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Use of nebulised saline and nebulised terbutaline as an adjunct to chest physiotherapy

P P SUTTON, H G GEMMELL, N INNES, J DAVIDSON, F W SMITH, J S LEGGE, J A R FRIEND

From the Departments of Respiratory Medicine, Physiotherapy, and Nuclear Medicine, Aberdeen Royal Infirmary, Aberdeen

ABSTRACT To determine whether sputum clearance is increased by using nebulised saline or terbutaline as an adjunct to chest physiotherapy, a radioaerosol method (using technetium-99m labelled human albumin millimicrospheres) was employed in eight patients with stable bronchiectasis on four occasions, for comparison of sputum clearance with four different regimens. These were: control, with the patient resting in an upright position; chest physiotherapy, by the forced expiration technique with postural drainage; and chest physiotherapy following five minutes' inhalation of either nebulised normal saline or nebulised terbutaline 5 mg. Use of both nebulised saline and nebulised terbutaline immediately before chest physiotherapy gave a significantly greater yield of sputum than did physiotherapy alone, and terbutaline also significantly increased radioaerosol clearance from the whole lung and from regions of interest. The mechanism is unclear, but this method may provide a simple way of increasing the efficacy of conventional chest physiotherapy.

Chest physiotherapy is widely used in hospital practice but there is little objective assessment of its value in different settings. A central function of chest physiotherapy in acute conditions is to mobilise excess secretions and enhance expectoration.[1] The use of an inhaled radio aerosol that is deposited on the tracheobronchial tree allows such secretions to be "labelled" and their subsequent clearance monitored. Use of this method has shown the contribution of cough,[2] vibration, or percussion[3] to clearance to be limited; greater clearance of airways secretions is obtained by the forced expiration technique in conjunction with postural drainage.[4,5] We have evaluated the use of nebulised saline and nebulised terbutaline as an adjunct to this optimal chest physiotherapy to determine whether sputum clearance is increased further.

Methods

We studied eight patients (six of them women), aged 36–71 years, with stable bronchiectasis on four occasions. Their mean daily sputum production was 36 (range 10–120) g. The results of spirometry before and after each of the four treatment days are shown in the table. No patient smoked, and bronchodilators and domiciliary physiotherapy were withheld on the morning of each study day.

Address for reprint requests: Dr P P Sutton, Hartlepool General Hospital, Hartlepool, Cleveland TS24 9RH.

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PHYSIOTHERAPY

The treatment schedules, given in randomised order, were: (1) control, patient resting upright; (2) chest physiotherapy; (3) chest physiotherapy following five minutes' inhalation of nebulised normal saline; (4) chest physiotherapy following five minutes' inhalation of nebulised terbutaline (5 mg).

Chest physiotherapy included the forced expiration technique and postural drainage and lasted for 20 minutes. For treatment 3, 4 ml normal saline was nebulised for five minutes immediately before physiotherapy by a Unicorn jet nebuliser with a mouthpiece and driven by oxygen at 8 l m^{-1}. For treatment 4, terbutaline respirator solution 5 mg in 4 ml was administered in an identical manner.

STUDY DESIGN

Spirometric measurements were recorded before each study. Radioaerosol was inhaled (see below) and the patient then sat with his back to a Nuclear Enterprise (NE5LF) gamma camera linked to a DEC PDP11/34 computer. Radioactive (Cobalt-57) markers were taped over the cervical spine and right lateral costal

Mean (SD) one second forced expiratory volume (FEV_1) and forced vital capacity (FVC) before and after treatments

	FEV_1			FVC		
*Treatment**	*Before*	*After*	*p*	*Before*	*After*	*p*
1	1·17 (0·79)	1·16 (0·74)	NS	1·70 (0·89)	1·74 (0·89)	NS
2	1·23 (0·80)	1·23 (0·78)	NS	1·76 (0·95)	1·81 (0·95)	NS
3	1·26 (0·73)	1·24 (0·73)	NS	1·85 (0·83)	1·81 (0·89)	NS
4	1·20 (0·73)	1·35 (0·77)	0·05	1·76 (0·88)	1·91 (0·89)	0·01

