Liquid Oxygen Therapy at home

AGENCE D'ÉVALUATION DES TECHNOLOGIES ET DES MODES D'INTERVENTION EN SANTÉ

Québec

Liquid Oxygen Therapy at Home

Report prepared for AETMIS
by Susan Law

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Scientific review
Alicia Framarin, M.D., M.Sc.

Editorial supervision
Suzie Toutant

Proofreading
Frédérique Stephan

Page layout
Jocelyne Guillot
Frédérique Stephan

Biographical verification
Mathieu D'Amours

Coordination
Lise-Ann Davignon

Communications and dissemination
Richard Lavoie, M.A. (Communication)

For information about this publication or any other AETMIS activity, please contact:

Agence d'évaluation des technologies et des modes d'intervention en santé
2021, avenue Union, bureau 1050
Montréal (Québec) H3A 2S9

Tel.: (514) 873-2563
Fax: (514) 873-1369
e-mail: aetmis@aetmis.gouv.qc.ca
http://www.aetmis.gouv.qc.ca

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Lee Soderström
Economist, Professor, Department of Economics, McGill University, Montréal

FOREWORD

The benefits of long term oxygen therapy for chronic obstructive pulmonary disease (COPD) have been well established and there is good consensus internationally around clinical indications for referral and treatment. There is, however, only limited evidence and guidance about the use of portable oxygen systems (liquid or gas) at home as a component of long term oxygen therapy.

The *Agence d'évaluation des technologies et des modes d'intervention en santé* (AETMIS) recently published a report on home oxygen therapy, and was subsequently asked by the Québec Ministry of Health and Social Services to examine the available evidence specific to liquid oxygen therapy, in terms of costs and benefits, and the implications for the home oxygen program in Québec.

Liquid oxygen systems for home use were introduced in the 1980s to offer patients the convenience of smaller, lighter equipment that delivered oxygen for an extended time period outside the home, in comparison to other oxygen delivery systems. There is a wide variation in the use of liquid oxygen at home and in the organization of services within and across jurisdictions. Technology in this area continues to evolve rapidly, although the specific benefits to patients have not been adequately documented. There is scant evidence regarding the contribution of liquid systems to enhanced duration and quality of life in comparison to other systems; there is some evidence that the technology has some advantages in terms of user-friendliness. Guidelines for use have recently been published in the United Kingdom and the United States that suggest criteria related to the patient's mobility, usage, and compliance.

There is no routine data available about the cost or utilization of liquid oxygen therapy in Québec, although its use is known to be rare as a 'traitement d'exception' in the public system, given the relatively higher cost and clinical concerns about added benefit. Its use is higher in Ontario where it is covered by the provincial Home Oxygen Program. It is likely that this technology would offer some benefit to active COPD patients although the identification of clinical and social criteria for assessment and monitoring should be developed by clinicians and decision-makers in Québec within the context of a comprehensive home oxygen program.

In submitting this report, AETMIS aims to contribute to informed decision-making across Québec with respect to what is currently known and what information we need in order to establish evidence-based policy and practice for the use of liquid oxygen therapy at home.

Dr. Luc Deschênes
Chairman and Chief Executive Officer

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The following individuals were instrumental in providing key support, information and guidance in the preparation of this report:

EXTERNAL REVIEWERS

Dr. Yves Lacasse
Respirologist, Hôpital Laval, Quebec City

Ms. Danielle St-Jules
RN, Head of the Regional Department for Home Care Services, Hôpital Maisonneuve-Rosemont, Montreal

AETMIS INFORMATION SPECIALISTS

Pierre Vincent
Micheline Paquin

CONFLICT OF INTEREST

None declared.

