



CHICAGO JOURNALS



Disinfection of Hospital Laundry Using Ozone: Microbiological Evaluation •

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Source: *Infection Control and Hospital Epidemiology*, Vol. 21, No. 4 (April 2000), p. 248

Published by: [The University of Chicago Press](#) on behalf of [The Society for Healthcare Epidemiology of America](#)

Stable URL: <http://www.jstor.org/stable/10.1086/503216>

Accessed: 20/01/2014 13:19

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Letters to the Editor

Survival of *Acinetobacter* on Three Clinically Related Inanimate Surfaces

To the Editor:

Acinetobacter species are increasingly recognized as nosocomial pathogens that cause outbreaks, especially in the intensive care unit (ICU). Survival of these bacteria on the skin and persistence in the hospital environment are believed to be important factors in the development and continuation of outbreaks. In Nottingham, we have experienced outbreaks in our adult ICU, and, during the most recent, patient and environmental isolates were indistinguishable.¹ This therefore prompted us to determine whether a local outbreak strain was capable of surviving for prolonged periods on commonly used clinical surfaces.

An enamel-coated drip stand and two horizontal surfaces, a Formica shelf and a stainless steel treatment trolley, were first decontaminated with a 2% (vol/vol) phenolic disinfectant (Hycolin, Adams Healthcare, Leeds, UK) and then rinsed with sterile water before sampling to confirm the absence of other bacteria. *Staphylococcus aureus* National Collection of Type Cultures (NCTC) 6571, *Pseudomonas aeruginosa* NCTC 10662, *Acinetobacter baumannii* isolated during the most recent outbreak,¹ and *Acinetobacter* species were assessed for their ability to survive drying. The *Acinetobacter* species was identified by tDNA fingerprinting² but did not match any of the 17 defined genospecies (having 50% similarity with *Acinetobacter johnsonii*) and therefore is referred to as *Acinetobacter* species throughout. Following contamination of Formica shelving with a range of inocula, an inoculum of 10⁶/mL was chosen for all subsequent experiments. This inoculum facilitated the assessment of contamination and, based on isolation rates from the skin of infected patients, probably also reflects the level of surface contamination that occurs during outbreaks. Individual areas of the Formica shelves and the stainless steel surface were each inoculated with 0.25/mL of an overnight broth diluted to 10⁶ organisms per mL and spread

over 8 cm² with a sterile glass spreader. The enamel-coated drip stand was similarly inoculated, but with a sterile sponge to ensure an even spread. Experiments were carried out at ambient temperature and humidity in a non-artificially ventilated room, ie, 20° to 22°C and 60% to 70% humidity. Sampling was carried out daily, in triplicate from individual areas, with contact plates containing cystine lactose electrolyte-deficient (CLED) agar. The entire process was repeated three times. The drip stand was sampled with a swab moistened in sterile saline and inoculated on to CLED agar at similar intervals. All plates were incubated in air at 30°C (*A baumannii* and *Acinetobacter* species) or 37°C (*S aureus* and *P aeruginosa*) for 48 hours. The number of colonies observed on the Formica shelving and treatment trolley was counted, and, for the drip stand, growth was assessed as either present or absent.

A baumannii and *S aureus* persisted for mean durations of 11 and 9 days on the Formica shelf, 12 and 10 days on the stainless steel trolley, and 6 and 3 days, respectively, on the drip stand. *Acinetobacter* species and *P aeruginosa* survived for 6 and 4 days on the Formica shelf, 6 and 5 days on the stainless steel trolley, and 3 and 1 days, respectively, on the drip stand. The number of colonies ranged from over 200 to 1 per plate, and the number usually decreased with time.

These results confirm that a local strain of *Acinetobacter* species may persist on common clinical surfaces for relatively long periods compared with other bacteria, and this may partly explain our recent finding that a Nottingham outbreak strain of *A baumannii*, recovered during 1985 to 1986 and 1992 to 1993, continues to be isolated from both patients and the environment.³ Further experiments are required, however, to determine whether other nosocomial isolates of *A baumannii* behave in a manner similar to this local strain.

