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COMMENTARIES

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Medical marijuana
Darrel Melvin, Andrea White Markham

ORIGINAL ARTICLE

Initial validation of a modified suction task training system
Umbar Khan, Steven Scott Atkinson, Brad Gable, Aimee K Gardner, Rami A Ahmed

Suctioning is a widely used procedure in diverse patient groups ranging from the acutely ill to chronically affected individuals requiring long-term airway support, and is a fundamental skill in patient care. Its efficacy, however, is not without attendant risks, which may include hypoxia, hypotension and mucosal hemorrhage, among others. Students and trainees, unfortunately, seldom have the opportunity to practice the technique on patients experiencing respiratory distress. Moreover, commercially available, high-fidelity simulator devices designed to recreate the process are not widely accessible. Accordingly, this study aimed to design, develop and test a novel suction task training system recreating the look and feel of suctioning secretions from an actual patient.

REVIEW

Home Oxygen Program review: Regionalization in Vancouver Coastal Health and British Columbia
Dan Sandberg

The Home Oxygen Program in British Columbia began as a small, centralized program clerically managed by the Ministry of Health in British Columbia. A pilot program launched in the mid-1990s, however, demonstrated the feasibility and myriad benefits of managing the program locally. Approximately seven years later, the pilot’s model and recommendations were implemented in British Columbia’s five health authorities, and the program has grown to include many clients. This article describes the development of the program from its infancy to its present-day success, focusing on regionalization and its incumbent challenges.

DEPARTMENTS

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Expanding the reach of respiratory therapy: A need for evaluation

On November 27, 2014, Medavie Blue Cross and the Canadian Lung Association announced a breakthrough in increasing access to essential respiratory services for patients with chronic obstructive pulmonary disease (COPD) and asthma. Patients will now be able to self-refer to certified respiratory educators (CREs), including respiratory therapists.

Chronic respiratory diseases comprise a significant health burden in Canada and around the world. Internationally, these diseases account for 4.7% of global disability-adjusted life years, and COPD comprises two-thirds of all chronic respiratory diseases, ranking it as the ninth most burdensome disease in the world (1). Recent estimates from Ontario identified a COPD population prevalence of 11.8% among adults ≥35 years of age (2). This prevalence increased by 64.8% from the mid-1990s to the mid-2000s, suggesting a significant growth in the number of individuals with COPD (3). Asthma prevalence similarly increased by 70.5%, with an overall population prevalence of 13.3% by the mid-2000s (4). Collectively, these diseases account for significant morbidity and mortality among Canadians, and represent major health expenditures for unplanned hospital admissions and drug spending.

Existing evidence suggests that an integrated disease management approach to the treatment of COPD is effective for improving disease-specific quality of life and for reducing health services utilization (5). In asthma, some evidence exists to support similar models of care; however, more investigation and studies of higher quality are needed to draw more robust conclusions (6,7).

The expansion of coverage for CREs presents an opportunity to improve the care of patients with chronic respiratory diseases across Canada, and to expand the reach of respiratory therapy services in the community. Presently, few respiratory therapists practice outside of acute care settings, despite a growing need for primary care services (8). As provinces continue to seek to improve care for older adults in particular, there is a strong need to identify programs and interventions that enable seniors to stay healthy and at home longer; the introduction of community-based respiratory therapy services is likely a core component of this.

From a research and professional practice standpoint, there is a strong need to evaluate the impact of these programs and this coverage to demonstrate clinical and cost effectiveness, as well as the impact of these interventions on the health system in general. Obtaining these data through robust study designs is essential for understanding the impact of these programs on important clinical and economic outcomes, and for justifying the further expansion of these programs to other payers. Several studies support the role of respiratory therapists in providing hospital-based care and education for chronic respiratory diseases; however, it is essential to extend these analyses to the other payers. Several studies support the role of respiratory therapists in providing hospital-based care and education for chronic respiratory diseases; however, it is essential to extend these analyses to the

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Accroître la portée de l’inhalothérapie : la nécessité d’une évaluation

Le 27 novembre 2014, la Croix Bleue Medavie et l’Association pulmonaire du Canada ont annoncé une augmentation de l’accès aux services respiratoires essentiels pour les patients atteints d’une maladie pulmonaire obstructive chronique (MPOC) et d’asthme. Les patients pourront désormais s’aiguiller eux-mêmes vers des éducateurs certifiés et réadaptation respiratoire (ÉCR), y compris les inhalothérapeutes.

Les maladies respiratoires chroniques s’associent à des coûts de santé élevés, tant au Canada que dans le reste du monde. Sur la scène internationale, ces maladies représentent 4,7 % de l’ensemble des années de vie ajustées en fonction de l’incapacité, et les MPOC, qui englobent les deux tiers de toutes les maladies respiratoires chroniques, arrivent au neuvième rang des maladies les plus coûteuses dans le monde (1). D’après les récentes évaluations ontariennes, la prévalence de la population atteinte de MPOC s’élève à 11,8 % chez les adultes de 35 ans ou plus (2). Cette prévalence a augmenté de 64,8 % entre la moitié des années 1990 et la moitié des années 2000, laissant supposer une croissance importante du nombre de personnes atteintes de MPOC (3). De même, la prévalence d’asthme a augmenté de 70,5 %, la prévalence globale en population étant passée à 13,3 % au milieu des années 2000 (4). Collectivement, ces maladies sont responsables d’une morbidité et d’une mortalité importantes chez les Canadiens et contribuent énormément aux dépenses liées à des hospitalisations non planifiées et aux médicaments.

Selon les données, la prise en charge intégrée du traitement des MPOC améliore la qualité selon la maladie et réduit l’utilisation des services de santé (5). Dans le cas de l’asthme, certaines données appuient des modèles de soins similaires, mais d’autres recherches et des études de meilleure qualité s’imposent pour qu’il soit possible de tirer des conclusions plus robustes (6,7).

L’expansion de la couverture aux ÉCR est l’occasion d’améliorer les soins aux patients canadiens atteints d’une maladie respiratoire chronique et d’accroître la portée des services des inhalothérapeutes dans la collectivité. Peu d’inhalothérapeutes travaillent actuellement à l’extérieur des milieux de soins aigus, malgré le besoin croissant de services de première ligne (8). Tandis que les provinces continuent de chercher à améliorer les soins aux adultes âgés, il est essentiel de déterminer les programmes et les interventions qui favorisent leur santé et leur autonomie plus longtemps. L’adoption des services d’inhalothérapie communautaires en sera probablement un aspect central.

Sur le plan de la recherche et de la pratique professionnelle, il est capital d’évaluer les répercussions de ces programmes et de cette couverture pour en démontrer l’efficacité clinique, la rentabilité et les
community and to these new roles to ensure that the care provided is safe and effective, and to demonstrate the impact of these services to decision makers.

In short, this initiative represents a large step forward for respiratory therapists practicing as CREs and certified asthma educators, and will likely solidify the role of respiratory therapists as leaders in respiratory health. However, this advancement should not be taken lightly, nor should it be taken for granted. We need to rigorously evaluate the impact of new policy changes to ensure that we continue to demonstrate the feasibility of expanding respiratory therapy services, as well as the impact of doing so. This is essential for ensuring the sustainability of the profession and for continuing to improve the health of Canadians.