SUMMARY

INTRODUCTION

The benefits of long term oxygen therapy (LTOT) for chronic obstructive pulmonary disease (COPD) are well established. Portable oxygen systems have been assessed in an AETMIS report published in 2004. These systems, developed to provide patients who are active outside the home with an oxygen supply include compressed gas systems, liquid oxygen systems, and oxygen concentrators. This report presents the results of a comprehensive literature review, prepared in response to a request from the Québec Ministry of Health and Social Services to examine the available evidence about the indications, clinical efficiency, and cost-effectiveness of liquid oxygen therapy as well as the implications on the organization of and access to the home oxygen program in Québec.

METHODOLOGY

A search and review of the scientific literature was undertaken in a number of databases including those of Health Assessment Agencies and of the International Network of Agencies for Health Technology Assessment (INAHTA). Other documents and government reports have also been reviewed.

RESULTS

Although there are no published clinical indications for the use of liquid oxygen systems at home, the prescription criteria of the available guidelines are based on patient's mobility and usage. The lighter liquid oxygen systems are recommended for LTOT-dependent patients who need to go outside their home on a regular basis.

There are no existing data which would indicate that liquid oxygen systems allow for extended daily duration of therapy or for improved quality of life in comparison to other oxygen supply systems (portable or stationary). Furthermore, there is limited evidence that this technology is more user-friendly and advantageous than the compressed gas systems. Comparative costs were reported in one study conducted in Sweden which reveals that liquid oxygen is four times as expensive as the standard therapy (concentrator plus portable cylinder). Utilization of liquid oxygen systems and access to this treatment vary within and across jurisdictions, and depend on the patients insurance coverage. In Canada, the use of liquid oxygen systems is higher in Ontario where it is covered by the provincial Home Oxygen Program. In Québec, given the relatively higher cost and clinical concerns about added benefit, liquid oxygen systems are offered in the public system only as a 'traitement d'exception' to patients who spend lengthy periods of time out of their home either for work or for leisure or need high flow rates. Nevertheless, patients who wish to use these systems can buy one directly from a supplier.

New systems of portable oxygen supply, such as a portable concentrator that has been developed in Montreal and is being tested for clinical use, may in the future compete as alternatives to liquid oxygen therapy.

CONCLUSION

There is very limited information about the effectiveness of liquid oxygen therapy in comparison to compressed gas delivery systems in terms of enhanced patient compliance, mobility, or quality of life. A small minority of patients with COPD on LTOT who have active lifestyles would likely benefit from the enhanced portability of liquid oxygen therapy. The identification of clinical and social indications or assessment criteria for the use of liquid oxygen therapy should be determined through a process of consensus amongst respirologists and decision-makers in Québec, within the context of developing overall guidelines for home oxygen programs.

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1 INTRODUCTION

The benefits of long-term oxygen therapy (LTOT) for chronic obstructive pulmonary disease (COPD) have been well established [MRC Working Party, 1981; NOTT Group, 1980], and there is good consensus internationally about its clinical indications for LTOT [GOLD, 2001]. Although they appear to have been universally adopted, these indications do not include criteria for prescribing portable or ambulatory oxygen therapy. There is a wide variation across and within jurisdictions around the use of portable or ambulatory systems, including compressed gas and liquid oxygen, as a component of LTOT. This is likely due to a number of factors, including:

- the limited evidence on clinical and cost-effectiveness of these systems;
- the lack of follow-up and monitoring arrangements that would provide information about utilization;
- and persistent problems with regard to patient compliance with therapy and professional knowledge of prescribing criteria.

Liquid oxygen systems for domiciliary use were introduced in the 1980s, in an effort to provide patients who are active outside the home with a lighter-weight, longer-lasting source of oxygen in comparison with compressed gas systems. Liquid systems are, however, more expensive and, as for portable systems in general, there is no consensus regarding indications for use or prescribing.

