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Major article

Staphylococcus aureus and the oral cavity: An overlooked source of carriage and infection?

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Background: The role of intraoral *Staphylococcus aureus* in disease and cross-infection sources is controversial. We present a 10-year retrospective analysis of laboratory data reporting isolation of *S aureus* from oral and perioral clinical specimens.

Methods: A review of laboratory records for specimens where *S aureus* was isolated were collated and analyzed from January 1998-December 2007 at the Oral Microbiology Laboratory, Glasgow Dental Hospital.

Results: There were 11,312 specimens submitted to the laboratory over the study time period. *S aureus* was isolated from 1,986 specimens (18%). Of these, 1,782 (90%) were methicillin-sensitive *S aureus* (MSSA), and 204 (10%) were methicillin-resistant *S aureus* (MRSA). The most common specimen type from which MSSA was isolated was an oral rinse, whereas for MRSA this was a tongue swab. Most of the MRSA isolates were EMRSA-15 or EMRSA-16 lineage.

Conclusion: These findings suggest that *S aureus* continues to be a frequent isolate in the oral cavity and perioral region. The oral cavity should be considered a source of *S aureus* in terms of cross-infection and dissemination to other body sites. The role of *S aureus* in the pathogenesis of certain oral diseases should also be considered as part of a differential diagnosis.

Staphylococci have long been recognized as constituents of the oral flora; however, their role in oral health and disease remains contentious.[1] Reported isolation rates for *Staphylococcus aureus* vary with the population studied, with reported carriage rates of 24%-84% in healthy adult dentate oral cavities[2,3] and an incidence of 48% among the denture-wearing population.[4] In addition, a number of distinct oral infections (eg, angular cheilitis,[5] parotitis,[6] staphylococcal mucositis[7]) are caused by this microorganism. More recently, it has also been suggested that *S aureus* may have a role in dental implant failure.[8,9] It seems likely that in line with infections caused by *S aureus* at other body sites, a number of oral staphylococcal infections are probably the result of cross-infection from a variety of sources.[10-12]

The aim of the study was to extend our previous 3-year retrospective study[13] with an additional 7 years of data reporting *S aureus* in specimens from the oral and perioral region. The study investigated links between reported clinical signs and symptoms from the oral cavity, different specimen types and cultures of *S aureus*, and genotyping of methicillin-resistant *S aureus* (MRSA) isolates.

MATERIALS AND METHODS

Laboratory identification of S aureus

A hand search was conducted of laboratory work sheets completed during the period January 1998-December 2007 of specimens submitted to the Regional Diagnostic Oral Microbiology Laboratory, based at Glasgow Dental Hospital and School. Work sheets were reviewed for reports of isolation of *S aureus*. Prior to this date, the laboratory was moved, and revised protocols for specimen processing were used. Information from specimen report forms containing *S aureus* were entered into an Excel (Microsoft Inc, Redmond, WA) spreadsheet. Data collected included the

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Table 1
Details of specimen types containing MSSA or MRSA over the period 1998-2007

Specimen	MSSA	MRSA
Oral rinse	597	32
Angle of mouth swab	384	26
Tongue swab	199	52
Hard palate swab	191	32
Nares swab	147	9
Upper denture swab	97	20
Lip swab	71	0
Face swab	31	8
Oral mucosal swab	29	18
Dentoalveolar abscess aspirate	15	2
Facial implant swab	11	0
Salivary gland aspirate	6	1
Other	6	4
Intraoral bone graft swab	2	2
Intraoral implant swab	2	0
Patients	1,303	126
Specimens	1,788	208

MRSA, methicillin-resistant *S aureus*; *MSSA*, methicillin-sensitive *S aureus*.

Table 2
Clinical details associated with isolation of *S aureus*

Clinical details	MSSA	MRSA
Angular cheilitis	333	17
Suspected candidal infection	182	39
Other (Inc cysts, implants)	176	24
Erythema and swelling	148	15
Painful and burning mouth	119	13
Facial abscess	85	1
Unknown	81	11
Sjogrens syndrome	74	3
Preoperative oral rinse cardiac patients	49	0
Denture stomatitis	44	3
Xerostomia	37	1
Suspected staphylococcal infection	14	6
Mouth ulcer	12	0
White patches	3	0
Lichen planus and lichenoid reaction	3	3
Elderly	3	7
Total	1,363	143

NOTE. Some forms have >1 clinical detail recorded.
MRSA, methicillin-resistant *S aureus*; *MSSA*, methicillin-sensitive *S aureus*.

patient age, sex, referring clinical unit, clinical presentation, specimen type, and antibiogram.

