Relation between quantitative nasal cultures and dissemination of staphylococci

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Quantitative nasal cultures, skin cultures, and air samples using slit-samplers have been made on 250 hospitalized patients. Only 4 per cent of skin cultures from patients who were not nasal carriers of staphylococci and 5 per cent of skin cultures from patients who were nasal carriers of less than 100,000 colonies per culture contained coagulase-positive staphylococci. However, 44 per cent of cultures of the skin of patients who were nasal carriers of more than 100,000 colonies contained staphylococci. Aerial dissemination of staphylococci during activity was also greater in patients who were nasal carriers of large numbers of bacteria. Over 20 colonies per cubic foot of air could be recovered from 35 per cent of air samples around patients who were carriers of over 100,000 colonies per culture but from only 8 per cent of air samples from patients who were either noncarriers or carriers of less than 100,000 colonies. Carriers of small numbers of staphylococci appear to be no greater hazard in the dissemination of staphylococci than are patients who are not nasal carriers.

In several studies[1, 2] a correlation between nasal carriers of staphylococci and staphylococcal infections has been described. Patients who were nasal carriers acquired postoperative infections and other types of staphylococcal disease more frequently than patients who were not nasal carriers. Also, a higher incidence of staphylococcal infections has been reported in the families of infants who were nasal carriers and who disseminated staphylococci in large numbers than has been reported in the families of infants who were also nasal carriers but who disseminated staphylococci poorly.[3]

The increased dissemination of staphylococci by infants who were nasal carriers was associated with concomitant viral infections. Therefore, it was postulated that viral infections might increase the number of staphylococci available for dissemination, increase mucous production and greater dissemination, or alter surface tensions and viscosity of the nasopharynx so that the same number of staphylococci might be disseminated more readily.

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In previous studies of quantitative nasal cultures for staphylococci among hospitalized patients, it was found that staphylococci could be isolated more frequently but not in larger numbers from the clothing of nasal carriers of large numbers of staphylococci as compared to either carriers of smaller numbers of organisms or to noncarriers.[4] Cultures of clothing were made by sweeping open Petri dishes over the patients' gowns, a relatively insensitive method for quantitating bacterial contamination. These studies have been continued using more accurate methods for measuring aerial dissemination; again, staphylococci could usually be isolated more frequently from the environment of heavy nasal carriers and, in addition, larger numbers of staphylococci were present more frequently in positive air samples collected around heavy carriers than in air samples collected around light carriers or noncarriers.

Methods

The methods of collecting and enumerating quantitative nasal cultures and phage typing of staphylococci were those described previously.[5] All staphylococci were coagulase-positive.

Air samples were collected near the beds of patients on the wards of the Louisville General Hospital using slit-samplers[6] at the rate of 1 cubic foot of air per minute. Only samples from patients without overt staphylococcal infections were included. Since we were attempting to observe conditions as generally present on the ward, no attempts were made to either increase or decrease activity during the period of sampling, but one sample from each patient was made while the patient was resting quietly in bed and one sampling from each patient was made while the sheets were shaken lightly for 15 seconds during the collection period.

Skin cultures were made by swabbing an area 3 by 1 inches on the forearm with a cotton swab moistened with heart infusion broth. The swab was then placed in a culture tube with 3 ml. of heart infusion broth and shaken for 5 minutes in a Kahn shaker. The broth was then enumerated for staphylococci as reported for nasal cultures.

Results

Coagulase-positive staphylococci were present in 4 per cent of skin cultures from patients who were not nasal carriers of staphylococci and in 5 per cent of skin cultures from patients who were carriers of less than 100,000 colonies per swab (Table I). However, staphylococci could be isolated from 44 per cent of

Table I. Correlation between quantity of staphylococci in the nose and the frequency of staphylococci on the skin

No. nasal staphylococci	*No. patients*	*Positive skin cultures*		
		No.	*%*	
0	139	6	4	
10^1-10^2	2	0	0	5
10^2-10^3	13	1	8	
10^3-10^4	10	1	10	
10^4-10^5	16	0	0	
10^5-10^6	18	7	39	44
$> 10^6$	23	11	48	
Total	221	26	12	

Table II. Correlation between numbers of staphylococci in the nose and in the air while patients were resting