In Québec, as in other jurisdictions around the world, there has been no clear policy to date regarding the use of liquid oxygen therapy within the home oxygen program. Recommendations for the use of home oxygen therapy were published in Québec [Comité d'oxygénothérapie à domicile, 2000] for COPD and other indications that are consistent with the international criteria, yet this does not include criteria for the prescription of portable systems. For patients requiring LTOT at home, predominantly those with COPD, the most common form of oxygen delivery system used at home is the fixed concentrator. An AETMIS [2004] report on portable oxygen therapy has been completed. This report found variable access to any form of portable oxygen therapy in Québec, although it did not synthesize the published evidence specific to liquid oxygen therapy.

In October 2003, the Québec Ministry of Health and Social Services requested AETMIS to undertake an evaluation of the costs and benefits of liquid oxygen therapy within the home LTOT program and specifically, the potential benefits for patients and the implications for the cost and organization of home oxygen therapy in Québec.

This report presents the results of a comprehensive search and review of the literature on the use and benefits of liquid oxygen therapy.

2 HTA RESEARCH QUESTIONS

1) What is liquid oxygen therapy; when and how did it evolve?
2) What is the evidence regarding the clinical and cost-effectiveness of liquid oxygen therapy—including impact on quality of life and safety issues—in comparison to fixed and gas systems of oxygen delivery?
3) How are services organized and delivered? What information is available on the pattern of utilization and access in Québec and other jurisdictions?

3 METHODOLOGY

The following databases were included in the search: MEDLINE (1980 to January 29, 2004); EMBASE (1980 to January 29, 2004); Cochrane Library, Issue 1, 2004; Government documents and reports (grey literature); HTA agencies—INAHTA database(s); Web-based search.

Key words used in the search included: liquid oxygen, liquid oxygen therapy, portable OR ambulatory, COPD, RCT, AND organization. For the MEDLINE and EMBASE search, the search statement was: "(liquid(w) oxygen and oxygen(2w)therap?)/human".

For inclusion in this report, all papers had to contain the following information:

- liquid oxygen therapy as part of LTOT;
- study subjects included COPD patients on LTOT;
- therapy delivered at home.

For questions 1 and 3, regarding the definition, utilization and organization of services, papers were selected that included:

- description of utilization, organization and supply;
- international comparisons;
- review papers.

For question 2, regarding the clinical and cost-effectiveness of liquid oxygen therapy, papers were selected that met the following criteria:

- comparisons studies of liquid vs. compressed gas and/or vs. fixed systems;
- randomized and/or controlled trials of liquid oxygen therapy vs. gas or placebo.

4 RESULTS

4.1 DEVELOPMENT OF LIQUID OXYGEN SYSTEMS

Liquid oxygen systems preserve 100% oxygen in a liquid state at -297.3 degrees Fahrenheit (-183°C). Liquid oxygen systems first became available for hospital use in the 1900s, although it was not until the 1960s and 70s that liquid oxygen was available outside the hospital [Kacmarek, 2000]. Liquid oxygen for home use was promoted on the convenience of its size—1 L of liquid oxygen is equivalent to 840 L of gaseous oxygen (using about 10% of the space required by compressed gaseous oxygen). Liquid oxygen systems for home use include a large stationary reservoir (about 40 L of oxygen) and a companion portable cylinder system. The portable cylinders can be refilled from the reservoir by patients who have received adequate training. At a flow rate of 2 L/min, 24 hours per day, these systems provide oxygen for about 11 days. At this rate, the reservoir typically needs refilling every 10 to 14 days by a supplier. Portable liquid oxygen cylinders last up to four times longer than portable compressed gas cylinders, and longer when equipped with an oxygen-conserving device.

The advantages of portable liquid oxygen systems are their smaller size and lighter weight, allowing patients to stay longer outside their home. Oxygen-conserving devices (OCD) that attach to portable systems provide oxygen on inspiration only, increasing the duration of use available with portable systems. When used with compressed gas cylinders, the time available is equivalent to liquid oxygen systems, depending on the flow and type of system [Royal College of Physicians, 1999]. Table 1 compares the three delivery systems available for home use.

