WALKING AID FOR PULMONARY EMPHYSEMA

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Summary A walking aid enabled five patients with severe airways obstruction due to pulmonary emphysema to double their walking distance. When given 100% oxygen to breathe, the walking distance trebled; when walking aid and oxygen were combined, walking distance increased eightfold. The walking aid is a simple effective means of increasing exercise ability in room-bound patients with severe pulmonary emphysema.

Introduction

FOR many patients with pulmonary emphysema a walk to the kitchen or to the toilet is a burden. They say that they are comfortable only as long as they sit still. This enforced immobility lowers morale and may contribute to the muscular frailty which is characteristic of this condition. Anything helping them move about more freely would be more than just a convenience.

Exercise ability can be improved by giving these patients oxygen to breathe,[1] but this approach is difficult in practice. Another approach has been described in one patient with severe pulmonary emphysema who derived considerable improvement in exercise ability using a walking aid.[2] It is a simple method but has not been more fully evaluated. We have evaluated a similar walking aid (fig. 1) and compared it with oxygen in five patients severely disabled by airways obstruction due to pulmonary emphysema.

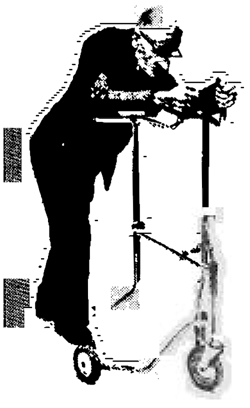

Fig. 1—The walking aid.

Patients and Methods

Patients

The five male patients aged 55–65 years were selected for this study because they were considered to be severely disabled by pulmonary emphysema. Their forced expiratory volume in one second (F.E.V.$_1$) was less than 600 ml., and less than 30% of vital capacity in all cases. All five patients had chest radiographs with the characteristic features of pulmonary emphysema.[3] Transfer factor ranged between 7 and 10 ml. CO per minute per mm. Hg (predicted normal range 22–28), measured by carbon-monoxide single-breath technique. None could walk more than 60 m. on level ground. P_aCO_2 at rest ranged between 39 and 52 mm. Hg and P_aO_2 between 62 and 78 mm. Hg, while arterial blood pH ranged between 7·34 and 7·40. No patient had clinical, radiological, or electro-cardiographic evidence of heart-disease. Corticosteroids were of no help in three patients in whom they were tried. Two of the five patients (including one of those who underwent an operation for ligation of emphysematous bullæ) subsequently died; in each severe panacinar emphysema was found.

All the subjects were inpatients when they were studied and had been brought to their optimal clinical condition by the conventional treatment of chemotherapy, physiotherapy, and bronchodilators.

TABLE I—RESULTS OF EXERCISE TEST

Patient	Inspired gas	Distance (m.)		Minute ventilation (l./min.)		Speed (m./min.)	
		0		0	+	0	
A	Air	10	21	13	12		10
	O_2	11	67	10	9		8
B	Air	18	38	18	19		21
	O_2	96	228	17	17		36
C	Air	62	141	22	23		45
	O_2	167	278	19	19		39
D	Air	24	26	19	19		23
	O_2	56	76	17	17		32
E	Air	24	56	11	12		29
	O_2	105	302	8	11		50

0 = without walking aid. + = with walking aid. O_2 = 100% oxygen.

TABLE II—MEAN (±S.E.M.) PERCENTAGE CHANGE OF DISTANCE, SPEED, AND MINUTE VENTILATION COMPARED WITH WALKING WITHOUT THE AID, BREATHING AIR

	Air		100% oxygen	
	0	+	0	+
Distance .. .	100	198 (±*22*)	316 (±*75*)	794 (±*200*)
Speed .. .	100	71 (±*5*)	104 (±*12*)	92 (±*15*)
Minute ventilation.	100	102 (±*3*)	84 (±*4*)	88 (±*5*)

0 is without the aid. + is with the aid.

Methods

The walking aid is a tripod on which the patient can lean (fig. 1). Each leg of the tripod is on a wheel, so the patient can walk as he leans on the aid. The angle at which the patient leans can be altered by adjusting the height of the aid. A Douglas bag filled with 100% oxygen was mounted in front of the walking aid, inverted to conceal a two-way stopcock which could connect up the inspiratory end of a one-way valve either to the Douglas bag or surrounding air without the knowledge of the patient. A Wright respirometer was connected to the expiratory side of the valve. 100% oxygen was used in this study to be quite sure that maximal benefit was being derived from this gas.

The exercise ability was assessed by asking patients to walk as far as possible and to continue until they could not take a step further. At the end of exercise the patients were asked why they stopped; in every case the reason given was that it was their breathing or that they were breathless.

No instructions were given as to the speed they should travel. The patients were first asked to walk unassisted breathing air, the walking aid being pushed alongside the patient, who was using the same mouthpiece and attached equipment on each occasion. Between each exercise the patient was allowed to recover fully. The distance walked and duration of exercise were measured. Total ventilation during the exercise was measured on the Wright respirometer, so the minute ventilation could be calculated knowing the duration of exercise. The next stage was to walk breathing air using the walking aid. These two exercises were then repeated giving the patient 100% oxygen to breathe from the Douglas bag, which was frequently refilled without the patient's knowledge so the appearance of the bag was not noticeable. At no time did the patient know the nature of the inspired gas.

