2009 to March 2010	16.0	5.0	35

including establishment of prophylactic isolation for risk patients, ntensified screening measures in the outpatient setting, employee screening, inimisation of antibiotics administration, and improved employee qualification.

Acknowledgements

Our thanks goes out to the infection control specialists in the Clinic Group, who made a substantial contribution to data collection, the administrative staff for making data from the hospital information system available, the employees in the laboratory who substantially contributed to the success of diagnostic procedures, and not to be forgotten, the many nurses on the wards who put our theoretical plans into practice.

Conflict of Interest

The authors declare that there is no conflict of interest as understood by the International Committee of Medical Journal Editors.

References

1. Nationales Referenzzentrum für Surveillance, KISS. Krankenhaus-Infektions-Surveillance-System: Modul MRSA-KISS, Referenzdaten, Berechnungszeitraum 01.01.2007-31.12.2007. 2008.
2. Nationales Referenzzentrum für Surveillance, KISS. Krankenhaus-Infektions-Surveillance-System: Modul MRSA-KISS, Referenzdaten, Berechnungszeitraum 01.01.2008-31.12.2008. 2009.
3. Nationales Referenzzentrum für Surveillance, KISS. Krankenhaus-Infektions-Surveillance-System: Modul MRSA-KISS, Referenzdaten, Berechnungszeitraum 01.01.2009-31.12.2009. 2010.
4. Robert Koch-Institut, Mitteilung der Kommission für Krankenhaushygiene und Infektionsprävention sowie des Robert. Kommentar zu den „Empfehlungen zur Prävention und Kontrolle von MRSA-Stämmen in Krankenhäusern und anderen medizinischen Einrichtungen". Epidemiologisches Bulletin. 2008, Bd. Nr. 42, S. 363–364.
5. Schulz M, Nonnenmacher C., Mutters R. Cost-effectiveness of rapid MRSA screening in surgical patients. Eur J Clin Microbiol Infect Dis. 2009; 28: 1291–1296.
6. Kunori T, Cookson B, Roberts JA, Stone S, Kibbler C. Cost-effectiveness of different MRSA screening methods. J Hosp Infect. 2002; 51(3): 189–200.
7. Batra R., Eziefula A. C., Wyncoll D., Edgeworth J. Throat and rectal swabs may have an important role in MRSA screening of critically ill patients. Intensive Care Med. 2008; 34: 1703–1706.
8. Robert Koch-Insitut. Zum Management des MRSA-Screenings. Epidemiologisches Bulletin. 2005, 42.
9. Reick, Doris. Persönliche Mitteilung. [Hrsg.] Landesgesundheitsamt Baden-Württemberg. 2010.
10. Clancy M, Graepler A, Wilson M, Douglas I, Johnson J, Price CS. Active screening in high-risk units is an effective and cost-avoidant method to reduce the rate of methicillin-resistant *Staphy-*

lococcus aureus infection in the hospital. Infect Control Hosp Epidemiol. 2006; 27(10): 1009–1017.

11. Eveillard M, Lancien E, Barnaud G, Hidri N, Gaba S, Benlolo JA, Joly-Guillou ML. Impact of screening for MRSA carriers at hospital admission on risk-adjusted indicators according to the imported MRSA colonization pressure. J Hosp Infect. 2005; 59(3): 254–258.
12. Harbarth S, Fankhauser C, Schrenzel J, Christenson J, Gervaz P, Bandiera-Clerc C, Renzi G, Vernaz N, Sax H, Pittet D. Universal screening for methicillin-resistant *Staphylococcus aureus* at hospital admission and nosocomial infection in surgical patients. JAMA 2008; 299(10): 1149–1157.
13. Wernitz MH, Swidsinski S, Weist K, Sohr D, Witte W, Franke KP, Roloff D, Rüden H, Veit SK. Effectiveness of a hospital-wide selective screening programme for methicillin-resistant *Staphylococcus aureus* carriers at hospital admission to prevent hospital-acqired MRSA infections. Clin Microbiol Infect. 2005; 11: 457–465.
14. McConeghy KW, Mikolich DJ, Laplante KL. Agents for the Decolonization of Methicillin-Resistant *Staphylococcus aureus*. Pharmacotherapy 2009; 29(3): 263–280.
15. Sandri AM, Dalarosa MG, De Alcântara LR, Da Silva EL, Zavascki AP, Sandri AM, Dalarosa MG, De Alcântara LR, Da Silva EL, Zavascki AP. Reduction in incidence of nosocomial methicillin-resistant *Staphylococcus aureus* (MRSA) infection in an intensive care unit: Role of treatment with mupirocin ointment and chlorhexidine baths for nasal carriers of MRSA. Infect Control Hosp Epidemiol. 2006; 27(2):185–187.
16. Simor AE, Phillips E, McGeer A, Konvalinka A, Loeb M, Devlin HR, Kiss A. Randomized controlled trial of chlorhexidine gluconate for washing, intranasal mupirocin, and rifampin and doxycycline versus no treatment for the eradication of methicillin-resistant *Staphylococcus aureus* colonization. Clinical Infectious Diseases 2007; 44(N2): 127–135.
17. Curran E, Harper P, Loveday H, Gilmour H, Jones S, Benneyan J, Hood J, Pratt R. Results of a multicentre randomised controlled trial of statistical process control charts and structured diagnostic tools to reduce ward-acquired meticillin-resistant *Staphylococcus aureus*: the CHART Project. J Hosp Infect. 2008; 70(2): 127–135.
18. Gastmeier, P. Reduktion nosokomialer Infektionen durch Surveillance: Nationale Referenzdaten durch das Krankenhaus-Infektions-Surveillance-System. 2005; 102(30): A-2098. Deutsches Ärzteblatt 2005; 102(30): A–2098.
19. Keshtgar MR, Khalili A, Coen PG, Carder C, Macrae B, Jeanes A, Folan P, Baker D, Wren M, Wilson AP. Impact of rapid molecular screening for meticillin-resistant *Staphylococcus aureus* in surgical wards. Br J Surg. 2008; 95(3): 381–386.
20. Wernitz MH, Keck S, Swidsinski S, Schulz S, Veit SK. Cost analysis of a hopital-wide selective screening programme for methicillin-resistant *Staphylococcus aureus* (MRSA) carriers in the context of diagnosis related groups (DRG) payment. Clin Microbiol Infect. 2005; 11(6): 466–471.