

The bacterial flora of the nasal cavity in healthy young men

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SUMMARY

The nasal cavity of 97 young healthy men (applicants for the pilot education in the Finnish Air Force) was examined. Bacterial culture demonstrated one or more species of aerobic bacteria in all 194 nasal cavities examined and anaerobic bacteria in 76.5%. In ten per cent of the cultures bacteria were detected after enrichment only. The most common aerobic bacteria were Staphylococcus epidermidis (79%), diphtheroids (41%) and Staphylococcus aureus (34%). Haemophilus influenzae was found in 5% and Streptococcus pneumoniae in 0.5%. Anaerobic culture yielded Propionibacterium acnes in 74.5% and Peptococcus magnus in 3.5%.

"Common cold" is the most frequent cause of upper respiratory tract infection during the cold season of the year. As a rule, common cold is an innocuous viral disease and patients recover completely in less than a fortnight. However, in some individuals complications develop, mostly bacterial infection affecting the nasal cavity and paranasal sinuses. Complications are most likely to occur if predisposing factors such as pathological changes in the mucous membrane, anatomical deformity or opportunistic pathogenic bacteria are present in the nasal cavity. This study was designed to investigate the condition of the mucous membrane and the bacterial flora of the nasal cavity in healthy subjects. The results of bacteriological and cytological examinations were compared with clinical findings and history.

SUBJECTS

Ninety-seven young men aged 18-22 years (mean 19.5 years) entered the study. They were selected among the men applying for pilot education in the Finnish Air Force in May 1984. The applicants were aware of the strict criteria by which only 40 of some 1000 applicants would be accepted for the training programme. The selection of trainers was made mainly on the basis of psychophysiological tests. Thus all the applicants considered themselves physically fit and completely healthy. None of the examined had been treated with antimicrobial agents during the preceding four weeks.

METHODS

History taking included questions about symptoms of upper respiratory tract infections, nasal congestion or discharge, and allergic symptoms. The clinical examination was performed by an ENT specialist. Anterior rhinoscopy was employed to examine the nasal cavity for the condition of the mucous membrane and possible presence of secretion in the nasal cavity. The cytological sample was taken from the posterior parts of the nasal cavity on both sides. A nasal secretion sample for bacterial analyses was taken through a nasal speculum, care being taken to avoid contamination from the vestibule. The bacteriological sample was placed in modified Stuart's transport medium (Transpocult, Orion Diagnostica, Helsinki, Finland) in which it was immediately transported to the bacteriological laboratory. The sample was cultured within 30 min on to blood and chocolate agar and Brucella agar media, supplemented by vitamin K1 and hemin, for isolation of aerobic and anaerobic bacteria. Aerobic plates were incubated in an atmosphere containing 5% CO₂ for 48 hrs, anaerobic plates in jars filled with mixed gas (10% H₂, 10% CO₂, 80% N₂) for seven days. Thioglycollate broth was inoculated as enrichment. Bacteria were identified by standard methods (Holdeman et al., 1977; Sutter et al., 1980; Lennette et al., 1980).

The sample for cytological examination was smeared on the objective slide, fixed in air and stained with the haematoxylin and eosin staining method. The number of cells was counted under the microscope and interpreted as follows: 20 or more cells per high power field (1000 ×) were classified as "many", 5-20 as "moderate" and less than 5 cells as "few".

Sixty-three of the subjects underwent radiological examination of the paranasal sinuses by occipitontal projection. Fifty subjects were tested for equalization of middle ear pressure in underpressure chamber. All of them passed the test.

RESULTS

Clinical findings

At the time of examination none of the subjects had significant clinical symptoms or signs of infection of the nasal cavity or paranasal sinuses. When asked 27 men reported slight nasal blockage and four some nasal discharge. Five gave a history of seasonal and four a history of chronic rhinitis (Table 1). Only one subject received treatment for his nasal symptoms (Lunarin mite). Anterior rhinoscopy did not reveal any abnormality in 76 subjects. Unilateral slight edema of the nasal mucous membrane was noted in 5 cases, unilateral lividity in 4, and dry crusts in 3. Bilateral edema was seen in 7 cases, lividity in 2, and crusts in 3 cases (Table 1). Deformity of the nasal septum was noted in 12 cases. No or clear (translucent) secretion was seen in 79 nasal cavities. Mucous secretion was found bilaterally in 15 cases and unilaterally in 2 cases. Yellowish secretion was present bilaterally in one case (Table 1).