No. nasal staphylococci	*No. patients*	*Positive air sample*		*> 5 colonies/ cubic foot*		*> 10 colonies/ cubic foot*	
		No.	*%*	*No.*	*%*	*No.*	*%*
0	112	13	12	5	4	2	2
10^1-10^2	1	1	100	0	0	0	0
10^2-10^3	9	0	0	0	0	0	0
10^3-10^4	10	4	40	2	20	0	0
10^4-10^5	16	2	13	2	13	2	13
10^5-10^6	16	4	25	3	19	2	13
$> 10^6$	23	5	22	3	13	2	9
Total	187	29	16	15	8	8	4

skin cultures from patients who were nasal carriers of more than 100,000 colonies per swab. Seventy-five per cent of staphylococci isolated from the skin of nasal carriers were the same phage type as those isolated from the nose.

Air samples were collected near 187 patients while they were resting quietly in bed (Table II). There were only slight differences in the frequency with which staphylococci could be isolated from the air around patients who were not nasal carriers than from that around either light or heavy nasal carriers. However, large numbers of staphylococci were present more frequently in air samples from patients who were nasal carriers of over 100,000 colonies per swab than in air samples from either noncarriers or carriers of less than 100,000 colonies. Seventy per cent of staphylococci isolated from air samples around nasal carriers were the same phage type as those isolated from the nose.

When the patients' sheets were shaken lightly for 15 seconds during the collection period, staphylococci were present in air samples approximately twice as frequently as when the air samples were collected with the patients resting quietly (Table III). Furthermore, staphylococci were isolated both more frequently and in larger numbers from air samples around nasal carriers of more

Table III. Correlation between numbers of staphylococci in the nose and in the air during activity

No. nasal staphylococci	*No. patients*	*Positive air sample*		*> 10 colonies/ cubic foot*		*> 20 colonies/ cubic foot*	
		No.	*%*	*No.*	*%*	*No.*	*%*
0	120	25	21	18	15	10	8
10^1-10^2	4	1	25	0	0	0	0
10^2-10^3	12	3	25	2	17	2	17
10^3-10^4	10	4	40	2	20	1	10
10^4-10^5	11	5	45	2	18	0	0
10^5-10^6	19	11	58	8	42	6	32
$> 10^6$	23	12	52	11	48	9	39
Total	199	61	31	43	22	28	14

than 100,000 colonies per swab than from air samples around either noncarriers or carriers of less than 100,000 organisms per swab. Thus, more than 20 staphylococcal colonies per cubic foot of air were present in 36 per cent of air samples around nasal carriers of more than 100,000 colonies, but only 8 per cent of air samples around either nasal carriers of less than 100,000 colonies or noncarriers contained this many staphylococci.

Twenty-eight strains of staphylococci from samples of air around nasal carriers were the same phage type as staphylococci isolated from the nose. The remaining 8 strains from air samples around carriers and the 25 staphylococci in the air around noncarriers were presumably derived from sources other than the nose of the patient.

Discussion

The role of the many possible sources of staphylococci on the occurrence of staphylococcal infections is not completely established. The largest reservoir of staphylococci, however, appears to be in the nose of patients and personnel, and a number of investigators believe that this is the major source of infections.[7]

Among patients who are nasal carriers there is a wide range of the number of staphylococci which can be recovered from the nose. In this study the number of staphylococci isolated varied from less than 100 to more than one million colonies per culture. Staphylococci could be recovered infrequently from the skin of nasal carriers of small numbers of these organisms but could be recovered from the skin of almost half of the nasal carriers of more than 100,000 staphylococci per swab. Also, air samples around patients who were heavy nasal carriers contained large numbers of staphylococci more frequently than air samples collected around light carriers or noncarriers.

The incidence of staphylococcal infections depends not only on the availability of staphylococci but also on the resistance of the patient to infection. However, other factors being equal, staphylococcal infections might be expected to be more frequent in an environment in which large numbers of staphylococci are present. If the patient population contained a large proportion of heavy nasal carriers of staphylococci, greater aerial dissemination of these organisms would be expected.

It remains to be proved, however, that nasal carriers of large numbers of staphylococci are a greater hazard to the carrier or to other patients in initiating infections than are nasal carriers of smaller numbers of staphylococci.

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