

Three of the patients were admitted under the care of Mr. Norman Gibbon. We wish to thank him for permission to record their case histories, and for his enthusiastic support throughout. We would also like to thank Mr. O. M. Jonathan for permission to record the case history of the patient (Case 4) admitted under his care.

ADDENDUM.—We have since seen a seventh case, which was admitted to hospital under the care of Mr. J. K. M. Rawlinson.

A stenosing circumferential ulcer of the small intestine was an incidental finding at operation for revision of colostomy and relief of subacute intestinal obstruction due to adhesions. Although stenosing, the ulcer was not obstructing. Non-specific ulceration was confirmed by biopsy and the stenosis relieved by enteroplasty.

The patient had had an abdomino-perineal resection of the rectum for carcinoma 15 years previously, and suffered from angina, for which he had been treated with Nephрил (poly-

thiazide with enteric-coated core of potassium chloride) for 2½ months followed by Centyl-K (bendrofluazide with potassium chloride) for six months prior to operation—both preparations one tablet three times a week.

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## Preliminary Communications

### Use of Trichlorethylene Inhalations during Physiotherapy

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Physiotherapists who treat thoracic surgical patients are well aware of the difficulty in obtaining the best results post-operatively because of pain, which so often limits the ability of the patient to carry out exercises. After surgery patients must breathe deeply, be able to carry out as full a range of arm movements as possible, and be able to cough sufficiently strongly to expectorate. These three functions are of great importance to recovery, and unless performed effectively from the first post-operative day difficulties can arise. Not only pain, but also fear of pain, can inhibit ventilatory efficiency. This can be gauged subjectively or measured by a reduction in vital capacity, peak flow, forced expiratory volume, PO<sub>2</sub>, or any other respiratory parameter; indeed, in many it may be obvious enough even in the most superficial clinical assessment.

Relief of pain is therefore of primary importance. The method most commonly employed is the administration of systemic analgesic drugs, but these cause respiratory depression and are not always completely effective in the face of active movement. Alternatively, nerve blocks with long-acting analgesic solutions or extradural blocks may be employed. Both can be effective; but long-acting solutions are notoriously unpredictable, while a continuous extradural block requires repeated "topping-up." Owing to the necessity for scrupulous asepsis, the latter technique is often time-consuming and may also lead to falls in blood-pressure, causing delay and wasting the time of the physiotherapist. Further, to give optimum results, both systemic analgesic injections and the "top-up" of an extradural block must be carefully timed. In practice, with overworked physiotherapists and inadequate nursing staff, particularly in the smaller centres, this is not always achieved. The more patients to be treated the greater are the difficulties, especially when it is realized that often, as in this hospital, each receives four treatments every day for the first three post-operative days.

The method described below has been designed to overcome these difficulties, at least in part, and to allow the physiotherapist to perform her work more efficiently without dependence on nursing or medical staff and hence with a considerable saving in time.

## METHOD

In effect, the post-operative patient is treated as a woman in labour, with the physiotherapist taking the place of the midwife. Analgesia is provided by the inhalation of 0.5% trichlorethylene delivered from an inhaler approved by the Central Midwives Board for use by midwives. The period of inhalation not only eases existing pain but also raises the pain threshold. Thus there is a feeling of relaxation and anxiety is removed. In consequence, patients are able to breathe more deeply, to move their arms more frequently, and to cough more vigorously. It was found that 8 to 12 breaths of 0.5% trichlorethylene were sufficient to give a beneficial effect for about two minutes. Often no more than six breaths were needed, but the amount required varied from patient to patient. Thus two to three periods of inhalations in the course of one physiotherapy treatment were usually needed. These inhalations were used in conjunction with, rather than as a substitute for, the normal post-operative injections of pethidine or papaveretum commonly given at intervals of four to six hours for the first 48 hours post-operatively. Such a combination—as in obstetrics—is ideal, but inhalations alone are also effective. Though inhalations can be repeated as often as they may be required, a cumulative effect sufficient to cause respiratory depression is not produced. A further advantage is the co-operation of the patient, which is maintained unless the inhalations follow heavy general sedation.

## RESULTS

During the past two and a half years 123 patients have been treated with trichlorethylene inhalations post-operatively: 91 were male and 32 female, with ages varying from the early 20s to the mid-70s.

The results are summarized in the Table. Most of the complete failures were encountered in the groups of patients undergoing lobectomy or pneumonectomy, but the total numbers do not warrant any particular significance being

## Summary of Results

	No. of Cases	Good	Effect Moderate	Nil
Lobectomy ..	35	19	13	3
Pneumonectomy ..	17	5	9	3
Pleurectomy ..	9	5	4	0
Cardiac ..	15	10	5	0
Other thoracotomy ..	28	17	10	1
Hiatus hernia ..	16	10	6	0
Abdominal ..	3	1	2	0
	123	67 (54%)	49 (40%)	7 (6%)

attached to this finding. However, it was noticed that these failures, with the exception of one, occurred in those suffering from carcinoma. It might be fair to assume that their mental as well as their physical state was poor, and this would be sufficient to account for a dispirited outlook and lack of full co-operation.