TABLE 1

Comparison of portable oxygen therapy delivery systems

SYSTEM	WEIGHT	MAXIMUM DURATION OF USE (AT 2 L/MIN) FOR PORTABLE USAGE
Compressed gas		
Aluminum E cylinder (680 litres)	7.5 lbs	5 hrs
M6 cylinder (140 litres)	N/A	2 hrs; 4-6 hrs with OCD
Liquid (1 litre cylinder: 840 litres gas)	3.5-7 lbs	3-4 hrs; 7-10 hrs with OCD
Concentrator (small portable device)	10 lbs	depends on battery size (e.g. 50 mins.)

N/A: Data not available.
Source: Adapted from Kacmarek, 2000; McCoy, 2001.

Danielle St-Jules, head of the Regional Department for Home Care Services at Hôpital Maisonneuve-Rosemont, provided additional information to supplement the published information above[1]: an OCD can now be installed with an E cylinder; in practice, an M6 cylinder will last only 1.4 hours without an OCD; patients are required to carry 2-3 batteries with them when using portable concentrators since a battery only last approximately 50 minutes.

1. Personal communication, May 6, 2004.

As with any home oxygen system, there is a risk of fire and burns to patients if the oxygen comes into contact with an open flame. The risks specific to liquid oxygen systems include the potential risk of frostbite while refilling the portable cylinder if the liquid oxygen comes into contact with the skin—this is an unlikely occurrence[2]—although not well documented in the literature in terms of frequency or incidence of accidental frostbites; the unit may freeze while refilling and cease to operate. Other important disadvantages with the use of liquid oxygen systems are that the reservoir is very large and requires adequate space in a patient's home to house the unit, and that oxygen evaporates from the cylinders and reservoir over time, requiring frequent refilling.

4.2 INDICATIONS FOR PRESCRIBING

There are no published clinical indications for the use of liquid oxygen systems at home. Indications for portable systems that use mobility and usage as key criteria for prescribing have recently been published in the United Kingdom and the United States.

In 1999, a working party of the British Royal College of Physicians (RCP) published guidelines for home oxygen therapy, including the following statement about portable oxygen:

> "Ambulatory oxygen therapy is indicated in patients on LTOT who are mobile and need to or can leave the home on a regular basis. The type of portable device provided will depend on the patient's mobility. Patients with considerable usage will require a liquid oxygen system or a small lightweight cylinder with an oxygen-conserving device attached" [RCP, 1999; p.18].

Further in this report, the Working Party states:

> "The daily usage of ambulatory oxygen will vary, depending on an individual patient's mobility, and this will dictate the type of equipment required. Patients who require a greater use of ambulatory oxygen, e.g. more than 2 or 3 hours outside the house, may need a portable liquid-oxygen system or a portable cylinder with an attached oxygen-conserving device. Patients who need only occasional ambulatory oxygen or under 2 hours daily will require a small portable cylinder only" [RCP, 1999; p. 29].

The RCP report emphasizes the importance of a clinical assessment to determine the appropriate prescription and system for patients, and proposed standardized assessment forms for LTOT and ambulatory domiciliary oxygen that specify the type of device prescribed. The information collected on these forms would contribute to audit and research activities.

In the United Kingdom, the National Institute for Clinical Excellence [NICE, 2004] has recently published guidelines for managing COPD developed by the National Collaborating Centre for Chronic Conditions (NCC-CC). These guidelines include the following consensus statements regarding the use of portable oxygen, including liquid oxygen:

- Ambulatory oxygen therapy can be used as a way of ensuring that patients who require long term oxygen therapy and who leave the home on a regular basis receive oxygen for sufficient hours to gain the benefits of LTOT.
- Liquid oxygen is considerably more costly to provide for the patient. Liquid-oxygen portable systems can on average supply 8 hours of oxygen at 2 L/min,

2. Danielle St-Jules, personal communication.

though they may be used in conjunction with oxygen-conserving devices. These liquid units must be filled from a large reservoir that is delivered to the patient's home. As liquid oxygen systems evaporate with time, the large home reservoir unit requires frequent filling or replacement.

