ables him to move the largest volumes of air most efficiently (as normal subjects do in quiet, subconscious breathing) and because control of this will eliminate unnecessary muscle work by accessory muscles of respiration, resulting in a more functional patient.

With regard to function, I would also draw to your attention the work on exercise physiology reflected in the "Trailing Coat-Tails" column of the South African Medical Journal of 17th January, 1976, in which Noakes draws attention to the ability of muscle cells themselves to adapt by being "trained" to require less oxygen for contraction. This adaptation takes the form of an increase in skeletal muscle mitachondria. This new emphasis on the importance of peripheral adaptation as opposed to central cardio-respiratory-vascular adaptations to increased work load provides a possible explanation for the success of physiotherapy breathing exercises and for the increasing "exercise tolerance" which is clinicaly demonstrated in the face of unchanged pulmonary function tests. The changes are taking place in the skeletal muscles and not in the heart or lungs!

Conclusion

I would conclude by making the point that I have attempted to draw attention to the shift in reasoning for the efficacy of diaphragmatic and controlled breathing without calling into question the efficacy of such activities. The emphasis is now on economy of movement. This is based on experiments on normal lungs and it is freely admitted that a great deal of quantitative investigation still remains to be done on damaged lungs. However, it has been shown that very little basis exists for claiming selective expansion of segments or even lobes of lungs (especially healthy ones) and so I would suggest that treatment time be devoted more to general breathing re-education, using primarily the diaphragm, and that over-particular localised breathing be deleted. The aim is to train a pattern of breathing movement. It also seems that the general activity exercises given to patients with chronic destructive and obstructive lung disease can benefit them functionally by training their muscles to manage on the reduced amount of oxygen with which the lungs can supply them.

I have not discussed postural drainage and the localised breathing which often accompanies it. I am sure this is a topic which would also prove most interesting to elucidate.

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COUGHING

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Physiotherapists who have worked in surgical wards are surely au fait with the most frustrating fact, that invariably, after spending some time with a patient, this particular patient coughs once she has moved on to treat the patient in the next bed! In fact this has almost tended to become my standard practice: if I persevere and demand gentle diaphragmatic breathing over a long enough period, the patient eventually coughs spontaneously. Similarly, physiotherapists involved in the treatment of patients suffering from diffuse obstructive airways syndrome will have noticed that these patients cough and cough, but oh so ineffectively.

The fact that passive movements and movement provoke coughing in the unconscious patient is also a fait accompli. These simple observations seem clearly to indicate that the physiotherapist should possibly think further before saying "breath in deeply, now cough". There is evidence that we could be far more specific when we demand coughing of our patients, specific in our teaching of the technique of coughing per se; specific with regard to treatment techniques; and specific in what we demand. Coughing is not always an easy or a pleasant procedure for the patient, and should therefore be as directed, and as non-drastic a procedure as possible. Schamroth (1976),[1] "The cough is a complex, highly co-ordinated act that results in the very rapid expulsion of alveolar gas at a very high velocity, presumably to sweep the airway free of irritant gases, dust, smoke, excess mucus, cell debris or pus. The first step is similar to the Valsalva manoeuvre — by a forced expiratory effort against a closed glottis, the patient develops high intrathoracic and intrapulmonic pressure. The glottis then opens abruptly so that there is a large pressure difference between alveolar pressure and upper tracheal pressure (now atmospheric). This results in a rapid flow rate. Equally important is dynamic compression of intrathoracic airways, including the trachea, due to high intrathoracic pressure (+40 mm H_2O)." Comroe (1974).[2] Furthermore, Comroe, also states that during coughing the non-cartilaginous part of the trachea is inverted by the forces of dynamic compression. This increases the velocity of the air passing through so that the linear velocity actually increases from 667 cm/sec. to 28 000 cm/sec. (500 miles per hour or 85% the speed of sound!) This sudden rush of air is responsible for the dislodging of foreign material.

Brink and De Kock (1973),[3] state that "The nerve ends of the upper airways are sensitive to contact with foreign matter, changes in volume and noxious gases. As the acinus has no nerve supply, pathology of the acinus will only stimulate coughing once the material reaches the upper airways. The larynx, carina and bifurcation of the larger bronchi are the most sensitive parts of the airways". Extremely limiting deformities of the trachea in the presence of diffuse obstructive airways syndrome have also been demonstrated by De Kock (1976).[4]

Leith (1968),[5] has several interesting suggestions. He maintains "The object of the game in coughing is to pump a 'liquid' up through a tube, using energy transformed from a gas, also moving up through a tube".

