Highly dynamic transient colonization by *Staphylococcus aureus* in healthy Malaysian students

Staphylococcus aureus carriage is a risk factor for infection in both community and hospital settings. Three main *S. aureus* carriage patterns have been described: non-carriage, persistent carriage (repeatedly culture-positive) and transient or intermittent carriage (may or may not carry at different time intervals). Persistent carriage in particular is associated with a higher risk for infections (Nouwen *et al.*, 2005, 2006). Although the anterior nares are the primary colonization site for *S. aureus*, throat carriage has frequently been reported (Uemura *et al.*, 2004; Mertz *et al.*, 2007). In Malaysia, the prevalence of nasal carriage of *S. aureus* is within the reported range of 20–25 % (Choi *et al.*, 2006; Neela *et al.*, 2008). However, data on the pattern of *S. aureus* carriage and the incidence of throat colonization are still unknown. Therefore, the aims of the current study were to determine the *S. aureus* carriage pattern of local Malaysian residents and the incidence of strain carriage in the nose and throat and to investigate the strain types carried in the nose and throat of the same subject.

A total of 324 nasal and throat swabs were collected by a trained health-care worker from 162 healthy students at the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang (Mertz *et al.*, 2007). Among the 162 subjects sampled, 95 (58.6 %), 64 (3.5 %) and 3 (1.9 %) were Malay, Chinese and Indian, respectively. *S. aureus* was isolated and identified from the nasal and throat swabs of the subjects as described by Uemura *et al.* (2004). The possibility of more than one strain type per sample was hereby ignored. Subjects positive for *S. aureus* in either their throat or nose were further sampled 1 month after the first sampling to determine their carriage pattern. *spa* typing was carried out according to Harmsen *et al.* (2003). All *S. aureus* isolates were tested for oxacillin resistance by using an oxacillin and a cefoxitin disc, in accordance with guidelines issued by the Clinical and

Laboratory Standards Institute (formerly the National Committee on Clinical Laboratory Standards). All strains were subjected to a PVL toxin gene PCR (Lina *et al.*, 1999).

In the first investigation, among the 162 subjects screened, 51 or 31.5 % (Malay, 34; Chinese, 16; Indian, 1) were colonized with *S. aureus*, of which 12 (23.5 %) and 28 (54.9 %) carried in the nose and throat, while 11 (21.5 %) were colonized at both anatomical sites. Twenty-two isolates from the 11 subjects colonized on both sites were subjected to *spa* typing; 3 carried (Table 1) the same strain in the nose and throat, while the other 8 were colonized with different strains. In the second investigation, among the 51 subjects (positive at the first investigation) screened, only 12 (23.5 %) were still colonized with *S. aureus*, of which 5 (41.6 %) and 7 (58.3 %) carried in the nose and the throat, while none of them were colonized at both sites. When the *spa* types of the strains from the 12 subjects from both investigations were compared, none of the subjects carried the same strains, indicating that the *S. aureus* carriage pattern was of a transient nature and the strains were of diverse genetic backgrounds. However, in both investigations, the sites of colonization were persistently occupied in subjects albeit with different strains. Overall, among the 162 subjects studied, 31.5 % ($n=51$) and 68.5 % ($n=111$) were transient carriers and non-carriers, respectively. No real persistent carriers were observed. None of the subjects were colonized with methicillin-resistant *S. aureus* (MRSA) or *pvl*-positive strains. Based on the percentage of three important ethnic groups in Malaysia, a chi-square goodness-of-fit test revealed that the prevalence of nasal carriage of methicillin-sensitive *S. aureus* among different ethnic groups ($P=0.157$) did not vary significantly.

Many studies have described the rates of nasal carriage in various populations (Kluytmans *et al.*, 1997). Nasal carriage rates have been shown to differ among races (Findlay & Abrahams, 1946; Noble, 1974) and also among people of different histocompatibility antigen (human leukocyte antigen) types (Kinsman *et al.*, 1983). However, studies on the precise *S. aureus* carriage pattern are limited, despite its importance in association with infection (Nouwen *et al.*, 2006). Here we describe the carriage pattern of *S. aureus* in healthy, young individuals in Malaysia. Overall, we found a 31.5 % carriage prevalence, which is slightly higher than the rate reported in Malaysia previously (Neela *et al.*, 2008), but within the range reported in other studies (25–35 %) (Wertheim *et al.*, 2005). One of the main reasons for recording an elevated carriage rate could be due to the inclusion of throat carriage. Our study shows that local *S. aureus* colonization patterns are primarily transient as no identical strains were isolated during the first and second investigations that had identical *spa* types. The absence of MRSA supports earlier investigations that MRSA carriage is still very low outside the health-care environment in Malaysia (Choi *et al.*, 2006; Neela *et al.*, 2008). Although both the throat and nose are habitats for *S. aureus*, isolates from both locations in the same individual were of different clones in 8 out of 11 subjects. Our results are in accordance with the findings of Uemura *et al.* (2004), who reported 11 out of 16 subjects being colonized in the nose and throat by different clones of *S. aureus*.

We show that *S. aureus* carriage in Malaysians is primarily transient with diverse bacterial genotypes occurring in single individuals. This suggests that screening for *S. aureus* or MRSA should involve both the throat and nose. This will increase the sensitivity of testing and aid in detecting multiple strain colonization.

Table 1. *spa* types of the first and second investigations

No.	Sample no.*	<i>spa</i> type	
		First investigation	Second investigation
1	1N		
	1T	t037	t2360
2	2N		
	2T	t4224	t008
3	10N		
	10T	t008	t4938
4	19N		
	19T	t688	t714
5	28N		
	28T	t521	t091
6	29N		
	29T	t3864	t359
7	32N		
	32T	t60	t267
8	37N	t84	t2636
	37T		
9	83N	t714	t008
	83T		
10	47N	t878	t359
	47T	t878	
11	49N	t189	t1544
	49T	t189	
12	59N	t037	t1427
	59T	t037	

*N, Nasal isolate; T, throat isolate.

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