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An evaluation of short-term oxygen therapy: the prescription of oxygen to patients with chronic lung disease hypoxic at discharge from hospital

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The provision of domiciliary oxygen to patients hypoxic at hospital discharge has been termed short-term oxygen therapy (STOT). This practice appears widespread, although there is a paucity of literature and no evidence-based guidelines.

We undertook this audit to examine the prescription of STOT and determine the proportion fulfilling for long-term oxygen therapy (LTOT) 2 months post-discharge.

STOT was defined prospectively: resting $PaO_2 \leq 7{\cdot}3$ kPa (55 mmHg) or PaO_2 between 7·3 and 8·0 kPa (60 mmHg) with any of the following: clinical evidence of cor pulmonale (pedal oedema or jugular venous distension), ECG evidence of pulmonale, echocardiogram evidence of pulmonary hypertension, haematocrit $> 0{\cdot}55$ (adapted directly from LTOT criteria). Patients were evaluated for LTOT 2 months post-discharge when clinically stable on optimal medical management. All referrals to the Auckland Regional Oxygen Service between July 1998 and 1999 were systematically reviewed.

The majority 289/405 (71%) of new referrals were for the prescription of STOT/LTOT in patients with chronic lung disease: 160/289 (55%) derived from hospitalized patients with the majority 130 (81%) fulfilling criteria for STOT, median age 73, range 24–96 years. Mean hospital stay was 10·2 days. Two months after discharge 22/127 (17%) of STOT patients had died, comparable with 4/22 (18%) not fulfilling criteria for STOT. A total of 123 patients were assessed for LTOT at 2 months; 76 (62%) fulfilled criteria for LTOT.

The prescription of oxygen at hospital discharge represented a considerable proportion of our referral load. There was a high mortality in the 2-month follow-up period. A significant proportion of STOT patients did not subsequently fulfill criteria for LTOT. Further prospective studies are required in order to develop evidence-based guidelines.

Key words: short-term oxygen therapy; chronic lung disease; hospital discharge.

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Introduction

No evidence-based guidelines exist for the prescription of oxygen at hospital discharge. However the provision of oxygen to hypoxic patients at the time of discharge would intuitively appear appropriate and is a practice followed in most OECD countries (pers. commun.). In the United States this practice is also recognized and attributed in part to increased financial pressures for early discharge. It is recommended that arterial blood gases (ABG) be retested 1–3 months subsequent to discharge when the patient is clinically stable and on optimum therapy (1). The provision of oxygen to patients remaining hypoxic at discharge may be termed short-term oxygen therapy (STOT), as there is an expectation that when clinically stable a proportion will not fulfill LTOT criteria. The prescription of long-term oxygen therapy (LTOT) is based on two landmark studies, demonstrating that survival was improved when oxygen was used for at least 15 h per day in clinically stable patients on optimal therapy (2,3). International guidelines were subsequently developed (4–7).

The Department of Respiratory Services at Green Lane Hospital (GLH) has regional responsibility for the domiciliary supply of oxygen in Auckland (population 1 250 000). A clinical audit performed at GLH in 1994 noted that 80% of oxygen referrals were from hospitalized patients following an acute exacerbation of chronic obstructive pulmonary disease (COPD) (8). Hence the assessment and management of such patients consumes a

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considerable proportion of our service's resource. LTOT guidelines cannot be directly applied in that hospitalized patients by definition cannot be deemed clinically stable. There is a paucity of literature describing the provision of oxygen to this group of patients who nevertheless are responsible for substantial healthcare costs. Consequently, there is an overwhelming need for prospective clinical studies on which to base guidelines.

Following the 1994 review, in the absence of published evidence-based guidelines, we prospectively devised formal criteria for STOT (8); necessarily a pragmatic adaptation of LTOT guidelines. Patients were carefully re-evaluated 2 months after discharge when clinically stable. This study aimed to systematically examine the prescription of STOT and determine the proportion fulfilling criteria for LTOT.