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RÉFÉRENCES
No smoke, no fire: What the initial literature suggests regarding vapourized cannabis and respiratory risk

Mallory Loflin MA, Mitch Earleywine PhD

As more municipalities relax restrictions on access to cannabis, questions about the plant’s potential for respiratory effects become more common. Given current limitations in developing an inhalant alternative for delivering cannabis medication, smoked marijuana remains the most readily accessible form of cannabis among medicinal users (1). An important question that remains is how to improve safety for the respiratory system in individuals who choose to use cannabis medicinally. Although frequent comparisons with tobacco emphasize that the smoke from cannabis has more carcinogens and respiratory irritants, the absence of nicotine likely mitigates the impact of some of these compounds (2). Evidence linking a link between cannabis and lung cancer is equivocal (2-4), but other concerns remain important. Frequent smokers of cannabis often report respiratory problems. Many users experience symptoms of bronchitis including coughing, wheezing and tightness in the chest (5,6). Informed health care professionals may consider making recommendations to their medicinal cannabis patients for vapourization of the plant, particularly for those who want the rapid relief that oral administration fails to provide. It is not our intention to encourage inappropriate use of the plant, but to increase safety for those who choose to use it. Vapourization of cannabis is likely less harmful than smoking. Nevertheless, researchers have yet to gather some of the most necessary data regarding the topic. There have been no published randomized clinical trials investigating vapourization with long-term follow-up; therefore, drawing firm conclusions about the impact of the technique is difficult. Preliminary findings do support the idea that vapourization is an improvement over smoking.

PULMONARY IMPACT OF CANNABIS

The plant’s effect on bronchial passages appears to vary with exposure; acute administration can lead to bronchodilation. Cannabis actually served as an asthma treatment in the 1800s and, perhaps, in ancient times (7). A meta-analytic review of 12 studies revealed average increases of 0.15 L to 0.25 L in forced expiratory volume in 1 s (FEV1), as well as improved peak flows and airway conductance (7). No overall metric of significance was reported; however, the majority of reviewed studies found statistically significant improvements. Data regarding the role of long-term exposure is less consistent. The long-term impact of cannabis use on measures of lung function, particularly FEV1, forced vital capacity (FVC) and their ratios, is significant in some studies but not others. A review of 14 studies emphasized vast variation in the quality of the research and found limited impact of use on relevant measures of lung function, particularly when investigators applied appropriate statistical controls for cigarette smoking, age and weight (6). One 2010 study (8) found that after controlling for nicotine use and other factors, cannabis users had an FVC, total lung capacity, functional residual capacity and residual volume comparable with those who had not used it. These data did reveal cannabis-related increases in airway resistance and significant decreases in specific airway conductance adjusted for thoracic gas volume. Potential changes such as these are worthy of the attention of health professionals (3).

Further work is needed to determine whether a link exists between cannabis use and lung cancer. A review of 19 studies (4) revealed elevated exposure to tars, dysfunctions in alveolar macrophages and histological deviations in bronchial mucosa, but no elevated risk for lung cancer, particularly after controlling for tobacco use. Work subsequent to the review focused on a large sample of Swedish conscripts in a 40-year cohort study. Results suggest that heavy use (defined as >50 occasions in a lifetime in this study) had a large and statistically significant impact on lung cancer, increasing rates by a factor of two in the subsequent 40 years. Most individuals reporting marijuana use in the study sample, however, were also tobacco users (91%). In contrast, smoking >10 cigarettes a day (a cut-off chosen by the authors of the article) increased risk by a factor of five. Any attempt to try to equate cigarettes and cannabis exactly is probably a fool’s errand, but these comparisons may help readers put cannabis’s impact on lung cancer into perspective. Only 189 cases of lung cancer occurred in >49,000 participants; therefore, all of these results must be interpreted cautiously (9). The teen years may be a particularly important time to avoid smoking entirely given that it is a critical period in lung development when exposure to irritants may have a dramatic impact. This point does, however, support the need for some type of intervention, such as the vaporizer, if teens need medical cannabis (10).

INCREASING POTENCY TO INCREASE SAFETY

At first glance, an obvious attempt to increase the plant’s safety would require higher concentrations of cannabinoids, thereby increasing the proportion of active ingredients to irritants in a single inhalation. Stronger cannabis would require smoking less, thereby decreasing exposure to byproducts of the high-heat decomposition of organic materials (pyrolytic compounds). This option relies on the assumption that higher-potency strains of cannabis do, in fact, deliver a higher ratio of cannabinoids to irritants. It also assumes that users are capable of titrating the dosages on their own. Recent evidence suggests that cannabis users will modify the amount of marijuana that they inhale depending on its active dose (11). Nevertheless, a significant proportion of medicinal users report that they prefer lower-dose forms of flower cannabis to concentrates for the very reason that effects can occur too swiftly. These participants also reported that extracts led to more tolerance (12). For these reasons, vapourized plant material may have advantages over extracts.

VAPOURING WHOLE-PLANT CANNABIS

Previous reviews of respiratory risk are quick to note that most research investigating cannabis has failed to control for the type of inhalation mechanism (13). The variability in mode of inhalation used across users (eg, joints, pipes, bongs, vapourizers), coupled with a lack of research differentiating users based on inhalation method, makes estimating risk associated with smoked cannabis difficult. Findings from the few studies that do attempt to isolate the respiratory risk associated specifically with vapourizers all demonstrate some level of benefit (5,14-16). Vapourizer technologies attempt to sidestep...
potential respiratory risks. Vapourizers heat the entire plant without igniting it, releasing the cannabinoids in a vapour that is relatively free from the byproducts of combustion. Most cannabis vapourizers require that users draw heated air across plant material. Other devices blow the air past the plant material independently so that the cannabinoid-rich vapour can fill a container, eliminating the user's exposure to the heat source. The majority of studies suggest that vapourizers adequately reduce risk of pulmonary symptoms (5,14-16), although complete safety may require a regulated source of plant material, rather than 'street' samples, which produce ammonia (17).

One of the first vapourizer experiments compared the emissions from multiple samples of vapourized or combusted research-grade cannabis (18). The vapour formed in the gas phase of vapourization of cannabis is composed overwhelmingly of cannabinoids with no significant pyrolytic compounds. Only trace amounts of three other compounds were found, including the terpene Caryophyllene and two other substances of undetermined origin. Analysis of the smoke produced through the burned cannabis method, however, resulted in a much lower ratio of cannabinoids to overall gas space (12% of the total mass compared with 94.8%), with 111 total detectable compounds. Five of these byproducts of combustion were known polynuclear aromatic hydrocarbons, organic pollutants with known toxic and carcinogenic effects. The findings suggest that vaporization reduces the delivery of toxic byproducts associated with the use of smoked cannabis. A subsequent experiment addressed exhaled carbon monoxide (CO) (14). The researchers found a statistically significant difference between the increase in CO exhaled following smoking cannabis versus vaporization. The amount of exhaled CO showed little to no increase following vaporisation compared with large increases following smoking, which would be expected for inhalation of a combustion product. These findings give further evidence that vaporisation reduces exposure to gaseous combustion toxins.

