

# An outbreak of community-associated methicillin-resistant *Staphylococcus aureus* infection in a boarding school in Hong Kong (China)

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**Background:** In November 2012, an outbreak of community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) skin and soft tissue infections affecting students at a boarding school in Hong Kong (China) was detected.

**Methods:** A case was defined as any student or staff notified with MRSA infection from 25 October 2012 to 5 July 2013 with the clinical isolate being of staphylococcal cassette chromosome mec type IV or V and positive for Panton-Valentine leukocidin gene. We conducted field investigations, advised on control measures and enhanced surveillance for skin and soft tissue infections at the school. Decolonization therapies were offered to all cases and contacts, and carrier screening was conducted.

**Results:** There were five cases; two (40%) were hospitalized and three (60%) required surgical treatments. Initial screening comprised 240 students and 81 staff members. Overall, four cases (80%) plus eight other students (3.3%) were carriers, with eight of 12 (66.7%) from the same dormitory. All staff members screened negative. After intensified control measures, the number of students screened positive for CA-MRSA decreased from nine to one with no more cases identified in the school.

**Conclusion:** Identification of carriers, decolonization therapy, monitoring of cases and contacts and strengthening of environmental and personal hygiene were control measures that helped contain this CA-MRSA outbreak in a boarding school in Hong Kong (China).

Community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) outbreaks in schools usually affect members of sports teams who come into bodily contact with one another. Considered as more virulent and transmissible than traditional MRSA strains,<sup>1</sup> CA-MRSA may lead to outbreaks associated with severe morbidities and hospitalizations in otherwise healthy young adults or teenagers.<sup>2</sup>

CA-MRSA has been a statutory notifiable disease in Hong Kong (China) since 2007. Medical practitioners are required to report any patient with confirmed MRSA infection fulfilling the surveillance definition and to submit the culture isolate to a government public health laboratory for CA-MRSA confirmatory testing. The disease is rapidly emerging as annual numbers surged from 173 in 2007 to 813 in 2012. Most cases

are sporadic skin and soft-tissue infections (SSTIs) with occasional clusters occurring in domestic settings.<sup>3</sup>

School X is a boys' boarding school in Hong Kong (China). In addition to academic teachings, the campus has a marine activities centre, and students spend a significant amount of school time in water sports or training. There are about 250 students living in six dormitories (about 40 students in each one) with plenty of mixing activities among students during training and daily activities.

In October and November 2012, the Centre for Health Protection received three reports of CA-MRSA SSTIs among students from School X, which had no previous reports of CA-MRSA SSTI. Therefore, the case-based investigations were expanded to an

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outbreak investigation to determine the extent of the outbreak and to identify possible source(s) of infection. In this report, we present the outbreak investigation, including the implementation and outcome of control strategies.

## METHODS

### Case definitions

A case was defined as any student or staff member of School X who was notified with SSTIs (e.g. boil, abscess and pustule) or other infections (e.g. pneumonia, sepsis) from 25 October 2012 to 5 July 2013, with MRSA isolated from any clinical specimen with the isolate being of staphylococcal cassette chromosome *mec* (SCC*mec*) type IV or V and positive for Panton-Valentine leukocidin (PVL) gene.

A carrier was any student or staff member of School X, without a clinical infection, who had MRSA isolated from any screening specimen collected from 25 October 2012 to 5 July 2013 with the isolate being of SCC*mec* type IV or V and positive for PVL gene. Cases were considered carriers if they had a positive screening result after their initial diagnosis.

### Case and carrier finding

Screening of students (after obtaining consent from parents/guardians) and staff from School X was

conducted from 5 November 2012 to 22 March 2013. Initially limited to close contacts of the first notified case (e.g. students in same dormitory, contact-sport team members), screening was extended to all students and staff when the second case was notified (i.e. outbreak established) in November. Attack rates (AR%) by dormitory were calculated by dividing the number of cases and carriers identified by the total number of students in the dormitory, assuming the total number remaining constant during the investigation period.

### Screening phases and decolonization

Decolonization therapies were offered to cases and screened contacts regardless of carrier status. The five-day regimen comprised daily application of a 4% chlorhexidine gluconate solution as liquid soap and shampoo together with thrice daily application of a topical 2% mupirocin cream to nostrils bilaterally.