Methods

STUDY DESIGN

All referrals to the Oxygen Service between July 1998 and July 1999 were identified though our service administration data base (Microsoft Access 1997) and individual patient records reviewed by C.G. Data collection included: demographic characteristics, referral source, diagnosis, assessment of clinical stability, smoking status, resting PaO_2 on air, evidence for cor pulmonale (clinical, ECG or 2D echocardiogram), haematocrit, resting cutaneous pulse oximetry (SpO_2), post-6-min walk (6 MW) SpO_2, overnight oximetry (if relevant), prescription details: LTOT, STOT, overnight oxygen, palliative, paediatric, symptomatic, outcome (discharge, follow-up, deceased).

TREATMENT GUIDELINES AND PROTOCOL (CURRENT OVER AUDIT PERIOD)

The Auckland Regional Oxygen Service has written treatment guidelines, which were developed in line with published international guidelines (4–7). Oxygen referrals require the completion of a formal request form. This form defines STOT/LTOT criteria and specifically asks for the appropriate details of smoking, clinical examination, ABG, etc. Adults are formally assessed by specialist oxygen nurse practitioners prior to a final recommendation and prescription by a specialist respiratory physician.

CRITERIA FOR THE PRESCRIPTION OF LTOT (4–7)

ABG measurements were made when the patient was clinically stable and on optimal medical management at least 2 months after discharge. Current smoking was an absolute contraindication to supply. Fulfils for LTOT was defined as an absolute $PaO_2 \leq 7{\cdot}3$ kPa (55 mmHg) or PaO_2 between 7·3 and 8·0 kPa (60 mmHg) with any of the following: clinical evidence of cor pulmonale (pedal oedema or jugular venous distension), ECG evidence of pulmonale, echocardiogram evidence of pulmonary hypertension, haematocrit $> 0{\cdot}55$. Oxygen was prescribed for at least 15 h daily. If patients were unable to attend outpatient clinic, patients were assessed in their home with cutaneous pulse oximetry. When only cutaneous oximetry was available LTOT was prescribed if $SpO_2 \leq 88\%$ or $\leq 89\%$ with evidence of cor pulmonale.

CRITERIA FOR THE PRESCRIPTION OF STOT

STOT refers to the prescription of oxygen to patients who remained hypoxic at the time of hospital discharge. The criteria used were as for LTOT (with the acknowledgement that patients by definition were not clinically stable). Formal assessment for LTOT was arranged 2 months post-discharge (when clinically stable and on optimal medical management).

Criteria for other forms of oxygen supply

(a) Palliative oxygen—supplied to patients with terminal illness, generally neoplastic if $SpO_2 \leq 90\%$ and the patient perceived a benefit.
(b) Paediatric oxygen—new-born to 18 years accepted for supply on the prior assessment and oxygen prescription details provided by nominated Specialist Paediatricians.
(c) Overnight oxygen—supplied to patients who demonstrated significant overnight desaturation ($SpO_2 \leq 88\%$) for a substantial period of the night. If a patient did not fulfil for LTOT on resting gases but exhibited evidence of cor pulmonale, overnight oximetry was arranged.
(d) Symptomatic oxygen—applied to cases such as cluster headaches where high flow use as required may be helpful. Oxygen was not supplied to relieve dyspnoea.
(e) Other—fulfilled above criteria but funded through private hospital.

STATISTICAL ANALYSES

Results are stated as medians (range) unless otherwise stated. Proportions were examined using Fisher's exact test. A P-value of less than 0·05 was considered significant. Clinical predictors of fulfilling for LTOT were explored using logistic regression. All analyses were performed using Stata Release 5 for Windows (State Corporation, College Station, Texas, U.S.A.).

