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Paradoxical Increase in Methicillin-Resistant *Staphylococcus aureus* Acquisition Rates Despite Barrier Precautions and Increased Hand Washing Compliance during an Outbreak of Severe Acute Repiratory Syndrome

SIR—We read with interest the report by Yap et al. [1] regarding the increased rates of methicillin-resistant *Staphylococcus aureus* (MRSA) isolation in the intensive care unit (ICU) during an outbreak of severe acute respiratory syndrome (SARS) in Hong Kong. The SARS outbreak in Singapore, which lasted from 4 March 2003 to 11 May 2003, also led to the adoption of heightened infection-control measures, including mandatory universal use of personal protective equipment (PPE) consisting of disposable long-sleeved gowns, gloves, goggles, and N95 masks by health care workers for all patient contacts. Compulsory training on the proper donning and discarding of PPE was instituted, and compliance with hand washing was reinforced. Observers were employed to ensure that these measures were followed by the ward staff. In addition, all patients with undifferentiated fever were nursed in single isolation rooms until the cause of their fever was ascertained. Whereas the data reported by Yap et al. [1] was confined to the ICU, we studied the effect of these measures on hospital-wide nosocomial MRSA infection and bacteremia rates in the National University Hospital, a 1000-bed teaching facility in Singapore.

MRSA bacteremia and infection rates were determined by surveillance of nonduplicative isolates identified in the microbiology laboratory from January 2003 through December 2003 (figure 1). Hand washing compliance was determined by trained observers in 2 surveys involving a total of 1004 subjects; the first survey, involving 829 subjects, was done in February 2003 (before the SARS outbreak), and the second survey, involving 175 subjects, was done in June 2003 (after the SARS outbreak). The overall rate of compliance with hand washing increased from 33.4% in February 2003 to 87.4% in June 2003 ($P = .01$). However, we too were unable to detect a corresponding decrease in MRSA infection rates (figure 1). Paradoxically, increases in the rates of MRSA infection and possibly MRSA bacteremia were observed, despite the use of intense infection-control measures during the epidemic period.

Like the findings reported by Yap et al. [1], our findings seem to suggest that the universal use of gloves and gowns did not produce the expected decrease in the rate of nosocomial cross-infection [2, 3]. Although protective to health care workers, inanimate objects (such as gloves and gowns) have been implicated as reservoirs of MRSA [4, 5]. In addition, although we were able to document a marked improvement in hand hygiene compliance, we were unable to show expected reductions in the rate of nosocomial infection [6, 7]. We suspect that despite—or perhaps because of—the increased emphasis on hand hygiene, compliance with glove change between patient contacts was reduced, and

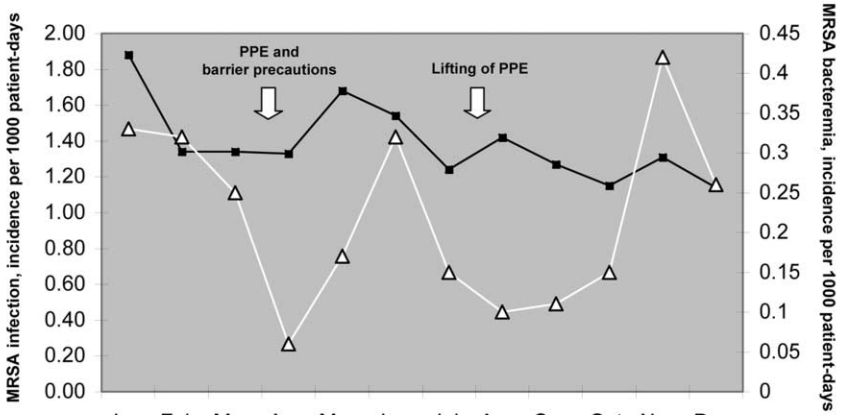

Figure 1. Methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia and infection rates, 2003. PPE, personal protective equipment.

this may have led to increased transmission of multidrug-resistant nosocomial pathogens on the gloved hands of health care workers [5]. Another possible explanation for the paradoxical increase in MRSA rates during the SARS outbreak could be the shunting of limited infection-control resources to SARS case surveillance and epidemiology and away from mainstream infection-control activities, thus compromising the effectiveness of baseline control measures against nosocomial infections.

As our data reinforce, during periods of intense alert for novel emerging pathogens, such as SARS coronavirus and avian influenza virus, it is imperative that "conventional" practices of infection control not be overlooked, because they remain essential for the control of infection with endemic nosocomial pathogens in our midst.