Wendt and colleagues have demonstrated that survival of *Acinetobacter* species in the environment is significantly associated with the strain and its source, with strains

recovered from dry sources or during outbreaks surviving for longer periods.⁴ We only compared one local isolate with other nosocomial pathogens, *S aureus* and *P aeruginosa*, and experiments involving a larger number of *A baumannii* strains suspended in a variety of other media are required to confirm this. We were mainly interested in determining whether the bacteria were present or not, but low numbers, which might not have been detected by our method, are probably less significant in the continuation of an outbreak. At the molecular level, mechanisms may have evolved to protect certain species from desiccation. For example, *Acinetobacter radioresistens* is a species with high radiation resistance that can persist in the environment for prolonged periods; mutant strains that lack the ability to repair DNA are sensitive to the lethal effects of both types of stress.⁵ Continued vigilance of adaptable bacteria, such as *Acinetobacter*, and effective cleaning regimens remain of paramount importance in controlling and preventing outbreaks.

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The authors acknowledge the support of the Trent Regional Health Authority during the conduct of this work.

Concise Communications

Evidence of Delays in Transferring Patients With Methicillin-Resistant *Staphylococcus aureus* or Vancomycin-Resistant *Enterococcus* to Long-Term-Care Facilities

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ABSTRACT

This retrospective case-control study examined whether there was a difference in length of time awaiting long-term-care placement for patients identified as having methicillin-resistant *Staphylococcus aureus* or vancomycin-resistant *Enterococcus* compared to controls. Thirty-nine patients with methicillin-resistant *Staphylococcus aureus* or vancomycin-resistant *Enterococcus* waited for placement an average of 61 days longer than controls ($P < .0002$). The average number of requests for placement was 2.5 compared to 1.7 for controls ($P = .015$) (*Infect Control Hosp Epidemiol* 2000;21:270-271).

In response to the continued rise in cases of antibiotic-resistant organisms (AROs), infection control measures have been proposed for acute-care and long-term-care facilities (LTCFs).¹⁻⁴ In the latter case, the need for infection control is balanced with the promotion of a healthy lifestyle for the resident, and the presence of methicillin-resistant *Staphylococcus aureus* (MRSA) or vancomycin-resistant *Enterococcus* (VRE) is not considered a reason to deny admission to an LTCF. Despite these recommendations, it has been the impression of infection control practitioners and social workers in our institution that patients with a designation of MRSA or VRE are more difficult to place in an LTCF. The objective of this study was to determine whether this perception was true, ie, to document whether there was any difference in time to place patients identified as having an ARO compared to controls.

METHODS

This was a retrospective 3-year case-control study to determine whether there was a difference in time to place patients identified as having MRSA or VRE in LTCFs compared to controls without an ARO. Cases were defined as patients identified with MRSA or VRE from at least one clinical specimen and awaiting placement to an LTCF or placed on the alternate level of care (ALC) list. Cases were closely matched to controls on a 1:1 ratio by means of a stepwise procedure, as described below, to ensure the best match. Cases were obtained by cross-referencing the Infection

Control Department's MRSA and VRE databases with the hospital information system's ALC list and the Social Work Department's discharge planning records. For each case, a list of potential controls was generated using the Social Work discharge planning records and the ALC list. From this list, a researcher independent of our institution chose controls for each case using the following criteria in the specified order: (1) level of care (ie, activities of daily living) at the time of ALC designation, (2) ward where first assessed, (3) date of Social Work assessment or placement on the ALC list (within 6 months), (4) gender, and (5) age. Wherever possible, comparable diagnoses at time of assessment were obtained between cases and controls. Charts and Social Work discharge planning records were reviewed for number of requested placements, reasons for placement denial, total days ALC, total time awaiting placement, and patient outcome.

In addition to the matched case-control group, the mean number of ALC days for MRSA and VRE patients was compared on a yearly basis to that of the general hospital population. The Ministry of Health definition of ALC was used: "an ALC patient is a patient who is finished with acute care. This patient is usually awaiting placement in a mental health facility, rehabilitation facility, intermediate or extended care institution, discharge home, home support or ambulatory program. If these services were available, the patient would be immediately discharged. ALC is not intended to be used for patients who require transfer from one acute service to another acute service."

Variables were analyzed using the paired Student's *t* test for analysis of matched samples. A $P < .05$ on two-tailed testing was considered significant.

RESULTS

There were 440 cases of MRSA and 13 cases of VRE identified from January 1996 to December 31, 1998 (291 in 1998, 99 in 1997, and 63 in 1996). Ninety patients were identified from the cross-referenced databases as potentially requiring placement, and of these, 56 cases were found on initial chart review. Patients who left the hospital to wait for LTCF admission from the community were eliminated from the study because of lack of placement information. The 39 cases who remained as inpatients until placed in an LTCF were paired with controls and entered into the study.