Results

We reviewed the case notes of 405 (87%) of 467 new referrals received between July 1998 and July 1999. The

TABLE 1. Patient characteristics; new adult referrals for STOT/LTOT assessment

	$n = 289$
Age median (range) years	74 (24–96)
Male : female	158 : 131
Diagnoses:	
COPD	230 (80%)
Bronchiectasis	14 (5%)
Interstitial lung disease	15 (5%)
Other e.g. pulmonary hypertension	30 (10%)
Referral source:	
Hospital inpatient	160 (55%)
Hospital outpatient	41 (14%)
General practice	88 (31%)

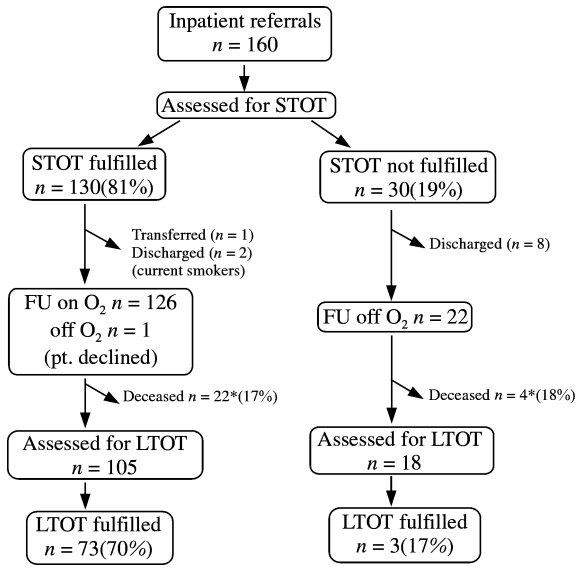

FIG. 1. Flow chart: oxygen prescriptions for inpatient referrals and 2-month outcome.

main patient groups and prescription outcomes were as outlined: 269 new oxygen prescriptions resulted from 405 referrals with the majority 167 (62%) supplied with STOT/LTOT. The remainder comprised palliative 64 (17%), paediatric 29 (7%), overnight 8 (2%), symptomatic 6 (1%) and other 9 (2%).

The majority 289/405 (71%) of referrals were assessments for the prescription of LTOT/STOT (Table 1). Over half the referrals (55%) were for hospitalized patients with chronic lung disease, median age 73 years (range 24–96 years); COPD accounted for 80%. Mean hospital stay (95% confidence interval) was 10·2 (8·8–11·6) days. Prescription details and outcomes at 2-month follow-up are detailed in Fig. 1, demonstrating the majority, 130 (81%) fulfilled the criteria for STOT. Three patients were not followed ($n = 2$ ongoing smokers, $n = 1$ transferred). Thirty patients did not fulfil criteria for STOT; eight of these were not followed. Two months after discharge 22/127 (17%) STOT patients had died; comparable with 4/22 (18%) patients not fulfilling criteria for STOT followed off oxygen. A total of 123 patients were assessed for LTOT at 2 months; 76 (62%) patients fulfilled criteria for LTOT; 73/105 (70%) of those patients fulfilling criteria for STOT at discharge fulfilled for LTOT. Only a minority, 3/18 (17%), of patients not fulfilling criteria for STOT at discharge fulfilled criteria for LTOT. Baseline parameters including resting PaO_2 and $PaCO_2$ were examined using logistic regression with no predictors for fulfilling criteria for LTOT identified.

LTOT outcome was further examined by mode of referral. Very few GP referrals (12%) fulfilled LTOT criteria, whereas over 50% of both inpatient and outpatient referrals fulfilled the criteria $P < 0{\cdot}0001$ (Table 2). Adherence to international guidelines (4–7) for LTOT was systematically examined. Patients were only assessed with cutaneous pulse oximetry in the community if extenuating circumstances were felt to preclude outpatient attendance. All patients satisfied stated criteria. Patient compliance was routinely measured using the hour meter on the oxygen concentrator; 47% of patients used the concentrator less than 15 h daily, median (range) 15·5 (3–24) h daily.

