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Methicillin-resistant *Staphylococcus aureus* (MRSA): a community-based prevalence survey

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SUMMARY

A prevalence survey of nasal methicillin-resistant *Staphylococcus aureus* (MRSA) carriage was undertaken on a random sample of adults (aged over 16) resident in the community in Birmingham, UK during 1998. Microbiological samples were taken from the anterior nares at the subjects' general practice or in their home. Information about risk factors for the acquisition of MRSA was obtained via a self-completed questionnaire. A 58% response rate (280/483) was achieved. The prevalence of nasal MRSA colonization was 1.5% [4/274, 95% confidence interval (CI) 0.03–2.9%]. Twenty-three per cent (63/274) of subjects were nasal carriers of *S. aureus*. Six per cent (4/63) of *S. aureus* isolates were MRSA and 2 of the 4 MRSA carriers reported previous contact with health facilities. The prevalence of MRSA colonization in the general adult population in Birmingham appears to be low.

INTRODUCTION

There is concern that the epidemiology of methicillin resistant *Staphylococcus aureus* (MRSA) is changing [1–3]. In some parts of the world MRSA is recognized as a community pathogen [4–8] and infection acquired from community sources has been documented in nosocomial outbreaks [9, 10]. This creates special problems for hospital infection control programmes.

Infection control teams in local Birmingham hospitals expressed concern that an increasing number of patients were being admitted to hospital already colonized with MRSA. Many of these patients were not admitted from nursing homes. It was suggested that there might be a high prevalence of MRSA in the local community and so we undertook a prevalence survey of MRSA colonization in the general adult population in Birmingham. As far as we are aware, no other studies have investigated MRSA carriage in the general population in the wider community setting.

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PARTICIPANTS AND METHODS

Sample population

The sample size required for the survey was calculated based on an estimated population prevalence of MRSA of 10% (the average of previous survey findings in selected UK populations [11, 12]). A sample size of 384 would estimate 10% population prevalence within 3% with 95% confidence. A smaller sample size of 270 would give a confidence level of 90%.

A two-stage sampling methodology was employed as outlined in Figure 1. A sample of 150 adults aged over 16 was selected randomly from the survey practices' list on the Health Authority population register using random number sequences. Nursing-

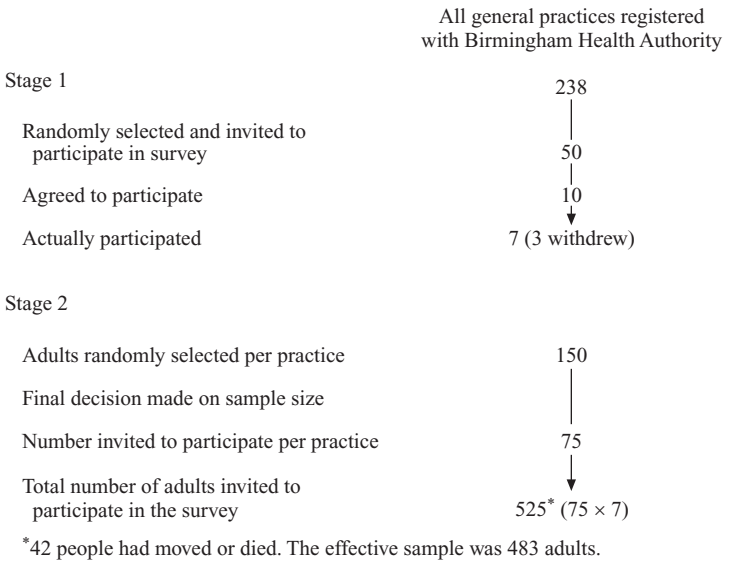

Fig. 1. Chart of sampling strategy and loss to participation.

Table 1. *Profile of participants in MRSA community survey*

Age group	Registered population (%) June 1998	Practice population (%)	Survey sample* (%)	Participants (%)	Survey response rate %
16–24	140753 (17)	3884 (12)	59 (12)	25 (9)	42
25–44	331645 (40)	11603 (37)	177 (37)	96 (34)	54
45–64	216100 (26)	9021 (28)	121 (25)	78 (28)	64
65–84	122177 (15)	6382 (20)	114 (24)	73 (26)	64
85+	19322 (2)	857 (3)	12 (2)	7 (3)	58
Unknown				1	
Total	829997	31747 (100)	483 (100)	280 (100)	58
Females	414999 (50)	16290 (51)	271 (56)	166 (60)	

* 42 patients found to have moved or died were excluded from the analysis.

home residents were specifically excluded from the survey by crossmatching the postcodes against Birmingham Health Authority registered nursing homes. General practitioners (GPs) were asked to check the appropriateness of the patients selected, their address, and provide an up-to-date telephone number for follow-up. The first 75 adults from each practice with a telephone number for follow-up were included in the survey. The total sample size was 525. Ethical approval for the survey was obtained from the four local research ethics committees operating within the district.