These results are consistent with self-report research, which suggests that users experience less respiratory irritation when using a vapourizer compared with a classic burning technique (5). After controlling for other known risk factors, using a vapourizer was associated with fewer reported respiratory symptoms overall relative to other burning techniques. Moreover, the study found a noteworthy interaction between amount of cannabis used and choosing to use a vapourizer on reported symptoms. The protective effect of the vaporizer on respiratory symptoms was greatest among those who used cannabis the most. These findings are particularly notable for medicinal users, who typically use more cannabis in both density and frequency than other types of users (1). Regular users appear to have strong intuitions about the potential for less respiratory irritation with the vapourizer. They report reduced emissions and perceived health benefits as two of the most prominent reasons for preferring vapourizers to smoked cannabis (19). Randomized clinical trials, in which users switch to the vapourizer, could bolster these data. One pre-post trial of regular users who reported at least two symptoms of bronchitis found that switching to the vapourizer for one month improved self-reported respiratory symptoms by a statistically significant 73% and FVC by a statistically significant 4.8% (0.22 L), with a trend toward significant improvement in FEV1 of 0.38 L (11.8%) (16). Suggestions to patients to consider choosing a vapourizer compared with a classic burning technique (5). After controlling for other known risk factors, using a vapourizer was associated with fewer reported respiratory symptoms overall relative to other burning techniques. Moreover, the study found a noteworthy interaction between amount of cannabis used and choosing to use a vapourizer on reported symptoms. The protective effect of the vaporizer on respiratory symptoms was greatest among those who used cannabis the most. These findings are particularly notable for medicinal users, who typically use more cannabis in both density and frequency than other types of users (1). Regular users appear to have strong intuitions about the potential for less respiratory irritation with the vapourizer. They report reduced emissions and perceived health benefits as two of the most prominent reasons for preferring vapourizers to smoked cannabis (19). Randomized clinical trials, in which users switch to the vapourizer, could bolster these data. One pre-post trial of regular users who reported at least two symptoms of bronchitis found that switching to the vapourizer for one month improved self-reported respiratory symptoms by a statistically significant 73% and FVC by a statistically significant 4.8% (0.22 L), with a trend toward significant improvement in FEV1 of 0.38 L (11.8%) (16). Suggestions to patients to consider choosing a vapourizer compared with a classic burning technique (5).

**UNDERGROUND MARKET RISKS**

Despite evidence supporting increased respiratory safety when switching to a vapourizer, some risks related to the underground market are noteworthy. Aside from the obvious legal sanctions in some municipalities, research confirms the presence of toxins in 'street' samples of cannabis that even a vapourizer cannot eliminate. Ion-flow tube mass spectrometry revealed toxins, including ammonia, in smoke and vapour from confiscated 'street' samples relative to cannabis obtained from the National Institute on Drug Abuse (17). Although the smoked samples released significantly more ammonia than those that were vapourized, the 'street' cannabis vapour contained approximately 70 parts per million (ppm) of ammonia, compared with 6 ppm for vapourized National Institute on Drug Abuse samples. The findings have important implications for those assisting in vapourization of cannabis in health care and hospital settings given the known toxicity of ammonia exposure (20). Although a regulated market could help sidestep these problems, health care professionals working where patients can only obtain cannabis from the underground market should be aware of this potential risk.

**SUMMARY**

As marijuana laws change, questions about the plant’s impact on respiratory function will undoubtedly increase. The human lung did not evolve to inhale the byproducts of combustion efficiently. Smoking marijuana does not harm lung function as dramatically as smoking tobacco does. Links between smoking marijuana and actual lung cancer are weak and difficult to replicate. Nevertheless, the habit clearly increases symptoms of respiratory irritation such as tightness in the chest, wheezing and coughing. It also has the potential to alter lung function when dose and frequency of use are high. Using stronger cannabis extracts has the potential to limit exposure to irritants, but data regarding this phenomenon are lacking. Many medical marijuana users prefer to use the entire plant. It appears to alter subjective state less dramatically as well as show lower potential for creating tolerance. Edible preparations are an obvious choice that would certainly not add byproducts of combustion to the lung, but these lack the rapid onset and easy titration of dosage available with inhaled products. Thus, the cannabis vapourizer appears to be an ideal harm-reduction approach to safer use.

The vapourizer runs heated air across the plant without igniting it, releasing the cannabinoids in a vapour free from the byproducts of combustion. Some types rely on the user's own inhalation to draw the hot air past the plant material, potentially exposing the lungs to more heat. Other devices blow air into an isolated bag, separating the heating element from the user and avoiding heat exposure. Laboratory work shows that cannabis vapour is composed almost exclusively of cannabinoids with virtually no pyrolytic compounds. The vapourizer raises cannabinoid levels in humans but does not raise exhaled CO levels. One pre-post design clinical trial showed that users with respiratory irritation improved symptoms and lung function after switching to a vapourizer. In short, vapourizers show promise for cannabis users who want to avoid pulmonary problems and prefer a more rapid onset than edibles provide.

**DISCLOSURES:** The authors have no financial disclosures or conflicts of interest to declare.

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The current issue of the Journal includes an article describing the use of vaporizers for medical marijuana. As respiratory therapists (RTs), we must be aware of the science behind the use of these devices and substances, including their benefits and harms.

Presently, there has not been an application to Health Canada for the approval of dried cannabis for medical purposes under the Food and Drugs Act (1). This is the standard process for approval of a therapeutic drug. Because this submission has not been made, the use of cannabis/marijuana as a therapeutic treatment has not been vetted through the review, regulations and standards associated with Health Canada’s approval process. This process would usually include clinical testing, quality control, guidelines for dosage, route of administration, contraindications and reporting/monitoring of adverse reactions (2,3).

In Canada, marijuana is currently regulated under the Controlled Drugs and Substances Act (CDSA) (4). The CDSA prohibits the production, possession and sale of marijuana as a controlled substance, rendering these actions a criminal act. Marijuana is also regulated through an international treaty, the Single Convention on Narcotic Drugs (5), to which Canada is a signatory. This treaty requires that scheduled substances, such as marijuana, be limited to use for medical and scientific research purposes. There are three such forms of marijuana-based pharmaceutical drugs approved by Health Canada for use in Canada: two of these are synthetic drugs in pill form; and one is an oral spray derived from plant extracts.

Health Canada introduced the Marihuana (sic) for Medicinal Purposes Regulations (MMPRs) to cover client access to only the dried cannabis plant and not any of the oil, resins, extracts or tinctures (6). MMPRs grant access to cannabis as a medical therapy for Canadians with grave or debilitating illness when conventional treatments are inappropriate or fail to provide adequate relief. The regulation defines a process in which medical practitioners and nurse practitioners are responsible for providing a medical document prescribing marijuana that clients can use to access marijuana from a licensed supplier.

Cannabinoids are chemicals found in the cannabis plant – a few account for most of the known actions of cannabis on cognitive and body functions. These active cannabinoids may be natural derivatives or synthetic preparations.

**A FINAL NOTE**

RTs have a duty to accommodate, as do all health providers. This duty does not extend to the use of medical marijuana in public places (eg, hospitals and health services sites, where it may place others at risk). Health Canada has made the following statement regarding the use of medical marijuana in public spaces (13):

*Given the nature of marihuana and the fact that the provision of marihuana is for your personal treatment needs, Health Canada recommends not consuming this controlled substance in a public place. Please take note that persons in charge of public or private establishments (eg, bars and restaurants) can request that you not smoke marihuana on their premises, even if you have authority to possess marihuana for medical purposes. There may also be municipal bylaws that prevent smoking. In addition, others should not be exposed to second-hand marihuana smoke.*

For individuals who choose to use medical marijuana, using a method that allows for inhaling the active ingredients of the dried marijuana without being exposed to combustion products may help to reduce, but not completely eliminate, harms to the respiratory system. There is no evidence supporting the use of ‘vaping’ marijuana oil in electronic cigarettes or other similar delivery devices, and this delivery approach is not currently approved by Health Canada. There is, however, preliminary evidence that commercialization of medical marijuana reduces the perceived risk of “recreational use of marijuana” (10).