*1—control; 2—physiotherapy alone; 3—physiotherapy and saline; 4—physiotherapy and terbutaline.

margin. This allowed three equal vertical strips to be constructed over the right lung field, enabling the calculation of a "penetration index," the ratio of the activity deposited in the outer region to that in the inner region. This index indicated the initial distribution of inhaled radioaerosol and also allowed measurement of regional clearance in addition to whole lung clearance. Radioactivity was recorded for 30 minutes and expressed after correction for physical decay and background radiation. Each patient then underwent a 30 minute treatment period, after which spirometry was repeated (table). They then resumed their position in front of the gamma camera for a further 30 minutes. The clearance of radioaerosol was expressed as the percentage change in activity from immediately before the treatment period to after treatment. Expectoration was encouraged throughout and the wet weight of sputum was recorded during and for 30 minutes after each treatment period.

RADIOAEROSOL

Technetium ^{99m}Tc labelled human albumin millimicrospheres (CIS international) were nebulised through a Unicorn jet nebuliser driven by compressed air at 10 l min^{-1}, the aerosol being shielded and stored in a 20 litre reservoir bag. The patient emptied the contents of the bag by breathing slowly using tidal breathing through a rubber mouthpiece with a one-way valve and with an inspiratory pause of about three seconds. Exhaled air and particles were trapped by a filter. The radioactivity did not exceed 20 mBq a study, giving a lung dose of 2 mGy (200 mRad) and an estimated whole body dose of 0·1 mGy. Permission for this study was given by the DHSS Administration of Radioactive Substances Committee.

STATISTICAL ANALYSIS

Two way analysis of variance was used to compare pretreatment spirometric measurements and the Wilcoxon rank test for paired differences for all other comparisons.

Results

There was no significant difference in pretreatment spirometric values on the different treatment days. The

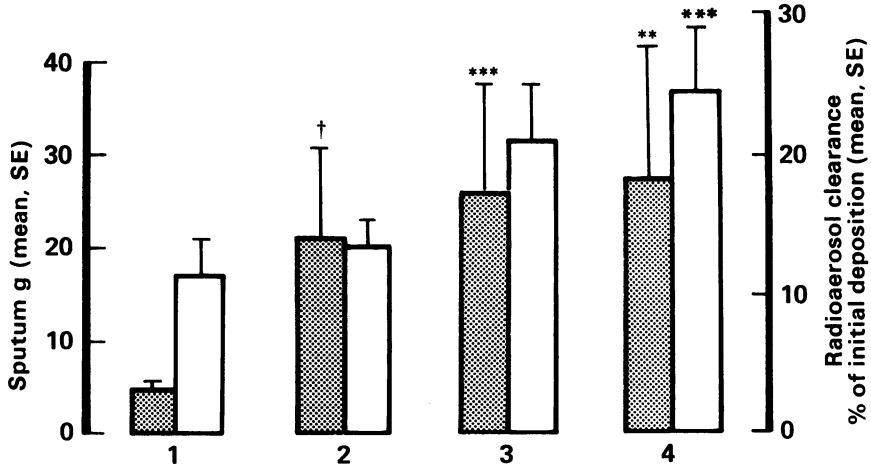

Fig 1 *Mean (SE) sputum weight and whole lung radioaerosol clearance after treatments 1–4 (see table). Hatched columns indicate sputum and open columns radioaerosol. **$p < 0.02$ and ***$p < 0.01$ v treatment 2; †$p < 0.01$ v treatment 1.*

