ORIGINAL ARTICLE

MRSA at an English children's hospital from 1998 to 2003

A Adedeji, J W Gray

Arch Dis Child 2005;**90**:720–723. doi: 10.1136/adc.2004.065235

See end of article for authors' affiliations

Correspondence to: Dr A Adedeji, Department of Microbiology, Birmingham Children's Hospital, Steelhouse Lane, Birmingham B4 6NH, UK; adekolaa@hotmail.com

Accepted 16 February 2005

Aims: To investigate the epidemiological and clinical aspects of MRSA among inpatients and outpatients presenting to hospital.

Methods: Analysis of demographic, epidemiological, and clinical data collected on 385 children first identified as having MRSA between January 1998 and December 2003 in a 250 bed English children's hospital.

Results: There were 267 inpatients and 118 outpatients. The number of new cases of MRSA declined from 72 in 1998 to 52 in 2003, whereas hospital activity increased. Ninety nine (37.1%) inpatients acquired MRSA outside the hospital; a further 90 occurred among 31 clusters of cases. One hundred and seventy eight (66.7%) inpatients were aged <2 years; cardiac services and paediatric & neonatal surgery accounted for 59.6% of cases. Dermatology and A&E accounted for 51.7% of outpatients; 73.8% of outpatients had recently previously attended the hospital. A total of 13.9% of inpatients with MRSA developed bacteraemia; MRSA accounted for 15% of *Staphylococcus aureus* bacteraemias. The risk of MRSA bacteraemia in colonised patients, and the proportion of *S aureus* bacteraemias that were MRSA, varied between specialties. Intravascular devices were the most common source of MRSA bacteraemia (63.4% of cases). The mortality rate was 7.3%.

Conclusions: Enhanced surveillance of MRSA can identify at-risk patient groups, thus facilitating targeting of control measures. The absence of a link between numbers of cases of acquisition of MRSA and bacteraemia suggests that the rise in MRSA bacteraemia may not solely reflect an increase in MRSA prevalence in children in the UK. The need for larger epidemiological studies is emphasised.

Methicillin resistant *Staphylococcus aureus* (MRSA) has been in hospitals for more than 40 years, and it is increasingly reported as a hospital acquired pathogen worldwide.[1–3] Recently, attention is being focused on MRSA in the paediatric population, and the opinion that children may be less susceptible to colonisation and infection with MRSA is changing.[4 5] It has also been reported that MRSA may be circulating among children in the community outside hospitals, with increasing reports mainly from the USA of community acquired MRSA in children with none of the traditional risk factors for MRSA acquisition.[6 7] However, recent reports have highlighted the lack of epidemiological and clinical data on MRSA in children in the UK.[4 5] We reviewed records of all children identified as having MRSA at our hospital over a six year period to investigate the demographical, epidemiological, and clinical aspects of MRSA in our hospital.

METHODS

Birmingham Children's Hospital is a teaching hospital and tertiary referral centre with around 250 beds, including a 20 bed paediatric intensive care unit (PICU). Specialist services include haematology, oncology, & bone marrow transplantation, cardiology, gastroenterology & hepatology, including liver and small bowel transplantation; nephrology; plastic surgery & burns, and paediatric & neonatal surgery. A hospital policy for the control of MRSA, based on national guidelines,[8] and reviewed every two years existed throughout the study period. Key elements of the policy include isolation of MRSA positive children; MRSA eradication therapy for colonised patients and staff; screening of patients transferred from high prevalence hospitals, and staff screening in response to apparent hospital acquisition of one or more cases. The main change to the policy during the period of this study was the implementation of routine screening of new staff in PICU, neonatal surgery, and cardiac services. The infection control team maintains records of demographic, epidemiological, and clinical data on all children with MRSA on a computer database (Epi Info6, Centers for Disease Control, Atlanta, USA). New isolates of MRSA that were detected within 48 hours of hospital admission were considered not to have been acquired in our hospital, unless the patient had recently been previously admitted or there was some other strong evidence to the contrary. Definitions related to bacteraemia have been published previously.[9] Isolates were not routinely typed, because most had antibiograms typical of the EMRSA-15 and EMRSA-16 strains that are prevalent in the English Midlands.[10] Data on all children first identified as being colonised or infected with MRSA between January 1998 and December 2003 were analysed retrospectively.

RESULTS

During the study period 385 children were identified for the first time as being colonised or infected with MRSA, of whom 69.4% were inpatients. Boys accounted for 240 (62.3%) cases. The numbers of new cases of MRSA in both inpatients and outpatients were lower at the end than at the beginning of the study period (table 1). During the same period inpatient activity increased by16.9% (from 21 775 to 25 454 consultant episodes); outpatient activity by 28.0% (from 82 976 to 106 221 attendances), and accident & emergency activity by 19.9% (from 37 005 to 44 368 attendances).