**WHAT SHOULD BE THE RTs RESPONSE TO MEDICAL MARIJUANA?**

The Canadian Society of Respiratory Therapists standards of practice obliges its members to behave within an ethical framework that includes following rigorous science. RTs are required to advocate for lung health, including the safe and effective use of therapeutic interventions, and in the promotion of disease prevention and wellness. For this reason, RTs have supported tobacco protection, prevention and cessation efforts across Canada to reduce the burden of chronic obstructive pulmonary disease and other tobacco-related diseases. As advocates for lung health, RTs should speak out against the use of products that are detrimental while other proven therapies exist. Where the use of medical marijuana has been shown to be effective, RTs should be supporting research to identify safe methods of delivery. While harm reduction maybe the rationale for encouraging the use of vaporized cannabis versus smoked cannabis, RTs and other health professionals require evidence that the reduction is actual, not simply hypothesized.

Because there is no sound evidence supporting the benefits outweighing the risk regarding the use of medical marijuana, RTs should add our voices to those of other Canadian professional medical bodies who have expressed a concern that the clinical evidence required to prescribe marijuana in an informed way is lacking (11,12). If marijuana is used as a therapy in Canada, it must be vetted through the same medical review required under the Food and Drugs Act to enable practitioners to make informed decisions. At the same time, RTs should also advocate for the development of synthetic cannabinoids with targeted effect and limited side effect.
Therefore, while some hospitals may allow use of medical marijuana with a vaporizer, they are not required to do so by Health Canada. Based on this, many hospitals are including ‘smoking medical marijuana’ under their smoke-free guidelines. The presence of a prescription for medical marijuana does not supersede these policies; however, some hospitals may consider the use of a vaporizer with similar precautions that are taken for nebulizing antibiotics (eg, negative pressure, filters on exhaled gases, etc).

REFERENCES
Initial validation of a modified suction task training system


BACKGROUND: Trainees rarely have the opportunity to practice suctioning copious or bloody secretions from the airways of patients in respiratory distress. The act of suctioning is frequently overlooked during the training of personnel in airway management and, thus, there is a dearth of simulated suction devices that can reproduce the fidelity of this process.

OBJECTIVE: The authors describe their experience developing and obtaining initial validation of a modified suction task training system.

METHODS: Senior-level students and faculty participated in the validation of this simulator. All participants used the modified Yankauer suction device in a simulated ‘mini’ scenario that required the use of suction. The panel of experts consisted of faculty from respiratory therapy, nursing and emergency medical services. After completion of the scenario, participants were asked to anonymously complete a survey.

RESULTS: More than 94% (n=36) of students agreed or strongly agreed that the simulated oropharyngeal suction was an important component in their learning experience. The expert panel (n=11) strongly agreed that the modified Yankauer suctioning of oral secretions was an important component of student training and also strongly agreed that this apparatus would improve their students’ suctioning skills (82% for both questions). Similar to the students, 90% of the faculty believed strongly that the simulator worked well.

DISCUSSION: The authors describe their experience developing and obtaining initial validation of a modified suction task training system that has both structural and functional fidelity, offering learners an opportunity to practice appropriate and effective suctioning in patients

Key Words: Airway training; EMS training; Nurse training; Respiratory therapy training; Simulator validation; Suction training

Suctioning is a procedure used to remove substances from the nose, mouth, pharynx or trachea, either through a natural orifice (nose or mouth) or artificial tubing (endotracheal tube, tracheostomy tube, nasal or oral airway). Respiratory therapists, paramedics, nurses and physicians use suctioning to promote secretion clearance (pulmonary hygiene) and/or maintain a patent airway. This technique is used in patients along the continuum of care, from acutely ill individuals in the community to chronically ill patients requiring long-term airway support. Controversy remains regarding the optimum technique for this procedure, which is not without its risks to patients (1-4). These risks include, but are not limited to, hypoxia, hypotension, mucosal hemorrhage and airway edema (5,6).

Unfortunately, students rarely have the opportunity to practice suctioning copious or bloody secretions from the airways of patients in respiratory distress. Simulated encounters may provide an important opportunity to fill this gap. However, the act of suctioning is frequently overlooked during the training of personnel in airway management and, thus, there is a dearth of simulated suction devices that can reproduce the fidelity of this process. We sought to create and validate a suction task training system that is able to recreate the look and feel of suctioning secretions from an actual patient, with the overarching goal of creating a trainer that was inexpensive and easy to replicate.

In the present study, we describe our experience developing and obtaining initial validation of the fidelity of a modified suction task training system. This system includes a Yankauer suction tip, tubing, suction canister and small-diameter end-tidal CO₂ sampling tubing (also known as ‘CO₂ tubing’) that allows the infusion of simulated oropharyngeal secretions into the system. When modified as described in the present study, it results in a task trainer that has both structural and functional fidelity, offering learners an opportunity to practice appropriate and effective suctioning in patients requiring advanced airway support (7).
A novel suction task training system was developed for the training of students from various disciplines. The following basic supplies were used: suction unit, suction tube with Yankauer, small-diameter tubing (preferably CO₂ tubing), scissors, caulking, foaming soap and red or yellow food colouring. This method of simulated suction was used in the training of health care staff through scenarios involving suction of vomitus and bilious secretion in intestinal obstruction, frothy secretion in congestive heart failure, bloody secretion in esophageal varices, tenacious sputum in chest infections and excessive sputum secretions.

To begin, the Yankauer suction catheter was attached to one end of the suction tubing and set aside (Figure 1A). The adapter was cut off one end of the CO₂ tubing and discarded (Figure 1B). The connection was also pulled off (not cut) from the suction tubing (opposite end from the Yankauer). The end of the small CO₂ tubing was lubricated where the adapter was cut. The internal diameter area of the suction tubing was also lubricated. This made it easier to push the CO₂ tubing through the suction tubing. The small CO₂ tubing was slid through the end of the suction tubing where the connection was removed (Figure 1C). The CO₂ tubing was pushed through the suction tubing toward the Yankauer catheter. There was approximately 6 inches (15.24 cm) of small CO₂ tubing protruding from both ends. Visible to the left (Figure 1D) is the Yankauer end and visible to the right (Figure 2A) is the suction tubing end from which the suction connection was removed. There was a 1 inch (2.54 cm) cut made in the suction tubing (Figure 2B) where the connection was removed.

After the small tube was slid through the cut in the suction tube (Figure 2C), the connection was glued back onto the suction tube with cyanoacrylate glue (Figure 2D). The small CO₂ tubing at the end of the Yankauer catheter was cut so that it was flush with the end of the catheter (Figure 3A). Silicone waterproof caulk was used to seal the small tube in place just below the connection cap (Figure 3B). The bag of simulated blood was spiked and hung. The use of a pressure bag was used to hasten the fluid expulsion process from the CO₂ tubing (Figure 3C). The end of the intravenous (IV) tubing was cut off and attached to the small CO₂ tubing (Figure 3D). Suction was hooked up.
Emergency oropharyngeal suction is an important skill to practice before attempting positive pressure ventilation or endotracheal intubation. Several millilitres of frothy soap water was placed in the mouth of the simulators to simulate flash pulmonary edema at the initiation of the scenarios.