For those with best results, improvements were seen in arm movements, coughing, and deep breathing. Those with only moderately satisfactory response showed improvement in one or more of these functions, which varied from patient to patient. Despite the subjective assessment of an individual, measurement of peak flow often gave an even more encouraging picture. This was measured in most of our patients, since it was thought that this test, by the nature of the forced expiration required, represented more closely than any other the effort made in coughing, which in fact the physiotherapist aims to encourage. Leg movements usually cause little pain except after a sternotomy, and were therefore performed without analgesia.

Failures are more likely to occur when there is lack of co-operation by the patient (confusion due to general sedation, low intelligence, extreme nervousness) or inability to breathe deeply enough from the inhaler. Of these, many difficulties can be overcome by careful pre-operative explanation and training. A few, mainly women, object to the smell of trichlorethylene vapour and the application of a face-mask.

#### DISCUSSION

The sequence of events during the physiotherapist's visit can be summarized as follows: (1) leg movements; (2) attempt deep breathing and coughing for assessment; (3) inhalation of trichlorethylene; (4) deep breathing and coughing; (5) inhalation of trichlorethylene; (6) arm movements and deep breathing (measurement of peak flow); (7) inhalation of trichlorethylene (measurement of peak flow); (8) coughing.

Peak flow was measured as indicated. On the first occasion it could be assumed that no analgesic effect remained from a previous inhalation and the patient was attempting to co-operate with the physiotherapist. The reading would therefore be maximal for the conditions at the time. A second reading was taken immediately after an inhalation. Patients had previously been instructed in the use of the peak-flow meter (Wright) and measurements were taken during the pre-operative period as part of the assessment of their respiratory function. At the same time the purpose of the inhaler was explained and patients had a number of trial inhalations. Thus the presentation and the use of both pieces of apparatus were already familiar during the post-operative application, and the importance of deep breathing to obtain the maximal effect from the inhaler was clearly understood. It must be stressed that success is dependent on attention to detail, and, just as in obstetrics, the surgical patient must be carefully instructed pre-operatively in the use of the apparatus and must understand the limitations of analgesia. The physiotherapist also must understand the apparatus, teach its use to the patient, and ensure that there are no air leaks. An adequate depth of respiration must be encouraged so that analgesia can be achieved in a reasonable time. Prolonged shallow breathing, while achieving analgesia ultimately, discourages the patient, and allows his attention to wander, with inevitable air leaks round the mask and still shallower breathing.

The inhalation of anaesthetic gases for the relief of pain was suggested at least 20 years ago, and, more recently, the administration of nitrous oxide has been described for the relief of post-operative pain in two series (Parbrook *et al.*, 1964; Parbrook and Kennedy, 1964). A further report gives an even wider application for the use of the inhalation of analgesic gases in the treatment of intractable pain, coronary thrombosis, and terminal states (Petrovsky and Yefuni, 1965).

However, nitrous oxide and air cannot be recommended because of the resultant hypoxia; nitrous oxide and oxygen requires special pre-set apparatus, and its use should be directly under medical supervision. There remains nitrous oxide and oxygen pre-mixed in cylinders, which, while obviating the above difficulties, allows only a 50% concentration of nitrous oxide, and this may not be adequate for pain relief. On the other hand, 0.5% trichlorethylene has been found to be as efficient as 75% nitrous oxide and oxygen in obstetrics and carries no risk of anoxia (Seward, 1949). It may be administered from an apparatus already approved for use by unqualified personnel, and has the added advantages of simplicity, minimal maintenance, reliability, and portability. Analgesia is produced rapidly, and it is suggested that this agent is eminently suitable for use by physiotherapists. The Emotril inhaler was used most frequently in this series, but the same advantages would apply to the Tecota. Under medical supervision any inhaler capable of delivering 0.5% trichlorethylene in air could be used; and it was found, incidentally, that the halothane induction unit (Bryce-Smith, 1964) though not particularly convenient, would, when charged with trichlorethylene, deliver this concentration for about 15 minutes and give as good results clinically.

It is believed that the use of this technique will give satisfactory results in a high proportion of patients, and since it is under the control of the physiotherapist a rigid time-table involving others becomes unnecessary. In this way, for general use it is believed that the method described has very real advantages over continuous extradural analgesia, which, though perhaps ideal, becomes ineffective through practical difficulties.

Though this series refers mainly to post-thoracotomy patients for ease of comparison, it has also been tried on a few patients who have undergone purely abdominal operations. The results were similar, and it is therefore suggested that this method might have a much wider application to any patient who has undergone surgery causing restricted respiratory or limb movement due to pain.

It would be preferable if each patient could be allotted his own breathing-tube and mask, which could remain in a plastic bag by his bedside. Failing this, both mask and tube should be cleaned by washing in soap and water after being detached from the inhaler. They must be sterilized by boiling after use on tuberculous patients.

#### SUMMARY

One hundred and twenty-three patients who had undergone thoracic surgery received 0.5% trichlorethylene/air inhalations to provide analgesia for post-operative physiotherapy. The results were gauged subjectively and by measurements of peak flow before and after treatment. The results were encouraging, and with only a 5% failure rate it is thought that this procedure could well be applied to any patient whose post-operative pain might restrict respiratory or limb movements. This method allows the physiotherapist to perform her duties without dependence on other personnel and with the minimum waste of time. Attention to details and instructions in the use of the inhaler pre-operatively are essential for success.

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