The diagnostic laboratory was a Clinical Pathology Accreditation certified laboratory (no. 0566; the laboratory has now merged with the Bacteriology Laboratory, Glasgow Royal Infirmary), with all specimens processed according to a standard operating procedure. Briefly, all suspected Staphylococcal isolates from selective or nonselective agar were gram stained and tested for catalase (bioMérieux, Marcy L'Etoile, France), coagulase (Staphaurex, Remel Europe, Dartford, Kent, UK), and, where appropriate, API staph (bioMérieux, Marcy L'Etoile, France). All isolates underwent susceptibility testing using the Clinical and Laboratory Standards Institute methodology. MRSA isolates were sent for confirmation and typing to the Scottish MRSA Reference Laboratory, Stobhill Hospital, Glasgow. Genotyping was performed by the methods in use at the reference laboratory, which varied during the period of the study, but pulsed-field gel electrophoresis was used to define lineages.[14]

RESULTS

For the period 1998-2007, there were 11,312 specimens submitted to the laboratory. *S aureus* was isolated from 1,986 (18%) specimens. Of these, 1,782 (90%) were methicillin-sensitive *S aureus* (MSSA), and 204 (10%) were MRSA. The 1,986 specimens were collected from 1,429 patients, with MRSA isolated from 126 (9%) of these patients. The most common specimen type from which MSSA (Table 1) was isolated was an oral rinse (33%), whereas for MRSA isolates this was a tongue swab (25%) (Table 1). The clinical description most commonly reported on laboratory request sheets for MSSA isolates (Table 2) was angular cheilitis (26%). A significant proportion of both MSSA (20%) and MRSA (22%) isolates were associated with erythema and swelling or pain and burning of the oral mucosa. For MRSA isolates, clinical descriptions on laboratory request sheets reported a larger proportion of suspected candidal infections (31%) (Table 2). With regard to the sources of specimens, most MSSA isolates were recovered from specimens submitted from the oral medicine department of Glasgow Dental Hospital, and patients from whom MRSA isolates were recovered were most commonly seen by community dental practitioners serving settings such as nursing homes and hospice centers for the terminally ill.

There were a total of 143 MRSA isolates available for typing specimens. The most common genotypes were E15 (n = 61; 67%) and E16 (n = 20; 22%); the remainder were a variety of genotypes. There was no particular pattern over the 10-year period in isolation rates of *S aureus* or MRSA genotypes.

DISCUSSION

Although this study presents an older data set (1998-2007), it extends previous observations on *S aureus* in the oral cavity for specimens submitted from patients with suspected oral and perioral diseases in a larger cohort. In this article covering a longer time period, we detected a larger proportion of specimens (10% vs 5%) and patients (10% vs 6%) positive for MRSA compared with our previous 3-year retrospective study.[13] However, these data must be interpreted with caution because specimens submitted to the laboratory depend on referral patterns from different clinics and clinical preferences, which will vary over a 10-year period. The difference in types of specimen from which MSSA (oral rinse) and MRSA (tongue swab) isolates were predominantly recovered is an interesting observation and may reflect differences in binding to epithelial cell receptors.[15] Alternatively, the association of both types of *S aureus* with mucosal disease (erythema and burning mouth) may reflect production of exotoxins by selected strains of *S aureus*.[7,16] Confounding factors also include variations in referral patterns because *S aureus* recovery rates increase in denture-wearing patients and patients with reduced salivary secretion. Detection rates may reflect increased carriage rather than disease association.

The recovery of MRSA from oral specimens from patients treated in a community setting is a timely reminder that MRSA is not restricted to the hospital environment or indeed the usually cited body niches (nose, throat, perineum). This reinforces the importance of standard infection control precautions for all patients (CDC MMWR 2003)[17] when undergoing dental examination or treatment.

Of particular interest is the emergence of certain MRSA lineages that are genotypically distinct from recognized hospital-acquired strains; these are known as community-acquired MRSA, and USA300 (ST8-MRSA-IV) is an example.[18] These strains are more likely than hospital strains to carry the gene for the Panton-Valentine leukocidin and therefore may be associated with necrotic skin lesions and abscesses. The predominant MRSA genotype detected in this study (EMRSA-15) is the predominant one circulating in Scotland, and it is not unexpected that it should be the most common in this study. No MRSA isolates belonging to recognized community-acquired lineages were identified. Of further interest from the infection prevention perspective is the recovery of small numbers of *S aureus* from aspirates of acute dental infections (n = 21). Nosocomial *S aureus* oral infections have been previously reported,[10] and it is possible that the isolates detected in this study are the result of cross-infection.[11] However, the lack of appropriate use of diagnostic microbiology