Training sessions
Faculty and students participated in the training sessions. Both groups were briefed on the objectives of the study and were provided an opportunity to not participate. The participants were divided into small groups of five or fewer. Each group was assigned to a station where the simulated oropharyngeal suctioning was set up for education and demonstration. A scenario was given to each student in which he/she had the opportunity to use the modified suction task training system. After completion of the scenario, the students and faculty were asked to anonymously complete a survey regarding their experiences with the task trainer.

Survey design
Face and content validity of the structural and functional aspects of this task trainer was assessed using a survey. Each survey consisted of four questions for the students and five questions for the faculty using a 1 to 5 Likert scale (Tables 1 and 2). The survey was adopted from a similar simulation device validation study (8). Each question related to the effectiveness or fidelity of the new modified suction task training system. The two most senior faculty who developed the survey are both board-certified physicians who completed fellowships in medical simulation. The survey was pilot tested by one EMS, one respiratory therapy and one nursing faculty member before executing the study. Feedback was incorporated into the final survey before utilization in the present study.

RESULTS
The responses of simulation participants are provided in Table 1. Of the students surveyed, 25% (nine of 36) agreed that the simulated suction catheter resembled a normal part of the equipment and the remaining 75% (27 of 36) of students strongly agreed with this question. More than 86% (31 of 36) of student participants strongly agreed that the simulated suction Yankauer worked well during their simulated training sessions. More than 30% (11 of 36) of students agreed and approximately 69% (25 of 36) strongly agreed that they enjoyed having the opportunity to practice oropharyngeal suction during their training. More than 94% (34 of 36) of students agreed or strongly

![Table 1](image)

**Table 1**
Survey responses from simulation participants (n=36)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The simulated suction catheter looked like it was a normal part of the simulation equipment</td>
<td>0 (0/36)</td>
<td>0 (0/36)</td>
<td>0 (0/36)</td>
<td>25 (9/36)</td>
<td>75 (27/36)</td>
</tr>
<tr>
<td>The simulated Yankauer worked well during my simulation session</td>
<td>0 (0/36)</td>
<td>0 (0/36)</td>
<td>0 (0/36)</td>
<td>14 (5/36)</td>
<td>86 (31/36)</td>
</tr>
<tr>
<td>I liked having the chance to practice oropharyngeal suction</td>
<td>0 (0/36)</td>
<td>0 (0/36)</td>
<td>0 (0/36)</td>
<td>30 (11/36)</td>
<td>69 (25/36)</td>
</tr>
<tr>
<td>The simulated oropharyngeal suction by Yankauer was an important component in my learning experience</td>
<td>0 (0/36)</td>
<td>5 (2/36)</td>
<td>28 (10/36)</td>
<td>66 (24/36)</td>
<td></td>
</tr>
</tbody>
</table>

Data presented as % (n/n)

![Table 2](image)

**Table 2**
Survey responses from expert panel (n=11)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency oropharyngeal suction is an important skill to practice during simulated resuscitation</td>
<td>0 (0/11)</td>
<td>0 (0/11)</td>
<td>0 (0/11)</td>
<td>0 (0/11)</td>
<td>100 (11/11)</td>
</tr>
<tr>
<td>The simulated oropharyngeal suction with modified Yankauer should be a part of any simulator</td>
<td>0 (0/11)</td>
<td>0 (0/11)</td>
<td>9 (1/11)</td>
<td>18 (2/11)</td>
<td>72 (8/11)</td>
</tr>
<tr>
<td>The simulated oropharyngeal suction with modified Yankauer works well</td>
<td>0 (0/11)</td>
<td>0 (0/11)</td>
<td>9 (1/11)</td>
<td>0 (0/11)</td>
<td>90 (10/11)</td>
</tr>
<tr>
<td>The simulated oropharyngeal suction with modified Yankauer was an important component in training my students</td>
<td>0 (0/11)</td>
<td>0 (0/11)</td>
<td>18 (2/11)</td>
<td>0 (0/11)</td>
<td>82 (9/11)</td>
</tr>
<tr>
<td>Practice of oropharyngeal suction with a modified Yankauer on a mannequin will improve my students suctioning skills</td>
<td>0 (0/11)</td>
<td>0 (0/11)</td>
<td>0 (0/11)</td>
<td>18 (2/11)</td>
<td>82 (9/11)</td>
</tr>
</tbody>
</table>

Data presented as % (n/n)

---

Participants
Senior respiratory therapy students, senior paramedic students and senior nursing students participated in the validation of this simulator (convenience sample of 36 students). All participants used the modified Yankauer suction device in a training session that required the use of suction. The group of experts consisted of seasoned respiratory therapy faculty, nursing faculty and emergency medical services (EMS) faculty. All experts were provided an opportunity to use the simulator and observe their students use the simulator before completing the survey evaluation of the simulator (convenience sample of 11 faculty). The study was considered exempt by the institutional review board because it did not meet the definition of human subject research.

Setting
The study was conducted at both the Summa Akron City Hospital Virtual Care Simulation Laboratory (Akron, Ohio, USA) and at the Stark State College Simulation Center (North Canton, Ohio, USA). The simulation resuscitation bag was equipped with a vital signs monitoring, basic and advanced airway equipment, the modified suction task training system, and either a full-size patient simulator (Laerdal, USA) or advanced airway head situated to appear as a full-body simulator for the simulation sessions. The training scenario involved the placement of the suction Yankauer orally for a patient with flash pulmonary edema requiring advanced airway treatment/manoeuvres before attempting positive pressure ventilation or endotracheal intubation. Several millilitres of frothy soap water was placed in the mouth of the simulators to simulate flash pulmonary edema at the initiation of the scenarios.
agreed that the simulated oropharyngeal suction was an important component in their learning experience.

The responses of the faculty are provided in Table 2. The faculty unanimously (11 of 11) strongly agreed that oropharyngeal suction is an important skill to practice during simulated resuscitation scenarios. Similar to the students, 90% (10 of 11) of the faculty believed strongly that the simulator worked well. The faculty strongly agreed (nine of 11 [82%]) that the modified Yankauer suctioning of oral secretions was an important component of student training and also strongly agreed (nine of 11 [82%]) that this apparatus would improve their students' suctioning skills. Approximately 72% (eight of 11) of the faculty strongly agreed that the modified suction task training system should be used during all simulated airway training sessions.

DISCUSSION

Airway management is a fundamental skill in the care of patients. Respiratory therapists, paramedics, nurses and physicians are all trained in airway management; however, few are explicitly trained on how to manage secretions or debris in the airway. Inability to clear secretions is multifactorial, but can be a result of an increase in the volume or viscosity of secretions, ineffective cough, closed head injury and cardiovascular dysfunction, among others (2,9-11).

Our task trainer stimulated rich conversations during debriefing with the students, who confirmed our supposition that there was a relative gap in their comfort in both setting up and using suction in acute scenarios. Many students voiced concern that the use of suction and suction catheters on acutely ill and intubated patients was an area in which they still felt apprehension as they transitioned into their formal roles. Students from all three programs believed that this skill was repeatedly overlooked and/or covered superficially. During our debriefing, it also became clear that the students were not clear on the potential complications of suctioning and the potential conditions that use of suctioning that may endanger the patient or cause harm.