Discussion

The results of this audit primarily serve to emphasize the problems inherent to the prescription of domiciliary oxygen

TABLE 2. Proportion of patients referred for STOT/LTOT who fulfilled criteria for LTOT by mode of referral

Inpatient referrals STOT fulfilled	Inpatient referrals LTOT fulfilled (Clinic follow-up)	Outpatient referrals LTOT fulfilled	GP referrals LTOT fulfilled
130/160 (81%)	76/123[†] (62%)	26/41 (63%)	11/88 (13%)*

*$P < 0{\cdot}0001$ GP referrals compared with both outpatient and inpatient referrals fulfilling criteria for LTOT.
[†]Attrition explained by deaths $n = 26$, discharged $n = 10$, and transfers $n = 1$.

to patients who remain hypoxic at the time of hospital discharge. These referrals comprise the majority of our work load, despite which there are no randomized, controlled studies to direct our practice. In the absence of guidelines a certain degree of pragmatism was applied. However, the strength of this study is that our criteria for STOT were devised prospectively and rigorously adhered to.

STOT presents its greatest problem in that hospitalized patients are by definition clinically unstable. Our previous audit noted that very few patients (13%) improved sufficiently to have oxygen removed (8). International guidelines for LTOT state that at least two assessments should be performed over 2–3 weeks when clinically stable and on optimal medical management. Following discharge it had been our practice to perform regular home visits with cutaneous pulse oximetry and spirometry. Several studies have discussed the use of oximetry in the assessment of patients for LTOT (9,10); the advantages being that it is rapid, portable, non-invasive and may be used by staff not skilled in arterial puncture. However, we acknowledge that oximetry is not sufficiently accurate to replace an arterial blood gas (ABG) (4,9). We were concerned about an overreliance on oximetry. However in defence, it was not infrequent to be faced with extenuating clinical circumstances such as co-morbidities, immobility, confinement to rest home where it was deemed unreasonable to insist on an outpatient clinic visit and blood gases. This is born out by previous work which revealed up to 45% of LTOT patients may be housebound (11). We were also aware of repeated visits incurred by patients who no longer satisfied criteria for the supply of oxygen and who had developed considerable psychological dependency to oxygen. Following the initiation of an oxygen clinic with more rigorous assessment including ABG, 30% of patients initially fulfilling criteria for STOT did not subsequently fulfil criteria for LTOT. This number is significant and argues strongly for comprehensive follow up of all patients prescribed STOT, unless robust predictors become available.

The prescription of STOT presents certain difficulties to the LTOT assessment. Any recommendation for LTOT must take into account that an increase in PaO_2 after a few months may be due to the so called 'reparative' effect of oxygen and does not provide prima facie justification for discontinuation (12). Conversely, any improvement may merely pertain to the genuine clinical improvement which continues for a variable period after an acute exacerbation. Hence, the frequent observation that a number of LTOT patients do not fit the clinical criteria for prescription when assessed at a later stage (2,11,13). A more concerning problem was the prevalence of patient misinformation and hence level of unrealistic expectation. Despite a specific information booklet provided at discharge, patients were often not prepared for the follow-up assessment nor the implications if found not to fulfil criteria for LTOT. Psychological dependency was frequently observed; a distressing situation for both patient and staff, requiring considerable resource and expertise to address. It is clear that the concept of STOT is generally poorly understood by both patients and allied health staff. This necessitates considerably more emphasis on education.

A further problem related to the inadequacy of referral data which was plagued by missing or imprecise information, despite a designated criteria specific oxygen referral form. Current smoking history as per the referral form is also unreliable. Smoking is acknowledged as an absolute contraindication to the prescription of LTOT (7,14) and hence of STOT. However we know from a previous local study that a considerable proportion (33%) of patients admitted with an acute exacerbation of COPD are still smoking (15). Even in the setting of a formal oxygen clinic simple questioning is insufficient. Unfortunately, an expression of willingness to achieve smoke cessation is not sufficient. We have found that the only way of ensuring consistency, although potentially contentious, is to obtain consent for random urinary cotinine testing. Patient acceptance has been excellent.

There was an expectation that discharge may have been expedited by the availability of home oxygen. This did not appear to be the case in that mean hospital stay was 10 days, longer than 7·5 days cited in a recent review of COPD admissions in Auckland (15). This is likely largely explained by severity of COPD and/or co-morbidities, but does suggest that discharge is not necessarily hastened by the availability of oxygen on discharge.