- The technology for the provision of ambulatory oxygen is developing rapidly.

Recommendations that pertain to ambulatory and liquid oxygen (all Grade D) (see Appendix) are reproduced below (recommendations specific to the use of oxygen for exercise desaturation were excluded for this report):

R. 68: People who are already on LTOT who wish to continue oxygen therapy outside the home, and who are prepared to use it, should have ambulatory oxygen prescribed.

R. 71: Ambulatory oxygen therapy should be only prescribed after an appropriate assessment has been performed by a specialist.

R. 72: Small lightweight cylinders, oxygen-conserving devices and portable liquid oxygen systems should be available for the treatment of patients with COPD.

R. 73: A choice about the nature of equipment prescribed should take account of the hours of ambulatory oxygen use required by the patient and the oxygen flow rate required.

This last recommendation refers to a table in the report of appropriate equipment based on usage. Compressed gas cylinders are recommended for usage less than 90 minutes; compressed gas cylinders with OCD for duration of use between 90 minutes and 4 hours. Liquid oxygen is recommended for usage greater than 4 hours or flow rates greater than 2 L/min with duration greater than 30 minutes.

Aetna, a major North American health insurance company, has published a Clinical Policy Bulletin, *Oxygen for Home Use*, recommending that very lightweight portable oxygen systems (including liquid oxygen) would be "considered medically necessary for members who regularly go beyond the limits of a stationary oxygen delivery system with a 50-ft tubing for two hours or more per day and for most days of the week (minimum six hours/week)" [Aetna, 2004]. It is noted that individual benefit plans determine the actual coverage for members; routine monitoring is mandatory to requalify for coverage. As in the United Kingdom, the main criterion for prescribing lightweight systems is the patient's level of mobility. Although less specific, the US Department of Veteran Affairs guidelines for issuing respiratory equipment states that liquid oxygen systems are prescribed for "[…] ambulatory patients who can use an extensive amount of oxygen from portable sources" [Department of Veterans Affairs, 2000].

4.3 UTILIZATION AND ACCESS

Liquid oxygen therapy is routinely available in the United States and in parts of Europe for selected patients when it is considered necessary for mobility. A review of US Medicare beneficiaries using home oxygen in 1991-92 indicated that 19% of current users and 14% of new users had liquid oxygen; factors associated with liquid oxygen use included portable oxygen claims, metropolitan residence, white race, and age (more claims were coming from patients age 66 to 75 than from patients over 76 years) [Silverman et al., 1997]. Kacmarek [2000] reports that due to cost pressures within the system and decreasing reimbursement for home oxygen therapy by the government, the use of liquid oxygen in the United States has declined to less than 10% of patients on home oxygen.

In their review of five European countries, Garattini et al. [2001] found a wide variation in the organization of home oxygen therapy services (including delivery and supply) and

in the utilization of different types of oxygen equipment. The predominant source of home oxygen therapy was via concentrators or gas cylinders; liquid oxygen was used by 10% or less of home oxygen therapy patients in Germany and Denmark, and by about 25% of patients in France. The exception to this was Italy, where liquid oxygen was used for over 80% of patients [Garattini et al., 2001; Fauroux et al., 1994]. In the United Kingdom, liquid oxygen is not available through the National Health Services, but may be purchased by hospitals or privately by patients [Wedzicha, 1999].

Garattini et al. [2001] were able to collect some data about prices for liquid oxygen therapy in some countries. However, it is difficult to determine from the available information what is included in these prices, how the funds flow in the particular system, and therefore how to compare delivery systems within and between countries. In Italy, pharmacies are reimbursed at €4.65 per cubic metre for liquid vs. €5.58 per cubic metre for compressed gas; the lower rate for liquid oxygen may explain the higher utilization in Italy. In France, it was stated that the daily rate per patient for a concentrator was €8.70; the daily rate for liquid oxygen was €16.4. The Danish National Health Service reimburses around €11.41 per patient per day for liquid oxygen; no comparable information was available for other delivery systems.