Subjects were invited to attend the GP surgery to complete a simple questionnaire about their health and have a nose swab taken. Each subject received an invitation to participate in the survey, information about the survey and an information leaflet about MRSA. Non-attendees after the first two mailings were sent a further invitation to an evening session. Trained research assistants undertook telephone follow-up of non-responders to three postal invitations. Data collected included demographic details, hospital admission ($\geqslant$ 2 days) in the past 12 months, recent antibiotic use (in past 4 weeks), and contacts with health-care facilities.

Microbiological methods

Nose swabs were obtained using PROBACT (Technical Services Cons., Ltd) transport swabs. The swabs were transported to the Hospital Infection Research Laboratory (HIRL), either on the day of collection or the next day for processing. Specimens were processed by incubation for 18 h on nutrient agar supplemented with 0.01% phenolphthalein diphosphate pentasodium solution and 1% defibrinated horse serum.

Colonies with the morphological appearance of *S. aureus* were examined for phosphatase activity by exposure to ammonia vapour. Phosphatase-positive colonies were examined for DNase activity by subculture onto DNase agar (Oxoid, Basingstoke, UK), which was incubated for 18 h and then flooded with 1 M HCl. A lack of precipitate around the colony confirmed DNase activity.

Isolates were tested for susceptibility to methicillin by incubation for 18 h at 30 °C on 5% blood agar overlaid with methicillin 25 μg strips (Mast Diagnostics, Merseyside, UK). Other antimicrobial agents tested were penicillin G (1 unit), tetracycline (10 μg), erythromycin (5 μg), kanamycin (30 μg), clindamycin (2 μg), methicillin (10 μg) and mupirocin (5 μg). Strains identified as MRSA were forwarded to the Staphylococcal Reference Unit, Central Public Health Laboratory (CPHL), Colindale for bacteriophage typing.

RESULTS

Response rates and participants

An overall response rate of 58% (280/483) was achieved (Table 1). Forty-two subjects had moved or died. There were 65 outright refusals. The remaining non-responders (138) included those who broke appointments for home visits, were not contactable by telephone or unannounced home visits. The response rate varied between 34 and 69% by practice.

Sixty per cent (166/280) of participants were females. Eight per cent (22/280) described themselves as being from a black or other minority ethnic group. Although no differences were noted in the sex distribution of non-responders and survey participants, non-responders were significantly younger. The difference in the proportions of participants under 45 years of age in the two groups was highly significant [χ^2 (Yates corrected) = 16·93, $P < 0{\cdot}001$].

Thirteen per cent (37/280) of respondents reported a hospital admission over 2 days (48 h) in the past year. Over half of the admissions were for surgery (54%, 19/37) followed by medical conditions (31%, 11/37) and childbirth (14%, 5/37). Just over 10% (29/280) of respondents reported taking antibiotics in the previous 4 weeks.

Microbiology

There was no growth from 6 of the 280 swabs collected. Sixty-three isolates of *S. aureus* were

Table 2. *Details of MRSA-positive individuals*

Case	Age	Sex	Ethnicity	Postcode	Eczema/ dermatitis	Hospital admission over 2 days in past 12 months	Antibiotics in past 4 weeks	Works in health-care setting	Children < 14 years in household	Health-care worker in immediate family
A	28	F	White	B36	No	No	No	Yes	Yes	No
B	31	M	Non-white	B9	No	No	No	No	Yes	No
C	58	F	White	B33	No	No	No	No	No	No
D	66	F	White	B34	No	Yes	No	No	No	No

obtained (prevalence, 23%). Six per cent (4/63) of these were MRSA. The overall point prevalence of MRSA was 1·5% (4/274, 95% CI 0·03–2·9%). Confidence intervals were calculated based on the Poisson distribution. Three of the four MRSA isolates were resistant to penicillin and methicillin only. The fourth isolate was also resistant to erythromycin. The four isolates were confirmed as EMRSA 15 by bacteriophage typing.