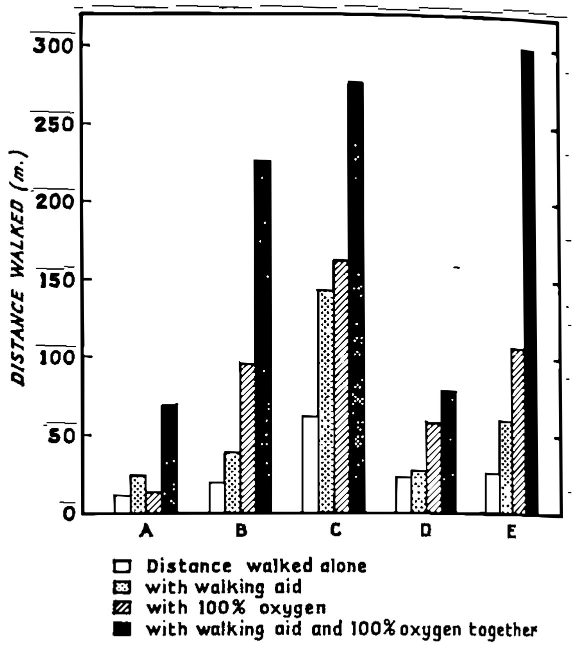

Fig. 2—Histogram of distances walked.

Results

Table I shows the results of the exercise test, and fig. 2 shows the results of walking distance in the form of a histogram. From these data the mean change in walking distance, speed, and minute ventilation were calculated for the patient using the walking aid, 100% oxygen, or a combination of both, and was compared with the values obtained when the patient walked without the aid breathing air. All five patients walked further using the walking aid alone (mean + 98%) or 100% oxygen (mean + 216%) or both (+

TABLE III—THE EFFECTS OF WALKING AID AND OXYGEN: ANALYSIS OF VARIANCE

Effect of	Mean change in distance walked (m.)	Mean change in minute ventilation (l./min.)	Mean change in speed (m./min.)
Walking aid ..	+66·0 (F = 10·0, P < 0·01)	+0·4 (F = 1·1, P > 0·25)	−3·66 (F = 6·5, P < 0·05)
Oxygen	+96·6 (F = 21·4, P < 0·01)	−2·4 (F = 38·8, P < 0·005)	+2·28 (F = 2·5, P > 0·10)
Interaction	+37·3 (F = 3·2, P > 0·05)	0·0	+1·44 (F = 1·0, P > 0·25)
	S.E.M. ±20·9	S.E.M. ±0·4	S.E.M. ±2·9

(94%) (table II). In four of the five patients (the exception was patient C) the effects of the aid and oxygen were multiplicative. The only other striking change was a 16% fall in minute ventilation when the patients used oxygen and a 29% drop in speed when the walking aid was used. Table III shows the results of the analysis of variance of a 2×2 factorial experiment.[4] The validity of using this analysis is uncertain because a normal distribution is assumed. We know of no method of verifying this analysis in a small sample, nor are there "distribution-free" methods for the analysis of a 2×2 factorial experiment.

Discussion

The walking aid alone enabled our patients to double their walking distance, while 100% oxygen alone trebled their walking distance; when both were used in combination an eightfold increase occurred. These results are less dramatic than those found in the patient studied by Campbell[2] of approximately a four, eight, and thirty-two fold increase, respectively; nevertheless, our findings again show that the walking aid is a useful method of improving mobility. Although the walking aid is not quite as helpful as oxygen, its relative simplicity is attractive. Portable oxygen is expensive, cylinders require frequent recharging from a master cylinder (which can be hazardous), and it may be difficult to arrange home supplies.

It is not clear how the walking aid helps. Doubling walking distances using the aid was associated with a 29% reduction in walking speed. Perhaps this slower walking speed enabled these patients to walk further by reducing the rate of accumulation of oxygen debt. Campbell[2] suggested that the walking aid reduces the oxygen cost of breathing and allows an increase in minute ventilation. We did not find any significant change in minute ventilation when the walking aid was used, but all the five patients insisted on adjusting the height of the aid so that the trunk was almost horizontal. In this position about a third of the body-weight can be supported by the apparatus, the weight of the shoulder girdle on the rib cage is reduced, and the redistribution of the abdominal contents may allow the anterior abdominal wall to be a more effective part of the respiratory musculature.

Encouraged by the results of this study, the walking aid has been modified to carry a 48 c.ft. cylinder so that oxygen can be administered by a face mask. Although the oxygen concentration is lower than that used in this study, it would probably suffice.[1]

The walking aid can be used only on smooth, level ground, but it may help the severely disabled emphysematous patient to exercise in hospital and move about more freely on one floor at home.

The apparatus described may be obtained from J. & A. Carters Ltd., 65 Wigmore Street, London W.1.

Requests for reprints should be addressed to B. J. B. G., Respiratory Research Group, Royal Postgraduate Medical School, London W.12.

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