All of the cases were matched to controls by level of care, ward when first assessed, date of assessment within 6 months, and gender. For 18 case-control pairs, the age difference was greater than 10 years; however, the mean age of cases was 74 years compared to 73 years for the controls. The average number of ALC days prior to placement was

130.4 for cases and 68.7 for controls ($P < .0002$). Patients with an ARO had an average of 2.5 requests for placement compared to 1.7 for controls ($P = .015$). Five cases and two controls died while awaiting placement ($P = .4$).

Justifications for denying placement were uncommon; however, the following reasons for refusing transfer of cases were documented: lack of resources to manage MRSA patients, staff not educated on caring for patients with AROs, inability to isolate patients, absence of policies on AROs, and institutional policies that prevented accepting transfer of patients with AROs.

DISCUSSION

The difference in the average days as an ALC patient was striking (130 vs 69) but in fact may have been underestimated. We were unable to analyze at least 17 patients with MRSA or VRE who had returned to the community to await placement. The personal experience of the infection control nurses and social workers was that many of these patients had become discouraged at the difficulty in placement while in hospital and elected to wait for admission to an LTCF from the community. Similarly, the number of denied requests was likely underestimated, particularly in the last 18 months. Social workers had begun automatically excluding certain institutions known to deny patients with ARO admission, rather than negotiating a difficult placement.

It is possible that patients colonized with AROs were sicker than controls, contributing to their longer time to placement. However, controls had a higher mean number of ALC days compared to other patients on the hospital ALC list, suggesting that they were sicker than noncontrol ALC patients. The potential for bias was further reduced by matching cases and controls by diagnosis 54% of the time.

The difference in time to place cases and controls was 61 days. Specific case costing is not yet available at our institution, and calculation of cost is subject to many assumptions. However, using the hospital mean daily cost per acute patient, the cost of the additional stay for ALC cases in our institution was \$2,076,867 over the 3-year period (61 additional days \times 39 cases \times \$873 [Ministry of Health per diem for an acute-care bed in Canadian dollars]). If the difference in cost between an acute-care and an LTCF bed is considered, the overall cost to the healthcare system for this institution's experience alone was approximately \$1,703,364 ($\$2,076,867 - [61 \times 39 \times \$157/\text{d}$ for an LTCF bed]) for the intervening interval. This does not take into account the 2,379 lost acute-care days and inability to accept acutely ill patients in transfer, nor the effect on patient morale and morbidity while awaiting placement. This study did not document whether the patient's level of care deteriorated while awaiting placement; however, personal experience was that relative immobility and restricted social interaction hampered the recovery of some of the patients during their acute-care stay.

Issues of placing patients with AROs into LTCFs may vary depending on factors such as bed availability, the tolerance for colonized patients, educational resources, and the level of medical sophistication. However, the significant

difference in time to place case- and control-patients demonstrated that, at least within our region, a gulf existed between policy and practice. We hope that documentation of the difficulty in patient placement will foster communication and cooperation among healthcare providers in the transfer of patients between facilities and result in more comprehensive patient-care plans for those with AROs.

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Disinfection of Hospital Laundry Using Ozone: Microbiological Evaluation

To the Editor:

We investigated a hospital laundry system that uses ozone gas as a disinfection agent. Ozone is a powerful oxidizing agent that has been used as a chemical disinfectant for water treatment in Europe since 1893.^{1,2} The use of ozone has increased in medicine lately due to the number of microorganisms resistant to chlorine.³

The process used for washing highly contaminated hospital linen can be summarized as follows: (1) execution of one washing cycle with conventional chemical products (humidification and pre-wash), (2) one washing cycle with ozone (4 mg/L) for 15 minutes, and (3) a softening cycle. Water samples were collected using sterile 20-mL syringes. Pre-wash samples were taken after 2 minutes of agitation without any additives. Post-wash samples were collected similarly, following the final cycle with ozonized water. The samples were evaluated for the most probable number of total coliforms and *Escherichia coli* using the chromogenic defined substrate test method (Colilert; Idexx Laboratories, Westbrook, ME).

The most probable numbers (\pm SD) per 100 mL of *E coli* and of total coliforms were $1.3 \pm 0.3 \times 10^4$ and $3.74 \pm 1.8 \times 10^5$ pre-wash, and were

reduced to 0.1 ± 0.1 and 1.24 ± 1.13 , respectively, post-wash (each $P < .0001$). Thus, despite intense contamination of the rinsing water, ozone at 4 mg/L proved able to control the tested microorganisms.