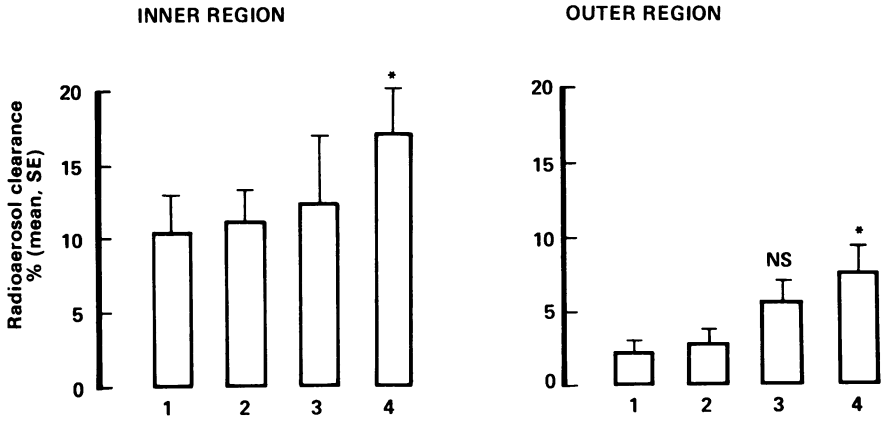

Fig 2 *Mean (SE) regional clearance of radioaerosol during and after treatments 1–4 (see table). *p < 0·05 v treatment 2.*

mean (SE) penetration index indicated a similar distribution of inhaled radioaerosol on each study day: treatment day 1, 0·44 (0·09); day 2, 0·61 (0·16); day 3, 0·52 (0·08); day 4, 0·57 (0·11). During treatments 1, 2, and 3 there was no significant change in FEV_1 or forced vital capacity (FVC) but after treatment there was a small but significant increase in FEV_1 ($p < 0·05$) and FVC ($p < 0·01$).

There was an increase in sputum yield ($p < 0·01$) between the control (treatment 1) and chest physiotherapy alone (treatment 2). Nebulised saline (treatment 3) and terbutaline (treatment 4) both caused a further increase in sputum yield above that achieved by physiotherapy alone ($p < 0·01$ and $p < 0·02$ respectively).

Terbutaline caused a significantly more whole lung radioaerosol clearance ($p < 0·01$) than did physiotherapy alone (fig 1). There was a similar stepwise increase in regional clearance of radioaerosol for both the inner region (predominantly large airways) and the outer region (small airways) from treatment 1 to treatment 4 (fig 2). The difference between nebulised terbutaline and physiotherapy alone was significant ($p < 0·05$) for both regions.

Discussion

The use of both nebulised saline and nebulised terbutaline immediately before chest physiotherapy gave a greater sputum yield than did physiotherapy alone. Both treatments also increased radioaerosol clearance both from the whole lung and from regions of interest above that achieved with physiotherapy alone, though the increase was statistically significant only after nebulised terbutaline.

Litt[6] postulated that hydration of periciliary fluid may be necessary to obtain optimal mucociliary clearance of secretions, and Pavia *et al*[7] showed enhanced mucociliary clearance after inhalation of saline aerosol. $Beta_2$ sympathomimetics have been shown to stimulate ion transport and water shift towards the airway lumen,[8] providing a further mechanism for increased hydration. Direct application of terbulatine will also increase ciliary beat frequency, tracheal mucus velocity, and whole lung clearance of airway secretions.[9] Thus the enhanced sputum yield after the addition of nebulised saline or terbutaline may be due to direct hydration or specific β_2 adrenergic stimulation, or to both mechanisms. The minor bronchodilatation that follows terbutaline may also aid the effectiveness of physiotherapy in some way, perhaps by increasing effective expiratory flow rates or improving regional ventilation; but the relationship between bronchodilatation and subsequent sputum clearance has not been specifically studied.

Thus the use of nebulised saline and terbutaline has been shown to increase the clearance of secretions when added to chest physiotherapy in patients with bronchiectasis. Although the mechanism of action remains unclear, their use may represent a simple means of improving the efficiency of conventional chest physiotherapy.

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