The high number of deaths in the 2 months subsequent to discharge is notable and must lead us to examine the prescription of oxygen more critically. Patient and indeed physician expectations may be very different from reality. Survival is the outcome measure on which the international guidelines are based (2,3). The NOTT study quoted mortality of 11% and 22% at 1 and 2 years respectively (2). In comparison, our previous study noted a disturbingly high 6-month mortality rate of 33% (8) and our current audit found 22 (17%) of patients commenced on STOT had died within 2 months. A point of interest is the similar mortality over the same time period in those patients found not to fulfil criteria for STOT. Our results are strikingly similar to a recent comprehensive review of patient outcomes following admission for severe COPD, which reported a 20% mortality at 2 months and 33% at 6 months (16). These sobering findings are borne out by other studies. McCallian *et al.* reported a 50% mortality rate within the first 3 months of LTOT (17). Further reports have variously cited 50% mortality at 2 years (18) and 60% mortality at 3 years (19).

This suggests that a large proportion of patients referred for consideration of oxygen are identified at a very late stage of their disease when the survival benefit is unlikely to be achieved. One could infer that if patients could be identified sooner the prescription of oxygen might achieve results closer to the studies from which the guidelines originate (2,3). As previously indicated most referrals originate from hospital admissions, while community-based referrals are few and generally inappropriate. Referrals by primary care practitioners made up less than one-third of our LTOT referrals and only 11% fulfilled criteria for LTOT. It appears that these referrals are often prompted by a distressed dyspnoeic patient under the misapprehension

that oxygen will relieve the problem. There is no doubt that there is a significant population of COPD patients in the community who fulfil criteria for LTOT but are not recognized as such by their medical practitioners. Roberts *et al.* evaluated the use of oximetry in general practice and revealed a number of patients not previously identified as fulfilling criteria for LTOT (20). A community study in the U.K. found 0·3% of COPD patients had a $PaO_2 < 7{\cdot}3$ kPa (21), a percentage that would further increase with the inclusion of patients with evidence of end organ damage and PaO_2 between 7·3 and 8·0 kPa. Hence, primary care providers require increased access to both spirometry and pulse oximetry as screening tools if we are to identify patients at an earlier stage who might conceivably be expected to derive optimal advantage from oxygen.

However, recent work has suggested that, with more modest hypoxia, the survival benefit may not be apparent (22). Although it is generally accepted that quality of life may improve with domiciliary oxygen, supporting evidence is scanty (23,24). Indeed, in some patients, the restrictive nature of oxygen has negative effects (18). Compliance with LTOT is variable and our results are very similar to other published work (19). Future guidelines should incorporate other outcome measures such as quality of life which may be more relevant.

Funding constraints are ubiquitous in healthcare. However by international standards our rate of prescribing during this audit was low (26/100 000 population), compared with 43 and 60/100 000 in Australia and Canada respectively (25), and whilst this may reflect tighter selection of patients, it is more likely that we are not meeting the needs of a significant number of patients who may potentially benefit from oxygen therapy.

In conclusion, our audit has exposed STOT as a specific problem which represents a considerable proportion of our referral load. Presently, we have no answer to such basic questions as which patients should be discharged home on oxygen. We still rely heavily on the two landmark studies that use inclusion criteria that may not be relevant to many of the patients now being referred for consideration of oxygen. The prescription of oxygen has generally conferred a commitment to indefinite treatment. This presents considerable implications in terms of resource both direct and indirect and impact on patient and carers both positive and negative. The benefits of oxygen are only likely to be realised if each decision is correct and appropriate to the individual circumstances of each patient. Conversely, oxygen is an expensive placebo for the distressed and dyspnoeic, yet not hypoxic patient. Misconceptions and misinformation surrounding oxygen continue to abound. This area remains confounded by emotion not only from the public but the paramedical and medical staff. There is a desperate need to disentangle the evidence from the myths. We remain greatly disadvantaged by the absence of clinical guidelines. There is an urgent requirement for a prospective study of the provision of oxygen at the time of hospital discharge. Clinical guidelines may then be developed.

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