Croup and epiglottitis represent serious relative contraindications to suctioning (12). Some additional relative contraindications to suctioning include bleeding disorders, acute facial/head/neck injuries, angioedema and laryngospasm (2,4). This information may be unfamiliar or underemphasized to senior-level students such as those in the present study. There are several complications that can occur as a result of suctioning, both orally and through an endotracheal tube in an intubated patient that include, but are not limited to, hypoxemia, atelectasis, mucosal trauma, pulmonary hemorrhage, cardiac dysrhythmia, hypotension and worsening airway edema (5,6,13-15). If the patient is unable to protect their own airway, health care professionals are trained to remove these secretions while simultaneously setting up and providing a temporary or definitive airway. One of the first methods used by providers to remove these secretions is suctioning. The methods for which suctioning is performed can vary widely (17,18). Previously, this was practiced on patients in clinical settings, placing these patients at risk for the aforementioned adverse effects. Enabling students to practice the use of suctioning equipment and techniques in various scenarios before encountering these situations in patients is imperative.

Often, airway curriculum involves discussion of intubation techniques, airway adjunct/rescue devices and troubleshooting strategies. The setup, approach and potential complications of suctioning and a review of this suction equipment are rarely emphasized for nursing and EMS personnel when compared with the training of respiratory therapists, and are not consistent across specialties (17-21). This is despite the relative frequency in which acutely decompensating patients present requiring orotracheal suctioning before intubation. To date, very few studies have investigated evidence-based approaches to several suctioning procedures, curriculum and application of training techniques (16,17,20-22).

In previous simulations, we observed students being too aggressive with suctioning (applying too much force to the oropharynx of the simulator), leaving the catheter in too long (suctioning >10 s each time the catheter is introduced) causing hypoxemia, suctioning too frequently, being too passive or demonstrating completely inappropriate technique to clear the airway (eg, not placing the patient in the ‘sniffing’ position when attempting to clear secretions and blindly sticking the catheter into the patient) during simulations. We have also identified students using too much negative pressure, potentially causing injury to underlying tissue. For this and several other reasons, we have identified this as a gap in the training of our students, which needed to be addressed via simulation.

The results from our pilot study demonstrate that our modified suction task training system provides a realistic means to deliver effective training in this particular aspect of airway management (initial face and content validity). Most mannequins do not provide secretions and bleeding in a manner that allows learners to manage the suction equipment in a high-fidelity scenario. Additionally, many modifications that can be made place the simulators at risk for damage from liquids, and could void the manufacturer’s warranty. Our proposed modified suction task training system provides a safe, inexpensive, reusable and reliable means of adding functional and structural realism of simulated body fluids and debris without exposing costly mannequins to potentially harmful substances.

Future research should further investigate the application and utility of this trainer in scenarios of increasing complexity to determine whether there is a transfer of skills and troubleshooting strategies into their practice pattern. A simple modification of this described task trainer can also be used to train students on how to perform suctioning of patients with an endotracheal tube in place. Training for suctioning via artificial airways within critical care environment scenarios may also be considered for further investigation.

A limitation of our study was that the task training system was evaluated after use in only one scenario. Further utilization in several cases may provide additional validation of this system. Additionally, this system was only evaluated by a small sample size of senior-level students and their faculty. Additional groups of trainees (ie, emergency medicine physicians, residents, critical care nurses, etc) would also provide valuable insight. Finally, based on the design of the present study, there was no way to determine how performance in the simulated environment may translate to actual behaviour in the clinical environment. We conclude that our modified suction task training system provides trainees a simple yet valuable means to train and use suction apparatus during high-fidelity scenarios that they may not otherwise have the opportunity to experience before actual clinical exposure.

This system provides an effective training device for educators to stimulate discussion and reinforce important concepts from the student’s respective curricula, including, but not limited to, the indications, contraindications and risks associated with suctioning before clinical practice. This system provides an important and frequently overlooked component in advanced airway training.

DISCLOSURES: The authors have no financial disclosures or conflicts of interest to declare.

REFERENCES

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There is ongoing education in the form of Webinars, Journal Clubs and Directed Reading Articles.

JOURNAL CLUB

Journal Club is a great way to keep up-to-date with current research. Journal Club consists of a group of CSRT members reviewing a research article together (online). All members who sign up will be asked to pre-read the article so the online chat and discussion will be done in a timely manner. CSRT members who participate will receive 2 CE credits.

Since its inception in the 1980s, the Home Oxygen Program in British Columbia was centrally managed by the Ministry of Health. Initially a small program with few clients across the province, it soon became a large program with many clients and increasing expenditures. A pilot program started in Victoria (British Columbia) in 1996 demonstrated that managing the program locally could offer better client care, better contract management and significant cost savings. In 2002, the pilot’s model and recommendations were implemented in British Columbia’s five health authorities. The present review details the experiences of regionalizing the program in the Vancouver Coastal Health authority. After fine adjustments to the model were developed and new contracts and criteria changes made, better care for clients was provided than the previous centralized model at a reduced cost to the taxpayer.

Key Words: British Columbia; Home oxygen; Home Oxygen Program; Medical eligibility; Oxygen provider; Regional; Regionalized; Registered respiratory therapist; Request for proposal; Vancouver Coastal Health

Home oxygen therapy has been provided in the British Columbia (BC) public health care system for almost 40 years, following four randomized controlled trials from 1980 to 2004. These studies showed the importance of providing home oxygen therapy to individuals with chronic obstructive pulmonary disease (COPD) with poor oxygenation on room air (1-4). The studies found a remarkable reduction in mortality when oxygen was provided to individuals with COPD and hypoxemia. For example, in the Nocturnal Oxygen Therapy Trial group (1), subjects with a resting partial pressure of arterial oxygen (PaO2) <55 mmHg with only nocturnal oxygen treatment had a 1.94 times mortality rate in the control (no treatment) group. Based on the results of these studies, domiciliary oxygen therapy became a popular treatment regimen to improve both the life expectancy and quality of life of individuals with COPD. Criteria for the use of home oxygen therapy in BC are based on these studies, among others (1-6).

Although the studies, recommendations and criteria are based on recommendations for the treatment of COPD, not all clients using oxygen therapy in BC have COPD. Because “there is limited evidence concerning the efficacy of home oxygen in other respiratory diseases... it is presumed to be effective based on the COPD data for hypoxicemic patients with other respiratory diseases such as pulmonary hypertension and fibrosis” (7). Aside from young children, BC medical criteria for home oxygen are generally applied to individuals with hypoxemia and of all ages, regardless of diagnosis or prognosis.

METHODS

Because the present article was written as an internal evaluation of the Home Oxygen Program (HOP), it did not require research ethics board approval from Vancouver Coastal Health (VCH). The article was written with a historical perspective spanning >12 years to present (Table 1). The data, including client volumes, lengths of stay, diagnoses and cost, were collected from the VCH program’s database, financial reports and program records.

BACKGROUND

BC’s HOP was once a centralized program operated by clerical staff from the Ministry of Health and a medical consultant. All applications from across BC were sent to a single location and adjudicated for eligibility on an approximately weekly basis. Physicians requested funding approval on behalf of his or her patient, supported with clinical data showing hypoxemia. Oxygen litre flow, hours of use per day and the equipment needed were also requested by the physicians. The program sent approved applications to an oxygen provider for set-up in the client’s home. The provider also needed to make arrangements for oxygen deliveries as needed, and have the client regularly assessed by a registered respiratory therapist (RRT).

1Home Oxygen Program, Vancouver Coastal Health; 2Vancouver Community Respiratory Services; 3COPD Transition Team, Vancouver General Hospital; 4Provincial Respiratory Outreach Program, Equipment loans and Meals programs, Vancouver, British Columbia
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Despite their expertise in home oxygen therapy, the oxygen provider's RRTs had limited latitude in scope of practice. They assessed the client and made suggestions to change the flow of oxygen or equipment, but were unable to make any changes without the physician's order. One further concern with this model was the potential conflict of interest if the company's RRT suggested changes, which resulted in an increase in the funding requirement.