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Outbreak of Methicillin-Resistant *Staphylococcus aureus* Infection Associated with an Outbreak of Severe Acute Respiratory Syndrome

Sir—We read with great interest the recent article by Yap et al. [1]. The authors report a significant increase in the methicillin-resistant *Staphylococcus aureus* (MRSA) acquisition rate, with a very high rate of ventilator-associated pneumonia—caused mainly by MRSA—in patients with severe acute respiratory syndrome (SARS) in an intensive care unit (ICU) that admitted only patients with SARS. Paradoxically, this increase occurred after infection-control measures (including the wearing of gloves and gowns at all times) were upgraded because of the SARS outbreak and despite a low importation rate of MRSA into the ICU.

Yap et al. [1] provide 3 possible explanations for this observation. First, the practice of wearing gloves at all times may have led to poor compliance with hand hygiene, and the routine wearing of long-sleeved gowns, which were not changed between contact with patients, could also have contributed to cross-transmission of MRSA. Second, the heavy use of antimicrobials active against gram-negative organisms could have promoted the overgrowth of MRSA. Third, the SARS-associated coronavirus (SARS-CoV) may predispose patients to secondary infection with *S. aureus.*

We agree with these hypotheses, but we disagree with the conclusion that "cross-transmission of MRSA may be increased … if the [infection-control] measures included excessive use of gloves and gowns" [1, p. 515]. An alternative explanation for the significant increase in the rate of MRSA acquisition may be a viral-bacterial interaction between SARS-CoV and *S. aureus,* leading to an explosive airborne dispersal of *S. aureus* and a very efficient transmission of MRSA from colonized to noncolonized patients (the "cloud phenomenon"). This phenomenon was described by Eichenwald et al. [2], who showed that newborn infants who are nasally colonized with *S. aureus* produce significant airborne *S. aureus* dispersal and become highly contagious after infection with a respiratory virus. These babies caused explosive outbreaks of *S. aureus* infection in nurseries. Because they were literally surrounded by clouds of bacteria, they were called "cloud babies" [2]. We have recently shown that the same mechanism also occurs in certain adult nasal *S. aureus* carriers ("cloud adults") [3–5]. Reports in the literature describe single health care workers nasally colonized with *S. aureus* who originated nosocomial *S. aureus* epidemics while experiencing a viral infection of the upper respiratory tract. This confirms that "cloud adults" can cause outbreaks [3, 6, 7]. Our data also indicate that clothing contaminated with *S. aureus* can amplify the dispersal of these bacteria into the air [4, 5], in agreement with previous observations [8, 9].

In conclusion, aerial dissemination of MRSA because of the "cloud phenomenon" may be the main reason for the described epidemic of MRSA infection. This may have occurred as a result of direct aerial dissemination or as a result of heavy contamination of the environment of colonized patients (including contamination of patient bedclothes or health care worker gowns). This, in combination with difficulties associated with frequently changing gloves and gowns, may have greatly facilitated MRSA cross-infection during the SARS outbreak.

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Reply to Bassetti et al.

Sir—We appreciate the comments on our article [1] by Bassetti et al. [2]. We agree that the fourth hypothesis, relating to the "cloud" phenomenon [3–5], may contribute to the spread of methicillin-resistant *Staphylococcus aureus* (MRSA).

However, we do not think that the cloud phenomenon is the main reason for the MRSA epidemic we describe [1]. During the study period, all staff in the intensive care unit (ICU) wore N95 masks. Because masks are effective in reducing the dispersal of MRSA [5], "cloud" health care workers would be an unlikely explanation for the epidemic. For patients who carry *S. aureus* in the nares, it appears that active breathing, sneezing, nose blowing, or snorting to the open air are important in the formation of airborne bacterial "clouds." We would like to point out that it is unlikely that our patients performed these activities to a significant extent. Unlike in patients with rhinovirus infection, nasal symptoms are rare in patients with severe acute respiratory syndrome. Furthermore, precautions to control aerosol spread in the ICU were extremely strict during the period of the SARS outbreak. The majority of patients received mechanical ventilation. All circuit connection and disconnection procedures were performed with extreme caution, and all suctioning was conducted in closed-suction systems. A high-efficiency bacterial/viral filter was incorporated into each breathing circuit, and the exhalation port of the ventilator was connected to scavenging systems. Surgical masks were worn by spontaneously breathing patients with nasal cannula or oxygen masks. For patients requiring high-flow oxygen, tight-fitting masks with filters were used. Use of Venturi-type masks, nebulization, and noninvasive positive-pressure ventilation were all avoided. Therefore, "explosive" dispersal of droplets or aerosols would have been unlikely.