He refers to a chemical engineers' handbook — "two-phase cocurrent upflow" and "Mist flow, in which liquid is carried as fine drops by the gas phase. Data indicate that this probably occurs for superficial gas velocities over about 70 ft./sec. (> 2 500 cm/sec.)". De Kock (1976),[4] on the other hand, feels that the two narrower bronchi joining to form a larger bore trachea make for the all important and necessary acceleration and increased velocity with respect to gas exit and coughing.

In addition Leith (1968),[5] reminds us of the mucociliary clearance system which extends to the remotest parts of the lungs as well as two other clearance mechanisms of the lung, viz. phagacytosis and lymphatic drainage. He also draws our attention to one more interesting possibility. The alveolar lining's surface tension falls to very low values when the area is decreasing, i.e. with expiration. This low-tension surface is thus drawn upwards and might possibly also be a clearance mechanism. Sighing and slow relaxed expiration could therefore possibly be of great significance to the physiotherapist.

Thus it would seem that primary requisites for efficient coughing are:

1. A mechanically sound anatomy, patent trachea and airways, ensuring dynamic compression. Muscle contraction must literally squeeze the lungs. The role the abdominal muscles can play in aiding breathing and lung clearance, albeit reflex, must be acknowledged. Bethune (1975).[6]
2. Velocity sufficient to create "mist-pumping". Raising the intrathoracic pressure can lead to an increased expulsive gas phase which would carry secretions from the trachea to the exterior.

With all these factors in mind one must now apply them to specific pathologies and one can easily see that specific techniques must be evolved for the various pathologies.

Firstly, let us look at the patient on the respirator. Opie and Spalding (1958),[7] have shown that the life-saving benefits of physiotherapy for patients receiving intermittent positive-pressure respiration are due to direct squeezing of the lung beneath the hands, and are not due to the rate of expiratory flow. These patients still need to be suctioned; increased expiratory flow with physiotherapy is not capable of expelling loose secretions through the tracheostome.

Secondly, coughing in the unconscious patient may be reflexly evoked by applying sustained stretch to the abdominal muscles, Bethune (1975).[6] This is an extremely useful technique with which to be acquainted.

Thirdly, the routine post-operative accumulation of increased mucous secretions can be effectively removed by coughing after maximum inspiration, whereas, if there is any evidence of diffuse obstructive airways syndrome where the equal pressure point moves proximally, it would seem wise to cough on a lesser volume of inspired air.

Fourthly, patients who suffer from diffuse obstructive airways syndrome should be instructed to cough with their necks in an extended position. This position withdraws the affected trachea from the thorax, "stretches it out" so to speak, facilitating expectoration, De Kock (1976).[4] Clinically this is a most effective manoeuvre.

Finally the value of postural drainage and gentle diaphragmatic breathing emphasising the expiratory phase in aiding the flow of sections to the area of the cough reflex should be neither under-estimated nor forgotten.

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BOOK REVIEW

Respiratory Physiotherapy and Pulmonary Care, by Ulla Ingwersen (Munksgaard, Copenhagen, 1976), John Wiley and Sons, New York/London/Sydney/Toronto. Price—Danish kroner 60,00.

In his foreword to this book Prof. H. Anderson, Surgeon-in-Chief of the Thoracic Surgical Department, Copenhagen County Hospital in Gentofte, Hellerup, said: "Respiratory physical therapy is a comparatively new speciality in Denmark. It was first used by thoracic surgeons, who now regard this speciality as indispensable, later by chest specialists and most recently by orthopaedists, who still have not yet begun to use it suffiicently."

Ulla Ingwersen describes the various techniques employed, fully and in good detail. It is a pity that there is no mention of the mechanical aids such as I.P.P.B. and ultra-sonic nebulizers that can be of great value in the physiotherapy treatment of some selected cases.

A lot of emphasis is placed on huffing — "a long, powerful expiration with open vocal cords by means of which the patient, so to speak, "rolls" the secretions up without any great effort and without an actual cough. Huffing should be considered the most important point in the treatment of patients with pulmonary secretions." I feel that this method has got some value in patients with a tension pneumothorax, severe air trapping and some thoracic surgical conditions but certainly the most effective way of removing secretions from the lung is by coughing. Huffing may cause pronounced increased bronchospasm.

The section on treatment of patients in Intensive Care Units is not adequately covered and no mention is made of the treatment of chest conditions of children in medical intensive care units.

From the point of view of physiotherapists in South Africa, we employ a much more advanced and sophisticated level of respiratory therapy.

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CORRECTION:

Contents of S.A.S.P. Journals 1975 and 1976

JUNE 1976

Management of Amputees, a Team Approach
Bernice Kegel,
B.Sc.Physio.(Rand), R.P.T.