This general model persisted for many years. Soon, more and more clients enrolled in the program, making it more challenging, complex and, of course, more expensive to manage. Fundamental program changes were in order.

**Pilot project**

With the Ministry of Health's approval, the Capital Regional District (CRD) of Victoria, BC, initiated a pilot project in November 1996 to manage how home oxygen was provided within the city. There were 444 HOP clients at the time and a steady number of applications per week. A full-time RRT was hired to assess clients in their homes, and a respirologist consultant was retained to provide medical support.

During the home assessments, it was discovered that some clients did not require any intervention, while many other clients needed changes. Oxygen flow rates were corrected immediately, and equipment was removed or added shortly after contacting the oxygen provider. Other clients clearly no longer met eligibility requirements for the program, and were discontinued within a few days after discussions with the client and the medical consultant. The client's physician was then notified.

When all 444 clients were assessed, the CRD HOP reported to the BC Ministry of Health on April 22, 1999 that the pilot “… reduced HOP utilization by a total of 35%”. During that time, 291 clients remained on the CRD program after <2 years since the program started. When weekly growth was taken into account, the letter stated that the reduction would actually have been 45%. The reduced use amounted to a reported savings of $150,000 in fiscal year 1998/1999. The CRD program continued in this manner while recommending expansion of their model across the province.

**Regionalization**

Several years after the CRD made its recommendations, in May 2002, the HOP finally regionalized and was modelled after the pilot across BC. Figure 1 shows BC's five geographically defined health authorities: VCH, Island Health, Fraser Health, Interior Health and Northern Health. Each health authority is responsible for providing public health care to the citizens residing in their geographical boundaries. In 2006, the population of BC was approximately 4.1 million, with 1.03 million of those residing within VCH's boundaries in the southwestern corner of BC (8). Funding was provided by the Ministry to each health authority based on previous year's payments to the oxygen provider with no additional operational funding.

**TABLE 1**

<table>
<thead>
<tr>
<th>Year/date</th>
<th>Initiative</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circa 1980</td>
<td>HOP began in BC</td>
<td>Few clients, basic equipment</td>
</tr>
<tr>
<td>Circa 1996</td>
<td>Centralized HOP: program review</td>
<td>Expenditures were skyrocketing; challenging to run program efficiently in current state</td>
</tr>
<tr>
<td>November 1996</td>
<td>Pilot project</td>
<td>Victoria, BC. One RRT hired to assess clients at home in place of the provider’s RRT. Remainder of BC continued in current state</td>
</tr>
<tr>
<td>April 22, 1999</td>
<td>Recommendations to Ministry of Health</td>
<td>Pilot program findings in letter to Ministry of Health (35% of clients no longer eligible and were discontinued). Letter recommends regionalization of HOP across BC</td>
</tr>
<tr>
<td>May 2002</td>
<td>Regionalization across BC</td>
<td>Each health authority required to operate their own HOP based on Victoria’s model; assumed existing contracts with oxygen providers; staff hired and began assessing existing clients.</td>
</tr>
<tr>
<td>December 2002</td>
<td>Request for proposal</td>
<td>Provincial request for proposal; new service model based on pilot; primary and secondary provider (80%/20% of business)</td>
</tr>
<tr>
<td>July 2003</td>
<td>Providers awarded</td>
<td>New contract started. Transitioned clients to successful providers</td>
</tr>
<tr>
<td>2003</td>
<td>Medical criteria revision</td>
<td>Collaborative effort across BC</td>
</tr>
<tr>
<td>March 2004</td>
<td>VCH HOP review</td>
<td>All existing VCH clients were assessed; 16% fewer clients (no longer eligible and were discontinued)</td>
</tr>
<tr>
<td>2007</td>
<td>Medical criteria revision</td>
<td>Collaborative effort across BC</td>
</tr>
<tr>
<td>2008</td>
<td>Request for proposal</td>
<td>Provincial request for proposal. Primary and secondary model (70%/30%); encouraged new technology, fewer deliveries. Transitioned clients to successful providers</td>
</tr>
<tr>
<td>July 2008</td>
<td>Providers awarded</td>
<td>New contract started. Transitioned clients to successful providers</td>
</tr>
<tr>
<td>2012</td>
<td>Medical criteria revision</td>
<td>Collaborative effort across BC</td>
</tr>
<tr>
<td>2013</td>
<td>Contract extension</td>
<td>Four-year term with existing providers until 2017</td>
</tr>
</tbody>
</table>

RRT Registered respiratory therapist; VCH Vancouver Coastal Health

**Figure 1)** Map showing British Columbia’s health authorities

Funding was for an indefinite period of time because the physician was expected to follow up with the client, adjust oxygen therapy or discontinue treatment as needed, with most changes requiring approval from the HOP. Each application or change often took considerable effort and time and, not surprisingly, HOP clients often remained on oxygen for many months or years longer than they would have been eligible for. Each oxygen provider had their own contracted monthly rates based on where the client resided and the equipment type provided (concentrators, cylinder sizes, regulators, liquid oxygen), which, along with providing receipts for every delivery, made reconciling invoices time challenging.

Despite their expertise in home oxygen therapy, the oxygen provider's RRTs had limited latitude in scope of practice. They assessed the client and made suggestions to change the flow of oxygen or equipment, but were unable to make any changes without the physician's order. One further concern with this model was the potential conflict of interest if the company's RRT suggested changes, which resulted in an increase in the funding requirement.
VCH appointed a program coordinator, medical consultant and three RRTs on short-term contracts to assess as many clients residing in Vancouver as soon as possible. There were 912 clients funded by the VCH HOP in May 2002. With the help of the contracted RRTs, many HOP clients were assessed at home. Following the CRD’s model, the therapists titrated oxygen flow rates and added or discontinued equipment as needed or provided a lesser expensive modality if tolerated (eg, liquid oxygen systems were more expensive than cylinder- or oxygen-conserving device systems). Of the first 191 VCH clients assessed, 45 (23%) were discontinued and 42 (22%) had equipment changed. Even with approximately 12 applications per week, by February 2003, the census showed 806 HOP clients enrolled in the program.

The contract RRTs' terms ended and, soon after, VCH staff grew to include one casual and two permanent full-time RRTs, one clerk, one program coordinator and one medical consultant. By March 2004, all existing clients were assessed and the VCH HOP client population was reduced to 762. This 16% reduction equated to approximately $330,000 per year in program efficiencies in our health authority alone. Efficiencies attributed to changes in equipment also provided more program savings (Figure 2).

A third RRT was later hired to provide support to a separate home health program in Vancouver as a result of further program efficiencies. VCH initial oxygen utilization reviews showed:

- Of 158 VCH clients in one particular sample review, 13% claimed they never used their portable oxygen.
- One client used oxygen only with a small torch for welding.
- Liquid oxygen for another client was kept in her closet, filled regularly by her oxygen provider (due to liquid oxygen constantly evaporating even if not used), but she never used it.
- HOP RRTs went to the last known address of a client whose telephone number was not in service. The home was dilapidated, boarded and vacant. It was later discovered the client had moved to another province five years earlier with her concentrator. The money paid to the provider over the five years was refunded.
- Some clients were deceased for months or years, but the surviving family members never notified the program.
- Many clients’ equipment in residential facilities was stored away or used for other residents after the client passed away.
- A few landlords stored, discarded or sold equipment after clients moved or were in hospital for extended periods of time.

