Bacterial contamination of home nebulisers

We have shown that the bacteriostatic and bactericidal agents edetic acid and benzalkonium chloride present in nebuliser solutions may cause bronchoconstriction when inhaled by asthmatic patients and suggested that this may account for some of the pardoxical bronchoconstriction that occurs after inhalation of nebulised bronchodilator aerosols.[1] As antibacterial agents may be removed from nebuliser solutions in the future we have investigated the extent of bacterial contamination of portable nebulisers used in domiciliary practice.

Patients, methods, and results

With the approval of Southampton University and Hospital's ethical committee, home visits were made to 50 patients aged 1-88 years (28 male, 22 female) who were using jet nebulisers at home for airways disease. Thirty four of the patients had asthma, 15 chronic obstructive bronchitis, and one cystic fibrosis. Bacterial samples were obtained from the face mask or mouthpiece directly on to agar plates held 10 cm from the outlet for one minute during nebulisation of the drug routinely used by the patient. On completion of nebulisation a 0·01 ml sample was removed from the remaining solution in the nebuliser and plated on to blood, chocolate, and cled agar plates. All plates were incubated aerobically for three days at 37°C and inspected for bacterial growth on days 2 and 3.

The 50 patients used different types of compressor manufactured by Medic-Aid (33 cases), Medix (14), Bard International (two), and Aerosol Products (one). The Acorn nebuliser (Medic-Aid) accounted for 39 of the aerosol generating units, irrespective of the type of compressor being used. Forty six patients used their nebulisers every day to deliver salbutamol (26 cases), sodium cromoglycate (13), terbutaline (three), beclomethasone dipropionate (two), ipratropium bromide (one), and tyloxapol (one). Appreciable bacterial contamination (>5 colony forming units/plate) was found in samples from 23 of the 50 nebulisers. This comprised contamination of the aerosol alone (10), reservoir fluid alone (five), and both aerosol and reservoir (eight). The table lists the range of bacteria cultured.

Bacterial isolates from nebuliser aerosols and solutions

Gram negative	Frequency*	Gram positive	Frequency*
Pseudomonas sp	4	*Staphylococcus albus*	23
Acinetobacter sp	2	Diphtheroids	11
Serratia marcescens	2	*Micrococcus* sp	8
Flavobacterium sp	2	β Haemolytic streptococcus	2
		Streptococcus viridans	1
		Staphylococcus aureus	1

*Number of positive isolates out of 50 units tested.

The same organisms were cultured in seven of the eight samples in which both aerosol and reservoir were contaminated. Nebulisers used to deliver drug solutions not containing preservatives (sodium cromoglycate, terbutaline, tyloxapol) were contaminated more frequently than those with preservatives (salbutamol) (50% *v* 16%, p=0·03; Fisher's exact test). In the case of salbutamol contamination was more frequent with the respirator solution containing 0·02% vol/vol benzalkonium chloride than with the prediluted unit doses containing 0·01% vol/vol of this agent, though the difference just failed to reach significance (p=0·06).

Comment

In this study over one third of nebulisers used in domiciliary practice were found to be contaminated with bacteria. The findings confirm a study from New Zealand in which a similar high incidence of contamination of home nebulisers was found.[2] In contrast with studies in which Gram negative bacilli predominated,[2] the most frequent bacterial isolates from aerosols and solutions in this series were Gram positive cocci. Though most of the bacterial isolates were of low pathogenicity, all were capable of causing severe lung infection, especially in immunocompromised hosts.[3,4] The high frequency of *Staphylococcus albus*, diphtheroids, and micrococci isolates suggests transfer of organisms from skin to the nebuliser chamber.[5] Isolation of the same bacterial species from both the aerosol and the nebuliser reservoir in seven of our eight cases when organisms were grown from both sources shows that enough bacteria were present in the nebuliser solution to be inhaled. A further finding was the inverse relation between the frequency of bacterial contamination and the presence of bacteriostatic agents in the drug solutions most frequently used by the patient.

Thus bacterial contamination is a frequent finding in home nebulisers and may be a source of pathogens. To diminish this risk we recommend careful and regular washing of nebulisers after use and their storage in dilute disinfectant solutions between use.

This work represents part of a fourth year medical student's study in depth by KLB.

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A simple test to diagnose iritis

Iritis (anterior uveitis) is difficult to diagnose without a slit lamp biomicroscope because the symptoms are non-specific and the macroscopic signs unreliable. Redness of the eye may be minimal, and microscopic adhesions between the lens and the iris occur in only 20%. The pain of iritis can be exacerbated by near visual tasks. This symptom, previously unreported, was investigated and a simple screening test developed that depended on inducing the synkinetic triple response (constriction of the pupils, accommodation of the lens, and convergence).

Patients, methods, and results

The investigation was in two parts. Firstly, a near visual stimulus (causing synkinesis) and a direct light stimulus (causing pupillary constriction alone) were compared to determine which was most effective at exacerbating iritic pain (comparison test). Consecutive new adult patients were examined at presentation to the eye casualty department. Patients were excluded if they had received steroid treatment or mydriatics. All patients were examined by slit lamp biomicroscopy to grade the cellular activity and identify posterior synechias. All received local anaesthetic eye drops to exclude pain from corneal or conjunctival lesions. Glasses were not worn. Altogether 56 patients were diagnosed as having iritis by biomicroscopy (2% of 2954 new patients). In the comparison test focusing on a reading card as it approached along a centimetre rule reproducibly exacerbated pain in 30 of the 56 patients with iritis. Blurring without pain, or a weakly positive response, was regarded as a negative response. Direct stimulation by a 3·5 W halogen bulb held 15 cm from the patient exacerbated pain in only four of the first 30 patients tested; as this was obviously not effective at detecting iritis no further patients were tested. The difference between the two tests was highly significant ($\chi^2=17·7$; $p<0·0001$).

In the second part of the study a simplified near task, in which the patient's outstretched finger was used as the moving accommodative target instead of the reading card, was assessed as a screening test (figure). The test was performed by junior nurses on 426 new, unselected adult patients with miscellaneous eye complaints before any history was obtained or examination performed. A doctor subsequently diagnosed 19 cases of iritis by microscopy. The nurses identified 28 patients as having iritis, of whom 14 proved to have the condition on microscopy (positive predictive value 50%). The ability to recognise patients without iritis (specificity) was 97% and to detect patients with iritis (sensitivity) 74%.

Comment

Near visual tests stimulate accommodation and constriction of pupils, which increase the forces transmitted to the pain receptors in the root of the iris,[1] causing an exacerbation of pain in the iritic eye. The finger to nose convergence test does not depend on good vision because the synkinetic response is also stimulated by proprioception. It is not significantly affected by posterior synechias ($\chi^2=2·0$; $0·25>p>0·10$), and the result is positive even in cases of iritis secondary to keratitis and foreign bodies. For each patient with iritis the test will detect a false positive case, but this is not too onerous as iritis is uncommon.