MRSA-positive individuals

Three of the four MRSA isolates were from females (Table 2). The mean age of those affected was 46 years. Two of the four carriers reported previous contact with health-care facilities. No geographic clustering of cases was noted. Subjects who were MRSA positive were compared with all other subjects and with subjects who were colonized with methicillin-sensitive *S. aureus* with respect to previous hospital admission, recent antibiotic use, any contact with a health facility and all other variables. No significant difference was found between MRSA-positive subjects and others using the χ^2 test and Fisher's exact method.

DISCUSSION

Over recent years there has been increasing concern about the spread of MRSA into the community [1]. A rise in the rate of community-acquired MRSA in children without any obvious risk factor was noted in a Chicago hospital [2] and outbreaks of MRSA related skin sepsis affecting healthy young people have been reported in the community [13, 14]. Nevertheless, Boyce [3] highlighted the need for caution before concluding that the community prevalence of MRSA is rising. A number of reasons are cited, patients with undetected MRSA nasal colonization may account for up to a third of patients with MRSA in a hospital at any given time and MRSA nasal carriage may persist for several years following colonization [15]. Indeed, patients may present up to 12 months after colonization with an infection caused by the organism.

Despite calls from a number of commentators [1–3] for community-based research on the transmission of MRSA, few studies have been conducted outside the outpatient or nursing home setting. Little information is available on the extent of MRSA colonization in the general community in the United Kingdom. A survey of 500 women attending antenatal clinics in London (1989–90) found 3/184 (2%) of the staphylococcal strains isolated were MRSA [12]. Since this time, the epidemiology of MRSA in the United Kingdom has been changing with the number of hospitals in England and Wales reporting MRSA incidents increasing year on year [16–18]. Over a third of staphylococcal bloodstream infection in England and Wales in early 1999 were due to MRSA [19] compared to 8% in 1994. A survey undertaken in nursing homes in Birmingham, UK (1996) found a 17% point prevalence of MRSA colonization [11] which is markedly higher than the 4% prevalence found in a survey of nursing-home residents in Northamptonshire in 1991 [20].

The point prevalence of MRSA nasal colonization observed in the general adult population in this survey was 1·5% (95% CI 0·03–2·9%). This is comparable to findings from surveys undertaken in emergency room attendees in Israel [21] and Brazil [22]. The low prevalence rate found in this survey supports the view that transmission of MRSA outside the hospital environment is a rare event [23]. All of the MRSA isolates recovered here were EMRSA 15, the prevalent strain circulating in Birmingham hospitals. Two of the carriers reported previous contact with health facilities. These cases may represent carriage of hospital-acquired strains in the community rather than transmission within the community. Further investigation is required to confirm this.

The survey described here has several limitations. Sampling bias may be an issue because of the small number of general practices involved. Both the survey sample and the participating practices' population had a significantly higher proportion of subjects over 65 years of age compared with the total population (age 16+) registered with all Birmingham GPs [χ^2 (Yates corrected), $P < 0{\cdot}001$]. A high non-response rate amongst younger adults (16–45 years) and the older age structure of the practices involved meant that participants were mainly older people. Despite considerable effort only a 58% response rate was achieved. A higher response rate would have been desirable to make the findings more robust. Not all known risk factors for 'community' MRSA acquisition were explored in the questionnaire. Hospital admission over 2 days was identified specifically as hospital-acquired infections are generally defined as those occurring after 48 h of admission. However MRSA acquisition may occur during shorter exposures in a variety of health-care settings. Nevertheless, 13% of hospital admissions met this criterion. This is slightly higher than the 10% self-reported

hospital use in the 1995 General Household Survey (Office of Population Censuses and Surveys) but may reflect the high proportion of older age groups in the sample. Our findings need to be confirmed in larger surveys, which allow more in-depth study of risk factors including detailed interview of MRSA-positive individuals regarding family contacts and contact with health facilities.

MRSA continues to be a problem primarily within acute hospitals in this area of the United Kingdom. Its transmission within the general community has important implications for the empirical management of staphylococcal infection in both the primary care and acute hospital settings. Given the low prevalence of MRSA found here, the empirical use of flucloxacillin for community-acquired *S. aureus* infections remains appropriate. At present, no reliable mechanism exists for the routine surveillance of antibiotic resistant organisms in the general community in the United Kingdom. This issue must be actively addressed to tackle the public health concern of widespread antibiotic resistance.

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