Some studies have shown that many species, ie, *E coli*, *Streptococcus*, and *Bacillus*, can be inactivated by 30 seconds of exposure to an aqueous solution of ozone (0.2 mg/L).⁴

In the current study, we demonstrated that ozone used in a laundry processing system reduced by five logs the total number of coliforms and *E coli* present in hospital laundry rinsing water. However, comparative studies testing different conventional disinfectant agents are still necessary to establish the efficacy of ozone as a laundry disinfectant agent.

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The authors thank Mr. Nascimento for the technical support; UNIFENAS, White Martins Gases Inds. (Praxair, Inc), for the technical and financial support; and Lavanderia Chancellor for technical assistance.

concludes that "... current evidence is providing a new perspective on the myth that its effect is decisive."¹ In obtaining that conclusion, Dr. Rello cites the publication of Dr. Lilia Soufir et al, in the same issue, regarding catheter-related bloodstream infection.² These articles are good pieces of evidence-based medicine, but I think Dr. Rello missed two points: (1) the impact of catheter-related bloodstream infection is debated, and thus this is a bad example to apply to other nosocomial infections; and (2) not every bacteremia is the same.

It is true that most reported bloodstream infections have been traced to catheter contamination; but, those are the reports from institutions that publish their results, which usually have research units and good nursing standards. Most reports of bacteremia from developing countries involve mainly *Klebsiella* and *Enterobacter*, organisms related to more extrinsic infusion contamination than to catheter contamination,³ as they are able to grow in parenteral fluids at room temperature. An endemic level of parenteral infusion contamination could exist in many hospitals throughout the world, because high-volume fluid bottles are being used to load burettes of different patients, bottles are left at room temperature for later use after initial manipulation, disposable syringes are used to inject different administrations sets, and vials of drugs designed to be used once are being used for multiple dosing. Some of these lapses in aseptic techniques could exist also for the growing number of patients receiving infusion therapy at home in developed countries.⁴

In our experience culturing in-use infusion fluids in Mexico, extrinsic contamination is common in many hospitals.^{5,6} Because of bias toward accepting publications from research-oriented hospitals, this type of problem has received little attention, and an immense international problem could be underestimated. *Klebsiella* and *Enterobacter* bacteremia is a disease of bigger impact on morbidity and mortality, particularly in neonatal units.

Thus, I consider that it is too soon to conclude that the study of the impact of bloodstream infection belongs in the field of mythology. We have observed a dramatic fall in mortality in a hospital after controlling infusate contamination, but have not made a comparative study.⁶ In this process of considering any defendant

Impact of Nosocomial Infections on Outcome: Myths and Evidence

To the Editor:

In the editorial of the June 1999 issue (1999;20:392-394) of *Infection Control and Hospital Epidemiology*, regarding the impact of nosocomial infections on outcome, Dr. Jordi Rello

not guilty until proven the opposite beyond statistical significance, it is very dangerous to release on probation suspects of serial killing.

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The author replies.

I agree with Macías that my editorial is just a piece in the complex puzzle of understanding the contribution of nosocomial infections (NIs) to outcome. The impact of NIs on outcome has been classically overemphasized by inappropriate estimations of attributable mortality, basically due to a failure to adjust for severity of illness, and this has contributed to the fact that this myth has flown too high. My current belief is that survival in patients with NIs depends above all on the degree of severity at the moment of the diagnosis.^{1,2} In our experience,³ most device-related infections are usually caused by pathogens involved in endogenous episodes, and this is a benign process with no significant excess of mortality, if appropriate antibiotic treatment is provided early.

In spite of this, I agree that pathogens acquired exogenously appear to have a poorer prognosis.

This trend was well documented in a study⁴ reporting that mortality directly related to pneumonia caused by *Staphylococcus aureus* was 20 times greater in methicillin-resistant episodes than in cases of pneumonia caused by methicillin-sensitive strains. What we have learned, and what this author's own experience^{5,6} confirms, is that the epidemiological pattern of exogenous organisms may vary from hospital to hospital, and control measures or therapeutic approaches should be customized to each institution.