During the outbreak of SARS, there was a hospital (Queen Mary Hospital; Pokfulam, Hong Kong) that explicitly banned "gloving all the time" and instead promoted glove use "only when indicated" and meticulous hand washing. This hospital managed a total of 52 cases of SARS, which is a substantially lower number of cases than were treated at our institution (Prince of Wales Hospital, Hong Kong). There was no change in the rate of MRSA acquisition in the ICU or in the hospital in general (W. H. Seto, personal communication).

In a health care environment, patient contact is the main mode of transmission for MRSA. During the period we reported, gloves were worn at all times by health care workers, and hands were not necessarily always washed between the changing of gloves [1]. These practices—together with the excessive use of antibiotics, including fluoroquinolones—may be the main driving factors underlying the outbreak of MRSA infection. After removal of gloves, hands are commonly contaminated with nosocomial pathogens such as MRSA, with contamination rates of up to 50% [6]. Occult breaks in latex gloves can cause substantial contamination of the hands [7], and it has been reported that 20% of latex gloves that had passed the watertight test allowed penetration of bacteria to the hands [8].

The "cloud" phenomenon is an interesting subject, and its relevance in the nosocomial transmission of pathogens deserves further evaluation. Health care workers should understand that wearing of gloves is not a substitute for hand washing.

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Strongyloides stercoralis Infection as a Manifestation of Immune Restoration Syndrome?

Sir—Kim and Lupatkin [1] describe a patient with fever, eosinophilia, hepatitis, and *Strongyloides stercoralis* larvae in stool, as revealed by microscopy. These clinical features developed after diagnosis of HIV-1 infection and commencement of HAART and are attributed by the authors to immune restoration. Empirical therapy for cerebral toxoplasmosis was also initiated with pyrimethamine and sulfadiazine, as was therapy with dexamethasone. The patient's condition responded to standard therapy with ivermectin.

A more likely explanation for this case is that the patient experienced an exacerbation of subclinical *S. stercoralis* infection following the institution of high-dose corticosteroid therapy. Corticosteroid therapy has long been recognized as the major risk factor for development of severe disease and disseminated strongyloidiasis in people with asymptomatic carriage of *S. stercoralis* [2, 3]. Furthermore, it has been noted that it is rare to develop disseminated strongyloidiasis in the absence of corticosteroid therapy. Although it was initially hypothesized that the immunosuppression secondary to HIV infection would result in an increased incidence of disseminated strongyloidiasis, such a rise in incidence has not been observed. For example, a general lack of correlation between HIV infection and strongyloides hyperinfection has been observed in regions where both are endemic, such as sub-Saharan Africa and Brazil [4]. We, therefore, suggest that the case presented may merely reflect *S. stercoralis* carriage progressing to clinical disease following the use of dexamethasone.

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Tropical Pulmonary Eosinophilia

Sir—In a recent article, Boggild et al. [1] tackled the problem of imported cases of tropical pulmonary eosinophilia (TPE). However, the diagnostic procedure that was used raised some concerns about the accuracy of the filarial etiology of the reported syndrome. TPE, as underlined by Boggild et al. [1], is characterized by pulmonary infiltrates and blood eosinophilia. This clinical picture can have various noninfectious or infectious etiologies; among the helminthiases, these include ancylostomiasis, strongyloidiasis, and visceral larva migrans (a major form of toxocariasis), which have been recognized as parasitic etiologies of pulmonary eosinophilia [2, 3]. Toxocariasis, a helminthozoonosis found worldwide, appears to be an especially common cause of pneumonitis with eosinophil infiltrates; 9 of 57 Argentine pediatric patients displayed this symptom [4].

How helminthiases other than bancroftian filariasis were ruled out was not reported by Boggild et al. [1]. Moreover, the diagnosis of filarial TPE was dependent on the results of an ELISA, the exact procedure of which was not described. ELISA that uses extracts of heterologous filaria worms is known to cross-react with serum samples from other roundworm diseases [5], but the use of recombinant antigens could resolve this problem [6]. Given these facts, we were surprised that Boggild et al. [1] did not test for circulating filarial antigens to ascertain the bancroftian origin of their TPE cases. Since its first use in the field by the middle of the 1990s [7], detection of the so-called Og4C3 antigen, by either immunochromatography ("card test") or ELISA, has proven to be a specific and sensitive method for the immunodiagnosis of *Wuchereria bancrofti* infections [8]. It is currently considered a major tool for the control of lymphatic filariasis [9]. We recognize that this test is unable to detect *Brugia malayi* infections, but none of the patients included in the study by Boggild

et al. [1] was from an area where *Brugia* lymphatic filariasis is endemic. Since the end of 2001, we have routinely used the commercial ELISA version of the Og4C3 assay (Tropbio). Of the patients attending the consultation unit of our hospital who were immigrants from or residents of a tropical area, 165 were tested by ELISA (Bordier Affinity Products) for the presence of filarial antibodies and Og4C3, on the basis of the presence of clinical signs consistent with a filarial infection (bancroftiasis, loiasis, or onchocerciasis), and/or blood eosinophilia. Of 17 patients who had significant filarial ELISA results (optical density of $\geqslant$.900), 1 patient was found to be infected with hookworm, 5 had strongyloidiasis, and 2 probably had toxocariasis. None of the cross-reacting serum samples from these patients had detectable Og4C3 antigen.