The utilization of liquid oxygen is unknown in Canada, although it seems to vary across and within jurisdictions, and depends on patients' insurance coverage [AETMIS, 2004]. It is known that usage of liquid oxygen is higher in Ontario where it is covered by the provincial Home Oxygen Program, using standardized assessment forms and centralized application processes for approval, and where the market has evolved differently[3].

There is no routine data available about the cost or utilization of liquid oxygen in Québec. Information gathered from the key informant survey conducted for the AETMIS [2004] report on portable oxygen therapy indicated that, given the relatively higher cost, liquid oxygen is only available under the public system in Québec as a 'traitement d'exception' (e.g. in the case of patients who spend considerable amounts of time outside the home for employment or leisure activities, or those requiring high flow rates). This does not preclude patients from making private arrangements with suppliers for liquid oxygen—with or without private insurance coverage.

4.4 CLINICAL AND COST-EFFECTIVENESS

Three randomized controlled trials that met the inclusion criteria stated in section 3 provided information about the effectiveness of liquid oxygen therapy. A summary of these studies is presented in Table 2.

The study by Vergeret et al. [1989] demonstrated that patients with portable systems (liquid or gaseous oxygen) had longer daily duration of therapy than those with fixed systems, although there was no difference between liquid or gaseous oxygen. Although only 60% of patients with portable systems used them, the proportion of patients who never used them did not include any liquid oxygen users. The study by Lock et al. [1992] was very small and with a short evaluation timeframe, but found longer time periods spent outside the home associated with the use of portable liquid oxygen in comparison to gas systems. No benefits to quality of life were found using the assessment tool, although patients stated a preference for liquid oxygen due to its user-friendliness compared to gas delivery systems. A Swedish study reported results on costs and quality of life separately. It found liquid oxygen to be approximately four times as expensive as standard therapy and that there was limited evidence to the effect that liquid therapy improved patients' quality of life [Andersson et al., 1998].

3. Danielle St-Jules, Hôpital Maisonneuve-Rosemont, and Christel Galea, Ontario Home Oxygen Program, personal communications.

TABLE 2

Randomized controlled trials (RCT) including information about the effectiveness of liquid oxygen therapy

STUDY AND OBJECTIVES	METHODS	RESULTS
Andersson et al., 1998, Sweden To compare effects of liquid oxygen vs. standard system (concentrator plus portable gas) on quality of life, and costs.	Prospective RCT, multi-centre Cost-utility analysis *n*=51 patients with hypoxemia (47 with COPD) who were active outside the home Patients randomized to: ▪ liquid oxygen (*n*=29) ▪ standard treatment (*n*=22) No statistical difference amongst the comparison groups Patients followed for 6 months HR-QOL instruments: SIP, EuroQol	SIP indicated improved quality of life after 6 months for the liquid oxygen group; no improvement for the standard group. Changes in QoL using the EuroQol were less clear. Average total cost (health care services, oxygen, equipment) per patient for 6 months was US$1,310 for standard group; US$4,950 for liquid group.
Lock et al., 1992, UK To assess the use and acceptability of liquid vs. gaseous oxygen.	RCT; cross-over design *n*=15 (12 male); all patients with chronic lung disease with hypoxemia; all non-smokers; all with at least 10% improvement using standard portable oxygen assessment tool. 11 were on LTOT; 8 had portable systems prior to the study. Liquid and gas oxygen provided in random order for 2 x 8-week periods CRDIQ* instrument used to assess quality of life at 4 week intervals; 6-minute walking test performed at baseline, 8 and 16 weeks; patients used diaries to record use of portable system and concentrators, and time spent outdoors.	Walking distance was not affected by the weight of either system. Information from diaries was available from 13 patients. Patients used the liquid oxygen longer (avg. 23.5 hrs/wk) than gas (avg. 10 hrs/wk). Patients using liquid oxygen spent 19.5 hrs/wk on avg. outside the home, compared to 15.5 hrs/wk on avg. using gas. The CRDIQ did not show any consistent change during the study. 11 of 15 patients preferred the liquid oxygen because of duration, ease of carrying and filling.
Vergeret et al., 1989, France To evaluate effects of portable oxygen on daily duration of therapy, daily activities; assess advantages of gaseous or liquid oxygen.	RCT *n*=159 (139 males) patients with severe COPD with hypoxemia who already had a fixed oxygen system but did not already have portable oxygen Excluded: patients already using portable systems, severe co-morbidities Patients randomised to: ▪ oxygen concentrator (OC) (*n*=75) ▪ OC plus portable gas (*n*=51) ▪ liquid oxygen (*n*=33) No statistical difference between characteristics of the patients in the different arms of the study Patients followed for 1 year Assessment included baseline then quarterly clinical check-ups and monthly home visits. Interviewers collected quantitative and qualitative information, using non-standardized instruments, on duration of therapy, patients' activities and opinion about the therapy.	No clinical or functional differences between groups. Patients using portable systems had longer duration of therapy (17 hrs vs. 14); no difference between gas and liquid. Only 60% of patients with portable systems used them outside the home; 25% never used portable system (all had gas systems).