Table 1. Clinical nasal symptoms and rhinoscopic findings in 97 healthy young men.

	cases
no symptoms	57
some nasal stuffiness	27
nasal discharge	4
history of allergic rhinitis	9
anterior rhinoscopy:	
normal	76
edema; bilaterally	7
unilaterally	5
lividity; bilaterally	2
unilaterally	4
crusts; bilaterally	3
unilaterally	3
secretion; clear or none	79
mucous bilaterally	15
unilaterally	2
mucopurulent bilaterally	1
septal deviation	12

Cytological findings

The nasal smears were studied for polymorphonuclear neutrophils (PMN) and eosinophilic leukocytes (Eos). Only a few or no PMNs were found in 171 nasal cavities. Eight samples showed many and 15 samples moderate numbers of PMN in the smear. Samples from 174 nasal cavities had few or no Eos. Many Eos were found in 6 and a moderate number in 14 nasal cavities (Table 2).

Table 2. Results of the cytological examination of the nasal secretion in 97 healthy men.

cell, type	many (+ + +)	moderate (+ +)	few(+) or none
PMN	8	15	171
Eos	6	14	174

Radiological findings

Radiological findings in the paranasal sinuses were normal in 58 of the 63 cases studied. A small cyst-like formation in the maxillary antrum was noted in 3 sinuses and swollen mucosa in the antrum of 2 cases.

Bacteriological findings

None of the bacterial cultures was negative. At least one species of aerobic bacteria was cultured from every cavity and at least one species of anaerobic bacteria from 76.5% of the cavities.

Table 3 lists the most common aerobic and Table 4 the most common anaerobic

Table 3. Aerobic bacteria cultured from the nasal cavity in 97 healthy young men.

bacteria	number of positive cultures	per cent
<i>Staphylococcus epidermidis</i>	154	79
<i>Diphtheroids</i>	80	41
<i>Staphylococcus aureus</i>	66	34
<i>Haemophilus influenzae</i>	10	5
<i>alpha-hemol. streptococcus</i>	8	4
<i>Moraxella species</i>	7	3.5
<i>Branhamella catarrhalis</i>	6	3
<i>Proteus mirabilis</i>	3	1.5
<i>Klebsiella oxytoca</i>	4	2
<i>Klebsiella pneumoniae</i>	3	1.5
<i>Enterobacter cloacae</i>	3	1.5
<i>Escherichia coli</i>	2	1
<i>Neisseria meningitidis, grB</i>	2	1
<i>Streptococcus faecalis</i>	1	0.5
<i>Alcaligenes faecalis</i>	1	0.5
<i>Citrobacter freundii</i>	1	0.5
<i>Acinetobacter calcoaceticus</i>	1	0.5
<i>Streptococcus pneumoniae</i>	1	0.5

Table 4. Anaerobic bacteria cultured from nasal cavity of 97 healthy young men.

bacteria	number of positive cultures	per cent
<i>Propionibacterium acnes</i>	145	74.5
<i>Peptococcus magnus</i>	7	3.5
<i>Eikenella corrodens*</i>	1	0.5
negative cultures		23.5

* microaerophilic

bacteria. The most common aerobic bacterium was *Staphylococcus epidermidis* which was isolated from 154 nasal cavities (79%), followed by *diphtheroids* (80; 41%) and *Staphylococcus aureus* (66; 34%). Potential pathogenic bacteria were present in 11 nasal cavities, *Haemophilus influenzae* (Hi) in 10 (5%) and *Streptococcus pneumoniae* (Pn) in one (0.5%). Of anaerobic bacteria the most frequently isolated species was *Propionibacterium acnes*, which was present in 145 nasal cavities (74.5%). Other anaerobes were *Peptococcus magnus* (3.5%) and *Eikenella corrodens* (0.5%). Forty-six cultures (23.5%) did not yield anaerobic bacteria on culture.

The pathogenic bacteria (Hi or Pn) were always accompanied by nonpathogenic bacteria.

Correlation between clinical, cytological and bacteriological findings

Table 5 shows the results of the cytological examination, the condition of the mucous membrane as revealed by anterior rhinoscopy, and clinical symptoms in

Table 5. Cytological and rhinoscopic findings and nasal symptoms in nasal cavities with pathogenic bacteria in culture.

case no.	bacteria	cytology		mucous membrane	symptoms
		PMN	Eos		
1	HI	+++	+++	normal	none
2	HI	++	+	normal	none
3	HI	—	—	normal	none
4	HI	—	—	normal	none
5	HI	—	—	edema	a.rh.
6	HI	—	—	edema	a.rh.
7	HI	—	—	edema	none
8	HI	—	—	normal	none
9	HI	—	—	normal	none
10	Pn	—	—	edema	none

a.rh. = allergic rhinitis

the 10 nasal cavities with pathogenic bacteria. One secretion sample showed many PMNs and Eos and another a moderate number of PMNs, while the finding was completely normal in the remainder of cases. Anterior rhinoscopy revealed some mucosal swelling in 3 nasal cavities; the others being normal. One subject reported a history of allergic rhinitis. The rest had no nasal symptoms. None of the cases in which radiography revealed abnormality in the antrum had pathogenic bacteria on culture.