In the field of ventilator-associated pneumonia, our group has demonstrated that effective drainage of subglottic secretions⁷ and periodic monitoring of the intracuff pressure⁸ are inexpensive and effective measures in preventing primary endogenous pneumonia. As expected, these measures reduced the period of intubation, but did not modify the ICU survival rate.⁷ In contrast, presence of secondary endogenous or exogenous pathogens will be associated with significant excess mortality,^{2,9} and I anticipate that these measures will become ineffective.

All of these pieces of the puzzle are partially recognized but are extremely important in addressing key messages regarding therapy and prevention. Careful handling of the artificial devices (intravenous catheters, intratracheal tubes) is extremely important in preventing NI. The current evidence, however, suggests that these measures should be customized to each institution, as is the case for empirical therapy for nosocomial infections.⁶ In the presence of appropriate infection control measures, mortality is not significantly increased, but the reduction in the rate of endogenous infections by specific interventions will contribute to reducing the economic burden associated with these infections. In contrast, in the presence of exogenous pathogens, the approach should be different and should be targeted to antimicrobial-control programs and increasing handwashing compliance.

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Reasons That Healthcare Workers Decline Influenza Vaccination in a New Zealand Hospital Environment

To the Editor:

The Centers for Disease Control and Prevention currently recommends that healthcare workers (HCWs) be vaccinated against influenza each year.¹ This policy seems to be focused on keeping hospitals operational in the event of a severe influenza epidemic and on preventing transmission to at-risk patients, rather than as a protective mechanism for HCWs (who neither fit into the usual high-risk groups nor show evidence of a greater risk of complications).

Auckland Healthcare has operated influenza vaccination programs for some years. Uptake generally has been poor despite extensive advertising, visiting immunization nurses, drop-in immunization clinics, and a no-charge program.

The occupational groupings of those vaccinated were identified, and nonvaccinated HCWs were identified from payroll lists. Of staff who

TABLE
REASONS FOR NOT ACCEPTING VACCINATION OFFERED BY STAFF

Group	Reasons for Not Accepting Vaccination						
	Un- aware of Cam- paign	Times Not Con- venient	Do Not Believe in Vaccina- tions	Do Not Believed Had Else- where	Not in Recom- mended Groups	Un- well at Time	Advised Not to by Their Doctor
Doctors (21)	4	4	2	2	8	1	0
Nurses (114)	2	7	63	3	33	1	5
Laboratory or clinical (58)	0	4	24	2	22	2	4
Clerical or managerial (95)	3	3	41	4	36	7	1
Totals	9 (3%)	18 (6%)	130 (45%)	11 (4%)	99 (34%)	11 (4%)	10 (3.5%)

had not had the vaccination, 700 were selected randomly and (anonymously) surveyed in June 1998 as to their reasons for not accepting vaccination.

Of eligible staff, 22% (1,554) received the vaccination. Nurses had the lowest uptake (402, or 15% of nurses), and nonclinical staff the highest (172 or 41%).

From the 700 nonrecipient staff surveyed as to their reasons for not accepting vaccination, 323 replies were received, of which 288 (41% of the nonvaccinated sample) were valid. The reasons for not being vaccinated are shown in the Table.

Good evidence exists as to the efficacy,^{2,3} safety, and cost-effectiveness^{3,4} of an influenza vaccination program. Heimberger et al⁵ identified previous influenza vaccination and knowledge that the vaccination does not cause influenza as a positive predictor of immunization, but noted less success among medical personnel. At Auckland Healthcare, 45% of responding HCWs cited not believing in vaccinations, and 34% cited not belonging to one of the recommended groups as their reason for not accepting influenza vaccination. There appeared to be an inverse relation between the degree of medical education and the acceptance of this vaccination. As a generalization, medical personnel did not lead by example.

Uptake at Auckland Healthcare can probably be further improved by a prolonged staff education program as to the reasons for vaccination and the appropriateness for their work group and by targeting communal areas where clinical HCWs congregate and service units with the high-risk patients. In addition, it may be appropriate to exclude (or make no

particular marketing effort toward) nonclinical staff.

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Once MRSA, Always MRSA? Setting up a Hospital Preadmission Questionnaire

To the Editor:

A gynecological carcinoma patient who previously had been vaginally colonized with a methicillin-resistant *Staphylococcus aureus* (MRSA) in another hospital was subsequently declared free of MRSA carriage. She later came to our hospital and had to be admitted to the intensive care unit (ICU) due to a respiratory infection, where MRSA of the original phage type reappeared at the same site. Worse still, an outbreak on the ICU followed, involving 14 patients.