Results of decolonization therapies were assessed by post-decolonization screening: Phase 1 aimed to screen all students and staff once, and this occurred over four occasions from 5 November 2012 to 28 January 2013; Phase 2 occurred between 29 January and 12 March 2013, when post-decolonization screening of carriers and cases was completed; Phase 3 occurred from 13 to 22 March 2013, when all cases and Dorm A students were targeted; and Phase 4 occurred between 23 March and 5 July 2013, when the carriers identified in Phase 3 were re-screened (**Table 1**).

**Table 1. Summary of CA-MRSA outbreak in School X by screening phase, Hong Kong (China), November 2012 to July 2013**

Phase	Phase 1 (control)	Phase 2 (control and follow-up)	Phase 3 (intensify control)	Phase 4 (surveillance and follow-up)
Period	5 November 2012 to 28 January 2013	29 January 2013 to 12 March 2013	13 to 22 March 2013	23 March 2013 to 5 July 2013
Summary	4 rounds covering 236 students and 81 staff; included screening and decolonization	Post-colonization screening of carriers and cases	Targeted re-screening of all cases and Dorm A students	Follow-up screening of carriers
Number that screened positive*	9 (Cases 1, 2) (Carriers 1–7)	4 (Cases 3,4) (Carriers 1, 2)	4 (Cases 1, 4) (Carriers 1, 8)	1 (Case 4)
Number of new carriers	7 (Carriers 1–7)	2 (Cases 3,4)	1 (Carrier 8)	0

\* Number screened positive in each phase included (a) those who remained in carrier status despite decolonization therapy offered in previous phase and (b) both cases and non-case carriers.

## Laboratory testing

Nasal, axillary and perineal swabs were collected during the screenings and were sent to the Public Health Laboratory Service Branch for culture, PVL gene polymerase chain reaction (PCR), SCCmec typing, molecular *spa*-typing as well as antibiotic susceptibility tests.

## Field visits

Field investigations were conducted by the investigation team, infection-control nurses and a microbiologist. Mixing opportunities in school premises, hygiene facilities and practices were reviewed in each field visit.

## Surveillance

From 25 March 2013, School X was requested to submit weekly reports of any skin lesions identified among students and staff to allow for early detection of potential new cases, timely referral for diagnosis, laboratory investigation and treatment.

## RESULTS

### Cases

Five cases were identified, aged between 13 and 16 years (median 15 years). Four lived in Dorm A (4/41, AR = 9.8%) and one in Dorm B (1/45, AR = 2.2%); both dormitories were located on the same floor. The first case developed symptoms on 14 October 2012, while the onset of the last case was on 18 February 2013. Two cases were diagnosed after initiation of the screening programme. Four cases presented with skin abscesses and one presented with a left arm pustule only. Two required hospital admission and three required surgical treatments such as incision and drainage. Their family members were all asymptomatic.

### Carriers

There were 254 students and 81 staff members at the school during the investigation period. Of these, 240 students (94.5%) (including the five cases) and 81 staff members (100%) were screened during Phase 1; two students refused screening and 12 were

either absent or had quit the school. Two students refused decolonization therapies.

Overall, four of the five cases (80%) and eight other students (3.3%) were confirmed as carriers. Eight of these 12 carriers lived in Dorm A (8/41, AR = 19.5%), two in Dorm B (2/45, AR = 4.4%) and two in Dorm C (2/41, AR = 4.9%). Screening specimens from staff members were all negative.

During Phase 1, two cases and seven carriers screened positive. Two initial cases that screened negative in Phase 1 and two student carriers from Dorm A confirmed during Phase 1 re-screened positive in Phase 2, suggesting poor compliance to therapy and possibly ongoing disease transmission among Dorm A students. During Phase 3, when all Dorm A students and the five cases were re-screened, one new carrier was identified; two cases (one that tested positive and one negative in Phase 2) and one other carrier (re-screened positive in Phase 2) also were identified as carrying CA-MRSA. These four carriers were re-screened in Phase 4 with one again confirmed as a carrier.

In summary, the number of carriers for CA-MRSA decreased from nine to one (Table 1) over the screening phases; from 25 March 2013, no further CA-MRSA infection cases were identified (Figure 1).