*CRDIQ: Chronic Respiratory Disease Index Questionnaire.

A Cochrane review of ambulatory oxygen (including all forms of portable oxygen systems) excluded the Vergeret and Lock studies given that they did not include placebo arms of the trial [Ram and Wedzicha, 2004]. The Andersson trial was not listed in the included or excluded studies. One previous RCT that investigated the effectiveness of liquid oxygen versus placebo (liquid air) was identified [Lilker, 1975] but not reviewed in this report given the date of the study and because it did not include any comparison with another delivery system. The Cochrane review included only one other RCT that did not involve liquid oxygen therapy [McDonald et al., 1995].

The first-ever placebo-controlled trial of portable oxygen therapy was recently conducted in Québec. Results have not yet been published[4], but preliminary findings were presented in November 2003 [Lacasse et al., 2003] for 22 of the 24 patients enrolled in the trial. Although the study design did not include liquid oxygen therapy, the results are important to the study of portable oxygen systems in general, but should be interpreted with caution given the small sample size and difficulties encountered with recruitment for the trial. The research team concluded that there is no justification for prescribing portable oxygen therapy routinely for oxygen-dependent patients with COPD since data indicates that portable systems do not improve quality of life and compliance with therapy.

A large prospective cohort study conducted in France [Pépin et al., 1996], including 10% of patients receiving LTOT chosen at random from 14 regional centres, found that 271 of the 893 patients (30%) on home oxygen therapy were prescribed portable systems (liquid or gas). Of these 271 patients, only 38 (14%) used oxygen outside the home, yet 37 of them had liquid oxygen systems. The criteria for prescribing either liquid or gas systems were not described in this paper.

To summarize, there is scant evidence that liquid oxygen systems contribute or not to enhanced daily duration of therapy and quality of life in comparison to gas or fixed systems. There is limited evidence that this technology is more user-friendly and has some technical advantages in comparison to compressed gas systems. These advantages are likely to be most beneficial to a select group of patients who are relatively active and compliant with therapy, although there are no agreed social or clinical indicators that would be reliable predictors of use or benefit.

4.5 PATIENT PERSPECTIVES

Some insight into the patient perspective on using liquid systems is available from a patient-run Web site[5]. Patient feedback on the different systems in the September newsletter included:

- liquid systems are less noisy than concentrators and do not generate any heat;
- concentrators require an electrical connection that costs patients between US$25 and $30 per month (as at September 2003); the added heat production may also increase hydro costs related to air conditioning during summer;
- compressed gas systems require about five times the number of delivery visits from the supplier to replenish the large and small cylinders versus liquid systems; liquid systems require deliveries every two to three weeks;
- under the Medicare fee schedule for some states (Florida was the example in the case recorded on the above Web site; price in US 2001 dollars), the co-payment for any system was the same: US$42.75 per month.