A total of 178 (66.7%) inpatients were aged under 2 years compared with 36 (30.5%) outpatients (table 2). Cardiac services and paediatric & neonatal surgery accounted for 59.6% of inpatients with MRSA, whereas dermatology (39 cases) and A&E (22 cases) were the most common outpatient

Abbreviations: MRSA, methicillin resistant *Staphylococcus aureus*; MSSA, methicillin sensitive *Staphylococcus aureus*; PICU, paediatric intensive care unit

Table 1 Numbers of new cases of MRSA in inpatients and outpatients, and MRSA bacteraemia, by year

Year	No. of new cases of MRSA that were:		No. of episodes of MRSA bacteraemia (% all episodes of bacteraemia with *S aureus*)
	Inpatients	Outpatients	
1998	47	25	6 (12.5)
1999	44	25	3 (6.8)
2000	51	17	11 (21.6)
2001	50	16	11 (26.2)
2002	40	18	4 (7.8)
2003	35	17	6 (15.8)
Total	267 (69.4%)	118 (30.6%)	41 (15.0)

specialties (table 3). A total of 23.6% of inpatients were receiving intensive care, whereas PICU accounted for only around 8% of hospital beds.

Ninety nine (37.1%) of the inpatients were judged to have acquired MRSA elsewhere than our hospital. A further 90 cases occurred among 31 clusters of two or more epidemiologically linked cases. Twenty eight of the clusters were associated with cardiac services, paediatric & neonatal surgery, or PICU, and in 17, one or more colonised staff members were identified, usually recent appointees. In response to this observation, routine screening of new staff in these three areas of the hospital commenced in 1998, 2000, and 2002, respectively. Data on previous hospital attendances were only available for children in the final three years of the study period: only 11 (16.2%) of 68 cases of MRSA in outpatients during this period had no previous attendances at our hospital during the preceding year.

There were 274 episodes of bacteraemia with *Staphylococcus aureus* during the study period, including 41 episodes of MRSA bacteraemia occurring in 37 children. Thirty seven (90.2%) MRSA bacteraemias were hospital acquired, whereas 125/233 (53.6%) bacteraemias with methicillin sensitive *S aureus* (MSSA) were community acquired. Only two children with MRSA bacteraemia did not have a significant underlying medical condition that required ongoing hospital care: there was one neonate ventilated on PICU for RSV bronchiolitis, and one girl aged 9 years with a surgical wound infection. The median interval from first isolation of MRSA to onset of bacteraemia was 8 days (range 0–831 days), and all the children who developed bacteraemia were inpatients when they were first documented to have MRSA. Overall, the risk of bacteraemia in inpatients colonised with MRSA was 13.9%, with the highest risk in children aged 2–10 years (table 2). However, MRSA accounted for a much greater proportion of bacteraemias with *S aureus* in infants outside the neonatal period than in any other age group. There were also considerable differences between specialties (table 3) in both the risk of bacteraemia in colonised patients and in the relative proportions of bacteraemia with MSSA and MRSA. Twelve (29.3%) MRSA bacteraemias occurred on the PICU, where MRSA accounted for 30.2% of *S aureus* bacteraemias. Intravascular devices accounted for 26 (63.4%) MRSA bacteraemias. The respiratory tract and skin or soft tissue were the foci of infection in six (14.6%) and three (7.3%) cases, respectively; in the other six cases a single focus of infection could not be determined with certainty. The mortality rate from MRSA bacteraemia was 7.3%, compared with 1.7% from MSSA bacteraemia ($p = 0.07$; Fisher's exact test).

DISCUSSION

There is growing concern about MRSA in hospitals in many countries, which in the UK has prompted a number of recent directives to reduce the incidence of nosocomial MRSA.[3 11 12] There have also been reports, especially from North America, of MRSA being transmitted in the community, even among children with no history of hospital attendance.[13 14] For children, acquisition of MRSA may mean that they have to stay in hospital for longer, or that they may have to be admitted to hospital for intravenous antibiotic therapy of relatively trivial infections.

There are few data on the pattern of MRSA in children.[15] MRSA accounted for only 6% of *S aureus* bacteraemias in New Zealand children between 1996 and 1998,[16] but only 30% of bacteraemias in that study were hospital acquired, compared with 52.9% in our study. Khairulddin *et al* reported that the proportion of *S aureus* bacteraemias in children in England and Wales that were MRSA increased from 0.9% in 1990 to 13.1% in 2000.[5] Overall, the fraction of *S aureus* bacteraemias that were MRSA in our hospital (15.0%) was comparable to that in the final years of the national survey. However, whereas Khairulddin and colleagues[5] reported an almost unbroken upward trend in the proportion of MRSA bacteraemias, we found that the proportion of MRSA bacteraemias varied markedly from year to year, ranging between 6.8% and 26.2%, and bore no relation to numbers of patients acquiring MRSA in the same year.