A previous history of MRSA has to be considered as a risk factor for unexpected hidden carriage as long as the original disease has not been cured; hence, the adage "Once MRSA, always MRSA?" To prevent a repetition of this episode, a questionnaire was introduced for all newly admitted patients to detect past or present MRSA carriage or possible risk factors, such as an earlier stay in a foreign hospital. Three questions and one suggestion are put to the patient by the attending physician via a flow-sheet (Figure).

In the Dutch opinion, all foreign hospitals are considered suspected for harboring MRSA. In accord with national guidelines, MRSA-colonized patients in Dutch hospitals are always put in strict isolation. Depending on the level of suspicion derived from the MRSA history, more or less strict preventive control measures, including nursing in isolation, are taken at admission.¹ Most answers lead, fortunately, to the result that no special hygienic precautions are required on admission. For all patients, except those admitted via the emergency

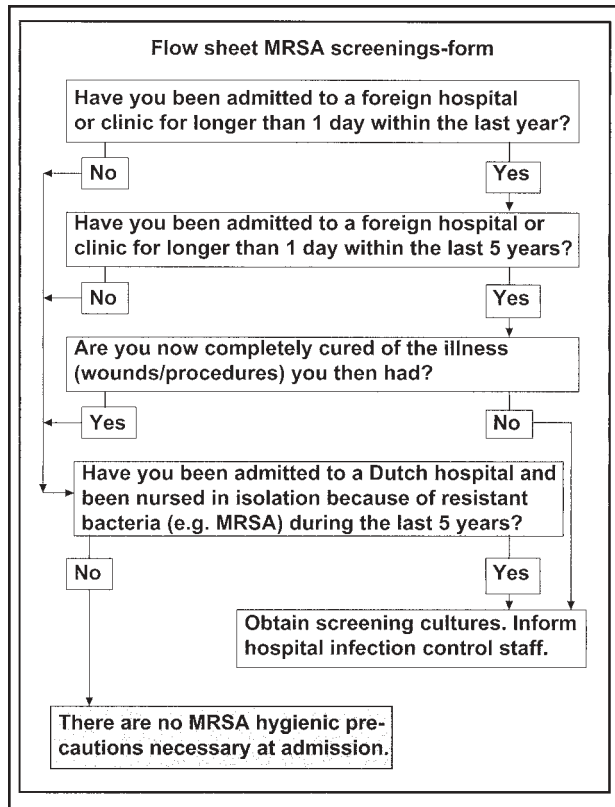


FIGURE. Structure of the MRSA flow sheet, to be processed by the attending physician (with name of physician, specialty, department, and date). Abbreviation: MRSA, methicillin-resistant *Staphylococcus aureus*.

department (nearly 50%), sufficient time is available to obtain screening culture results, which are performed with an additional enrichment broth as previously described.²

As compliance with this formula is not complete for every medical specialty, and the ICU is particularly vulnerable to further spread of MRSA, an extra administrative control by the nursing staff on the content of the questionnaire is performed when the patient is actually admitted and when transfer of a patient from a ward to the ICU is indicated. After a reminder letter, the average compliance rose from 50% to more than 75%, but we are aiming for a higher percentage, as

reached by the emergency department, with nearly 100% of forms correctly processed.

In the past year, 191 of 30,283 admitted patients were recognized as having risk factors, and these patients had cultures for the presence of MRSA. No MRSA was found. Due to emergency admission or absent screening forms, 84 patients were isolated preventively; all were MRSA-negative. In contrast, 2 patients, not subjected to the questionnaire and subsequently admitted on surgical wards, were found colonized with MRSA and became involved in (rapidly contained) MRSA outbreaks. As the additional costs of two outbreaks

in the past were estimated as \$150,000 (US), we think that an investment as described here is certainly cost-effective.

European healthcare insurers tend more and more to allow their patients to seek elective treatment in foreign hospitals. As our large, regional, 800-bed teaching hospital is situated in the border region with Belgium and Germany (~15 km from Aachen) a frontline situation has been created for us in this way.^{3,4} Such questionnaires may become of increasing importance to prevent the unexpected introduction of MRSA into the Dutch hospitals, but still better is the prevention of such an outbreak of MRSA on European scale. Not only local or national solutions¹ will suffice in a united Europe; international guidance should be considered as a task for European Union healthcare policy institutions.⁵

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