Therefore, the possibility of bancroftian filariasis in patients 2, 8, 9, 13, and 15 from the study by Boggild et al. [1], who had a moderate level of antifilarial antibodies, appears to be questionable. The efficacy of diethylcarbamazine therapy cannot be considered circumstantial evidence of filarial infection, because this drug was found to be effective for treatment of toxocariasis [10].

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Impact of Recommendations by Clinical Microbiologists on Antimicrobial Treatment in the Intensive Care Units of a Dublin Teaching Hospital

Sir—We read with interest the article by Lo et al. [1] regarding adherence to recommendations made during infectious diseases (ID) consultations. The data, which were from a prospective cohort study of 465 consultations at 2 large tertiary care centers, revealed an overall rate of compliance to recommendations of 80%. Compliance was higher when recommendations involved therapy, compared with those that involved diagnostic procedures (92% vs. 70%). Only 5% of consultations were made in the surgical intensive care unit (ICU). In his editorial commentary, Tenenbaum [2] highlights the fact that, at his institution, ID physicians have little impact when it comes to altering inappropriate antimicrobial use in the ICU. In this era of increasing concern about antibiotic stewardship, there have been a number of studies investigating the impact of ID consultative care on patient treatment in various settings [3–5].

In light of the findings by Lo et al. [1] and with regard to the difficulties highlighted by Tenenbaum [2], we would like to outline the consultative practice at the ICUs at our institution. Beaumont Hospital (Dublin, Ireland) is a 650-bed tertiary referral center and contains the national neurosurgical center for the Republic of Ireland. There is a 10-bed general ICU and an 11-bed neurosurgical ICU, both of which are open. On a daily basis, from Monday to Friday, a specialist registrar and/or consultant from the clinical microbiology service, together with a specialist registrar and/or consultant in intensive care medicine, review data for all patients in both ICUs. At other times, advice on patient treatment is given, if required, by the consultant clinical microbiologist on call. Recommendations are made on these daily rounds on the basis of clinical features, radiological findings, laboratory results (including microbiolog-

Table 1. Characteristics of 264 therapeutic recommendations made for 178 patients

Recommendation	No. of recommendations made	No. (%) of recommendations followed
Commence antibiotic treatment	69	69 (100)
Change antibiotic treatment	60	56 (93.3)
Discontinue antibiotic treatment	135	128 (94.8)
Total	264	250 (94.7)

ical data), changes in ventilatory support, and inotrope requirements, etc., to commence antimicrobial treatment. Recommendations are also made regarding diagnostic procedures.

Over a 3-month period from 1 May to 31 July 2004, using clinical microbiology service records, we retrospectively reviewed compliance with our therapeutic recommendations for 178 patients. Treatment modification (i.e., initiation, change, or discontinuation of antibiotic treatment) was recommended for 128 patients. In total, there were 264 therapeutic recommendations during the period (table 1).

These results demonstrate that consultation with a laboratory-based clinical microbiology service, delivered in collaboration with intensive care medicine, can ensure a very high degree of compliance with treatment modifications. The high level of acceptance of this service may be related to the fact that care is delivered by medically qualified clinical microbiologists who have undergone postgraduate training in general internal medicine and have then undertaken $\geqslant$5 years of training about all aspects of infection—diagnosis, prevention, and therapy. In addition, clinical microbiologists supervise hospital microbiology laboratories, so that a single individual ensures a direct flow of information from bench to bedside, resulting in patient-focused care.

In many US hospitals, microbiology laboratories are supervised by scientists and/or managers, patient consultation and antibiotic advice is provided by ID physicians, surveillance of hospital-acquired infection is undertaken by a hospital epidemiologist, infection prevention is the remit of infection-control practitioners, and liaison between the microbiology laboratory and the attending physician is undertaken by clinical pharmacists. In this arrangement, a lack of integration may result in inadequate communication between divisions, leading to a poor uptake of therapeutic advice. In the integrated model, the clinical microbiologist has a pivotal role in all aspects of "infection" as it pertains to the ICU. The system in operation in this hospital, as in much of Europe, improves antimicrobial stewardship and optimizes patient care.

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