DISCUSSION

The aim of the present study was to obtain baseline data on the bacterial flora of the normal nose. In order to exclude any significant abnormality the subjects were examined by rhinoscopy to evaluate the condition of the nasal mucosa, exfoliative cytology and history taking. We chose applicants for pilot training in the Air Force to represent a "normal" population sample partly because, subjectively, they were probably the healthiest portion of the population and partly because they were to undergo a pressure chamber test which would identify any gross latent pathology in the nasal airways. It is often very difficult to select healthy normals for this type of study, because substantial pathological changes, though present in the nasal cavity, may not cause subjective nasal symptoms. Moreover, when specifically questioned, few individuals consider themselves completely free from nasal symptoms.

In many earlier reports on bacteriological (or cytological) baseline data, the term "symptom free nose" was used to denote the normal healthy nose, and subjects were usually collected among patients consulting an otolaryngologist for other reasons than nasal problems. Very few of these studies combined bacteriological culture with cytological examination of the secretion. In a cytological study of nasal secretion samples from 98 "symptom free" volunteers, Holopainen (1967)

reported negative bacterial culture in 80 cases, saprophytes in 12, and poorly growing pathogenic bacteria in 6 cases. Five percent of nasal smears showed fairly abundant numbers of PMNs but possible correlations between PMN occurrence and pathogenic bacteria were not discussed.

Also other early studies of nasal secretion report very few cells, mainly PMNs (Torrighiani, 1925; Hilding, 1930). According to Urfer (1937), it was not possible to define the borderline between normal and inflammatory secretion.

In the present study cytological examination revealed increased numbers of PMNs in 23 nasal cavities (many in 8 and moderate in 15-12%). Pathogenic bacteria (Hi and Pn) were isolated from only 2 of these nasal cavities, and of the 11 cases from which pathogenic bacteria were cultured, only 2 showed an increase of PMNs in the nasal smears. This indicates that no active infection was present in most of the cavities which were found to harbour pathogenic bacteria.

Secretion eosinophilia was observed in 20 cavities (11%). A history of allergic rhinitis was almost equally frequent (9%) but a positive history of allergic symptoms coincided with secretion eosinophilia in only two subjects. According to Malmberg (1979) increased numbers of eosinophils are found in about 10% of nasal smears of healthy normals. No correlation was observed between secretion eosinophilia and pathogenic bacteria in our study. The only case positive both for pathogenic bacteria and secretion eosinophilia also showed many PMNs in the smear.

The normal flora of nose includes staphylococci, diphtheroids and other saprophytic bacteria in variable percentages (Palva et al., 1962; Lystad et al., 1964; Hays and Mullard, 1972; Axelsson and Brorson, 1973; Winther et al., 1984). Usually the frequency of staphylococci has been found to be fairly low, ranging from 15% (Hays and Mullard, 1972) to 33% (Axelsson and Brorson, 1973). These percentages are considerably lower than our figures (*S. epidermidis* 79%, diphtheroids 41% and *S. aureus* 34%).

According to earlier studies, part of the nasal cavities do not show any growth of bacteria, the proportions of negative cultures varying between 10% (Axelsson and Brorson, 1973) and over 50% (Winther et al., 1984). In our subjects the nasal culture was positive at least for one bacterial species. These differences in findings may partly be explained by differences in methods. We placed special emphasis on prompt (< 30 min) processing of the specimen and employed aerobic and enrichment methods simultaneously. For anaerobes we used prolonged 7-day incubation, which has been shown to enhance recovery of anaerobes (Sutter et al., 1980). Ten per cent of our isolates grew only after enrichment in thioglycollate broth. The normal anaerobic flora of the nose has not yet been very well documented in the literature. Our findings indicate that at least such species as *Propionibacterium acnes* and *Peptococcus magnus* are part of the normal nasal flora.

ZUSAMMENFASSUNG

Die Nasenkavität von 97 jungen Männern (Bewerber um einen Studienplatz bei der Pilotenausbildung der Finnischen Luftwaffe) wurde untersucht. Bakterienkultur wies eine oder mehrere Arten von aerobischen Bakterien in allen von 194 untersuchten Kavitäten nach und anaerobische Bakterien in 76.5%. In zehn Prozent von den Kulturen wurden Bakterien nur nach Anreicherungskultur entdeckt. Die häufigsten aerobischen Bakterien waren *Staphylococcus epidermidis* (79%), *diphtheroids* (14%) und *Staphylococcus aureus* (34%). *Haemophilus influenzae* konnte man in 5% und *Streptococcus pneumoniae* in 0.5% feststellen. Die anaerobische Kultur wies *Propionibacterium acnes* in 74.5% und *Peptococcus magnus* in 3.5% nach.

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