### Laboratory investigations

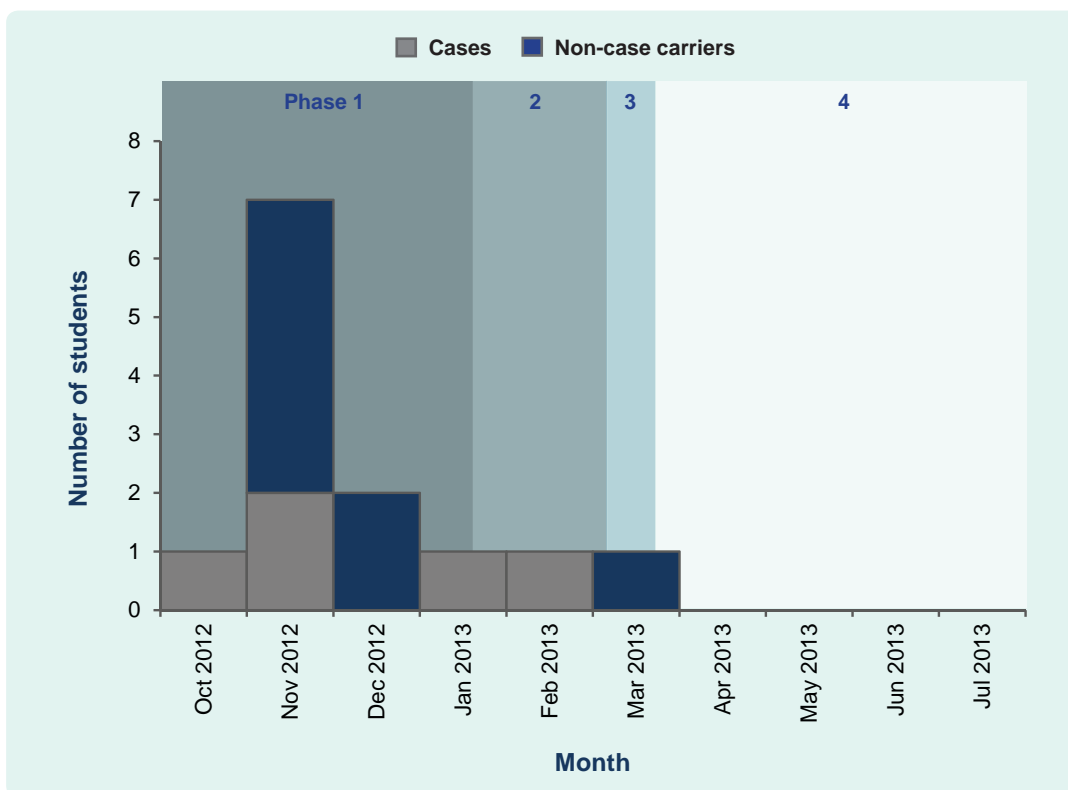
All case isolates ( $n = 5$ ) and all screening isolates ( $n = 12$ ) were of *spa* type t441 and were resistant to erythromycin and clindamycin but were sensitive to gentamicin, vancomycin and mupirocin.

### Field investigations

Seven field visits to the school occurred. Health talks during each field visit provided information to students and staff on disease, personal and environmental hygiene, advice on wound treatment and exclusion from sports. The school was advised to conduct terminal cleansing during the Easter holiday (28 to 29 March 2013) when all dormitories were vacated.

Substantial mixing opportunities in the dormitories, bathrooms, laundry and common areas (e.g. gymnasium)

Figure 1. Cases and non-case carriers of CA-MRSA in School X by outbreak phase and month of onset (for cases) or first identification (for non-case carriers), Hong Kong (China), October 2012 to July 2013



CA-MRSA – Community-associated methicillin-resistant *Staphylococcus aureus*

Box 1. Deficiencies identified and control measures advised in School X regarding the CA-MRSA outbreak, Hong Kong (China), November 2012 to July 2013