4.6 NEW DEVELOPMENTS

New systems of portable oxygen supply may in the future compete as alternatives to liquid oxygen therapy, although the implications for cost and/or effectiveness have not

4. According to Dr. Yves Lacasse, the trial is in the process of being published (personal communication).

5. www.portableoxygen.org / (accessed February 16, 2004).

been scientifically investigated in comparison to existing systems. This includes home concentrators that can refill gas and liquid cylinders, and portable concentrators [McCoy, 2001; Kacmarek, 2000]. It appears that a portable concentrator has been developed in Montreal that is being tested for clinical use [Bouchard, 2004].

5 CONCLUSION

There is very limited information about the effectiveness of liquid oxygen therapy in comparison to compressed gas delivery systems in terms of enhanced patient compliance, mobility, or quality of life. It is, however, clear that a small minority of patients with COPD on LTOT who have active lifestyles would likely benefit from the enhanced portability of liquid oxygen therapy. It could contribute to enhanced quality of life for particular patients even if this is supported by limited evidence from the published literature.

It is unlikely that further scientific evidence regarding cost-effectiveness will contribute to solve the dilemma of how to set policy for a service which may provide additional benefits but at a higher cost.

The identification of clinical and social indications or assessment criteria for the use of liquid oxygen therapy should be determined through a process of consensus amongst respirologists and decision-makers in Québec, within the context of developing overall guidelines for home oxygen programs.

6 IMPLICATIONS FOR POLICY, PRACTICE AND RESEARCH

As indicated in the broader review of portable oxygen therapy [AETMIS, 2004], it is highly unlikely that there will be further trials of portable oxygen therapy to help resolve the questions about appropriate indications and usage of liquid oxygen therapy. It would likely be more productive and practical to encourage a consensus-based approach amongst researchers, clinicians and decision-makers in order to identify the appropriate types of patients and conditions under which liquid oxygen should be prescribed and how it should be monitored, within the context of a home oxygen therapy program. There is some uncertainty, however, amongst professional providers about the extent to which the specification of criteria would be considered a priority, relative to other needs of this group, and helpful to clinical or policy decision-making.

APPENDIX : HIERARCHY OF EVIDENCE AND GRADING OF RECOMMENDATIONS

HIERARCHY OF EVIDENCE		GRADING OF RECOMMENDATIONS	
Level	**Type of evidence**	**Level**	**Type of evidence**
Ia	Evidence from systematic reviews or meta analysis of randomised controlled trials	A	Based on hierarchy I evidence
Ib	Evidence from at least one randomised controlled trial		
IIa	Evidence from at least one controlled study without randomisation	B	Based on hierarchy II evidence or extrapolated from hierarchy I evidence
IIb	Evidence from at least one other type of quasi experimental study		
III	Evidence from non experimental descriptive studies, such as comparative studies, correlation studies and case control studies	C	Based on hierarchy III evidence or extrapolated from hierarchy I or II evidence
IV	Evidence from expert committee reports or opinions and/or clinical experience of respected authorities	D	Directly based on hierarchy IV evidence or extrapolated from hierarchy I, II or III evidence
NICE	Evidence from NICE guidelines or Health Technology Appraisal programme	NICE	Evidence from NICE guidelines or Health Technology Appraisal programme
HSC	Evidence from Health Service Circulars	HSC	Evidence from Health Service Circulars

Source: National Institute for Clinical Excellence (NICE). Chronic obstructive pulmonary disease: Management of chronic obstructive pulmonary disease in adults in primary and secondary care. Thorax 2004; 59(Suppl 1):13.

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Québec