The finding that MRSA accounted for an increasing proportion of *S aureus* bacteraemia has been used to suggest that MRSA is increasing in UK hospitals. However, during the six years studied, we found no increase in the numbers of children acquiring MRSA. This may reflect our management of MRSA, which mirrors the Dutch *Search and Destroy* strategy.[3] In particular, our enhanced surveillance has allowed us to target high risk areas of the hospital leading

Table 2 Acquisition of MRSA in inpatients and outpatients, and MRSA bacteraemia, according to age group

Age group	No. (%) of cases of MRSA in:		No. (%) of inpatients with MRSA who developed bacteraemia	No. of episodes of MRSA bacteraemia (% all episodes of bacteraemia with *S aureus*)
	Outpatients	Inpatients		
Neonate (⩽4 weeks)	5	44	3 (6.8)	3 (12)
Infant (>4 weeks–1 year)	31	134	21 (15.7)	25 (22.9)
2–5 years	36	42	8 (19.0)	8 (13.1)
6–10 years	25	20	4 (20.0)	4 (9.5)
>10 years	21	27	1 (3.7)	1 (3.0)
Total	118	267	37 (13.9)	41 (15.0)

Table 3 Acquisition of MRSA in inpatients and outpatients, and MRSA bacteraemia, according to specialty

Specialty	No. of cases of MRSA in:		No. of inpatients with MRSA who developed bacteraemia	No. of episodes of MRSA bacteraemia (% all episodes of bacteraemia with *S aureus*)
	Inpatients	Outpatients		
A&E	0	23	0	0
Cardiac services	90	1	8 (8.9)	8 (19.5)
Dermatology	0	39	0	0
Gastroenterology & hepatology	15	3	7 (46.7)	8 (22.2)
General paediatrics	31	4	4 (12.9)	5 (17.2)
Haematology & oncology	8	4	5 (62.5)	5 (5.1)
Neurosciences	15	1	1 (6.7)	1 (20)
Orthopaedic surgery	7	6	0	0
Paediatric & neonatal Surgery	69	7	11	13 (38.2)
Plastic surgery & burns	10	6	0	0
Respiratory medicine (including cystic fibrosis)	9	17	0	0
Other medical specialties	6	2	1 (16.7)	1 (6.25)
Other surgical specialties	7	5	0	2 (0)
Total	267	118	37 (13.9)	41 (15.0)

us to introduce screening of new staff in these areas. Early indications are that this strategy has been successful: in 2003, the first year in which staff in all three highest risk areas were screened, there were only two clusters of acquisition of MRSA.

Our experience of a relatively high proportion of MRSA bacteraemias, together with year-on-year variation, against a background of unchanged or decreasing numbers of children acquiring MRSA suggests that increasing complexity of medical care may have been an important contributory factor to the surge in MRSA bacteraemias seen during the 1990s. The observations that more than half of MRSA bacteraemias were intravascular device related, and that 30% of them occurred in the PICU further support this hypothesis. It is well recognised that colonisation with MRSA can be persistent.[17] In our series, although the median time between first isolation of MRSA from any site and onset of bacteraemia was only 8 days, 18.9% and 13.5% of patients had been colonised for more than one and six months respectively at the time of onset of bacteraemia. This indicates that treatment to attempt eradication of MRSA colonisation is worthwhile in any children undergoing continuing hospital care in order to reduce the risk of subsequent MRSA bacteraemia.[18]

It is notable that there was no increase in the numbers of outpatients with MRSA during the period of surveillance, and that few of these children had no history of recent hospital attendance. Previous hospitalisation has previously been identified as a risk factor for acquiring MRSA in the community.[13 14 19] Thus while reports from the USA in particular suggest that MRSA is circulating widely among children outside hospital, our small study, dealing only with children presenting to hospital services, suggests that this may not be the case in the UK.[13 14]

There are conflicting reports on whether the mortality rate due to bacteraemia with MRSA is higher than that from bacteraemia with MSSA, because of the effect of confounding host variables. However, many studies have found the mortality rate due to MRSA bacteraemia to be higher.[20 21] However, mortality due to *S aureus* bacteraemia in children is uncommon,[22] and small numbers in studies such as this do not allow an assessment of the relative risks.

In conclusion, ongoing surveillance of MRSA in our hospital has identified patient groups at greatest risk of acquiring MRSA, thus facilitating targeting of control measures. Early evidence suggests that our strategy of screening high risk staff and patients has been successful in reducing both the absolute number of cases of MRSA acquired in our hospital, and the number of clusters of epidemiologically linked cases. We found no link between numbers of cases of acquisition of MRSA and MRSA bacteraemia, suggesting that the nationally reported rise in MRSA bacteraemia in children[5] cannot be assumed to reflect a large increase in the prevalence of MRSA among children either in hospitals or in the community. Other factors, such as the increasing complexity of medical care, may be important contributors to the rise in MRSA bacteraemia. We reiterate the need for larger studies to investigate the epidemiology of MRSA in children in order to determine the future direction of control measures.

What is already known on this topic

- MRSA may be an increasing problem among children in England and Wales
- Reports have highlighted the lack of epidemiological and clinical data on MRSA circulating among children in the community outside hospitals

What this study adds

- We found no evidence that MRSA is becoming more common in our hospital
- Few cases were seen without a history of recent hospital attendance, suggesting that MRSA is not endemic in the community
- Hospital acquisition of MRSA is most common in certain specialties which should facilitate targeting of control measures

Authors' affiliations
A Adedeji, J W Gray, Birmingham Children's Hospital, UK

Competing interests: none

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