Observations	Recommendations
<p><b>Student Dormitories</b> Bunk beds separated by one metre of space without partition. Social gatherings often held on the beds. Linen and blankets not washed and changed regularly.</p>	Wash and change linen and blankets weekly and provide alcohol-based hand sanitizers in each dormitory.
<p><b>Bathrooms and lavatories</b> Shared facilities among each dormitory. Wet towels of different students hung closely or overlapped on hanging racks with reports of sharing towels. Hand-washing soap not provided and curtains at the entrances not washed regularly. Carpets placed near entrances. Lockers in bathrooms not partitioned.</p>	Space out and separate towel hooks using labelled partitions to avoid cross-contamination and provide liquid soap and hand dryer/disposable paper towel. Discard or wash very frequently all curtains and carpets at entrances. Install partitions for lockers to avoid cross-contamination of personal items.
<p><b>Common areas</b> Equipment in gymnasium (e.g. dumbbells and gym mattresses) not disinfected after use. A sofa shared by all students had no removable/washable cover and was difficult to clean. Frequently touched surfaces such as stair-rails and lamp switches not cleaned regularly.</p>	Minimize shared use of equipment in gymnasium and disinfect between uses. Provide easy-to-clean and removable cover for sofa to be changed regularly. Clean frequently touched surfaces at least twice daily with diluted (1:49) bleach.
<p><b>Cleansing and laundry equipment</b> Mops and cleansing towels not disinfected and dried after use. Dirty and clean linen were placed together in buckets.</p>	Disinfect and dry mops and cleansing towels after use. Label separate buckets for dirty and clean laundry. Wash all laundry from Dorm A using hot water cycle (up to 90 °C for 45 minutes) during outbreak period.

were identified. Deficiencies in hand-hygiene facilities and awareness and suboptimal environmental and personal hygiene were possible factors for CA-MRSA transmission in School X (**Box 1**). Staff of School X were also asked to supervise non-compliant students for decolonization therapy to intensify outbreak control.

## DISCUSSION

We reported a CA-MRSA outbreak affecting five students in a boarding school in which two (40%) were hospitalized and three (60%) required surgical treatment; this was the largest institutional CA-MRSA outbreak recorded in Hong Kong (China). In the early phases of outbreak control, despite repeated field inspections, universal screening and decolonization therapies in the school, compliance to decolonization therapy and progress on environmental interventions remained suboptimal. Two cases initially screened negative in the first phase were detected as carriers in the second phase, indicating possible ongoing transmission.

A regimen of intranasal mupirocin and chlorhexidine body wash have been found to eradicate CA-MRSA colonization in more than 80% of carriers in Hong Kong (China).<sup>4</sup> This decolonization regime was adopted early in the control of this outbreak, but compliance appeared to be poor as one new case and subsequent carriers were identified. Supervised decolonization therapy was then adopted as part of intensified measures together with reinforcement of environmental and personal hygiene control. Intensive cleaning of the school during the school holidays in March 2013 and weekly surveillance to ensure early identification and prompt treatment of potential skin lesions, as per a previously reported outbreak,<sup>2</sup> were also adopted. The outbreak was contained after such coordinated efforts and interventions.

Previous local studies suggested that sharing of personal items is a risk factor, while good hand hygiene may protect against infection.<sup>5</sup> In this outbreak, most cases (4/5, 80%) and carriers (5/8, 62.5%) lived in the same dormitory with shared use of facilities. Field investigations also revealed suboptimal hygiene practices which may have facilitated transmission within, and to a lesser extent between, dormitories in the school.

CA-MRSA isolates in Hong Kong (China) have been predominantly of spa type t019 and t437,<sup>6</sup> different to the spa type t441 identified in this outbreak. However, the latter has occasionally been found in other Asian countries and is closely related to t437,<sup>7</sup> belonging to the same lineage (sequence type 59, the Taiwan [China] clone).<sup>8</sup>

For future outbreaks, we recommend that systematic data be collected in each phase (e.g. hand hygiene and decolonization compliance) for quantitative analysis of the effectiveness of individual control measures.

## CONCLUSION

We reported a CA-MRSA outbreak affecting five students in a boarding school in Hong Kong (China). Identification of carriers, decolonization therapy, intensive monitoring of cases and contacts and strengthening of environmental and personal hygiene were important strategies to help contain this school outbreak.

### *Conflict of interest*

None declared.

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