There are more stories similar to these; however, in each case, HOP had rented the equipment not knowing the equipment was no longer used as intended.

Challenges with transition to a regional model
When the VCH RRTs reassessed the existing clients for the first time and found them to be no longer eligible for funding, many clients were relieved they no longer needed oxygen. There were, however, some long-term oxygen users who may have developed a psychological dependence on oxygen and were concerned. These clients believed that oxygen provided them with symptomatic relief. Its ongoing use was often supported by their physicians, health care staff and family, despite the client being well-oxygenated breathing room air (BC’s HOP medical eligibility does not provide oxygen for individuals with dyspnea without hypoxemia). Other clients simply wanted to have oxygen in the event something happened to them in the future (ie, in case of an exacerbation) and some clients could not believe an RRT could tell them they no longer needed oxygen when their physician told them otherwise. The following efforts were made to ease the funding discontinuation for clients who were concerned:

- Some were weaned off oxygen over a number of days or weeks (reducing flow or removing equipment gradually)
- Some were reassessed at a later date as a comparison, which also gave them some more time to consider their situation.
• Some were offered assessments in a pulmonary function laboratory
• Some were recommended to pursue self-pay/extended health benefits as an option to continue receiving oxygen.

Supported by home assessments, medical evidence and medical support, the program was eventually able to press through the challenges. Before long, the stakeholders accepted the new program model.

The HOP’s view was, and remains, to never challenge the physician’s prescription for oxygen therapy; it is really a matter of who would fund it (the client, other source or HOP). Clients must initially qualify and are required to show ongoing eligibility during follow-up assessments. A prescription for oxygen was no longer considered to be funded for an indefinite period of time. These important fundamental principles were necessary for our program to be mindful of considering providing publicly funded oxygen in VCH.

Requests for proposal
In December 2002, once the program model, legal terms and provider service expectations were agreed upon by the health authorities, the group published the first provincial request for proposal (RFP). The RFP required one primary and one or two secondary oxygen providers per health authority for five-year contracts. The primary provider would be awarded 80% of new HOP clients and the remainder shared with the other awarded providers. The terms of the program required equipment set up in the home within certain hours of discharge along with oxygen deliveries, 24 h/7 day service and equipment maintenance. Daily flat rates were required to simplify billing purposes and were based on the equipment provided (ie, concentrator, any portable system or a combination of both).

Within the first few postdischarge months, the new oxygen providers transitioned clients from the unsuccessful proponents. For VCH, the majority of clients transitioned to one of the successful companies; however, 58 remained with their original oxygen provider and paid privately. The transition period in VCH witnessed 330 clients being transitioned within a span of four months.

Before the end of the first contract term, a second provincial RFP was published in 2008 with a few changes to the service requirements. One of the significant changes was to encourage newer technology equipment (quieter concentrators, portable oxygen concentrators and home-fill systems) to help improve client experience, independence and reduce the numbers of deliveries. The model also required one primary and one secondary provider. Client transitions were again required. All but approximately 100 clients moved to successful providers in VCH, and all remaining transitioned within a matter of a few months.

The five-year term of this contract expired in July 2013 and all health authorities in BC chose to extend the contracts with the three existing providers to 2017.

New model basics
The new HOP program became both a funding agency and a clinical program provided by RRTs who understood the importance of close follow-up and the benefits of direct management of a client’s oxygen therapy. Although the client’s physician or nurse practitioner is still required to provide hypoxemia data and sign the application form, once that is accomplished and the application is approved, the HOP becomes directly involved in managing oxygen therapy for the client and titrating the flows, equipment and funding, when and as needed.

The signed application form serves as both an application for oxygen funding as well as a prescription for oxygen therapy with the ability for the HOP respiratory therapists to titrate to ≥90% oxygen saturation without the need to confirm with the physician first. New community-based applications (from family physicians and specialists) are usually approved by the HOP the same day they are received. Set-up is usually performed by the following working day. Acute care clients are set up within a few hours of discharge seven days a week without previous approval by the HOP. Depending on the needs of the client, an oxygen provider RRT will also assess the client at home the next business day. The first follow-up assessment by VCH HOP staff is performed within six weeks of set-up. If the client still meets criteria, oxygen will continue to be funded; if not, changes are made in a matter of days (sometimes involving addition of equipment or removal, or complete discontinuation) and the physician is made aware.

Safe use of oxygen
Unfortunately, there are some clients who choose not to follow safe practices with oxygen, resulting in many ‘near misses’, some injuries and a few deaths. All new clients are provided with verbal and written education about how to be safe with oxygen on set-up and during follow-up assessments. Some clients claim to forget or simply do not believe they will get injured. When incidents do occur, they are reported to the HOP by the client or caregiver (family, home health, home support, oxygen provider). The client is promptly re-educated about the importance of safety and reminded that a second incident will result in removal of the equipment for their safety and the safety of others. A letter is written to the client, the physician and the home health team and, on most occasions, a telephone conversation occurs with someone on the team.

In VCH, 48 safety events have been reported to the office since 2004, with three of these resulting in death. Twenty-four of these events were flash fires, causing injuries to the client and/or property damage (18 in 2010 to 2011); at least two fires were sufficiently extensive to cause general evacuation of the area. This approach of reporting, ongoing educating, communicating among stakeholders and actually withdrawing oxygen when needed not only educates the client, but also educates the home health team and physicians who may be involved with future clients on oxygen and results in fewer incidents. In 2012 and 2013, there were only two reported incidents in each of those years. Although constant education to ensure safe practice with oxygen is undertaken with the goal of zero incidents, it is a challenge because the actions of clients cannot be monitored or controlled every minute of every day.

Medical eligibility criteria
The development of medical eligibility criteria was another collaborative effort between managers and medical consultants across the province. Referring to the available literature, national and global program comparisons and expertise from the medical consultants, the HOPs in BC agreed on common language and eligibility requirements of the programs. Eligibility revisions occurred in 2003, 2007 and 2012 (9).

Benefits of regionalization
Regionalization benefits all HOPs in BC through collaborative efforts, but it also offers local control and management of the program by local staff who are responsible for day-to-day operations of the program.

Benefits of regionalization include:
• Continuity of care from improved liaison and communication with local community and acute health care teams. In 2011, >80% of existing HOP clients in VCH were known to home health services at one time. Fifty percent of VCH clients are currently receiving an average of 2.6 other home health services such as nursing, occupational therapy, physiotherapy, palliative care, home support, mental health and chronic disease management.
• Improved communication among all stakeholders, including acute, residential and home health staff, clients, family members and physicians, enable easier access to HOP staff.
• Improved electronic medical records to track clients’ needs who also receive other health services.
• Improved responsiveness to the needs of existing clients.
• Improved access to the program in which queries are addressed in a timely manner.
• Improved knowledge of the local population and needs.

Current state
As of November 2014, there were approximately 600 HOP-funded clients in VCH, with approximately 90% residing in the urban lower
mainland area. The remainder of HOP clients reside in more rural areas accessed by car, ferry or air.

Figure 2 shows the payments made to oxygen providers from 1996 to 2012/2013 for clients receiving home oxygen in the VCH area. The trend from 1996 to regionalization in 2002 (black line) shows the staggering increase in costs to run the program for VCH. Following regionalization, it is clear that the program became more cost effective due to the new service model, revision of medical eligibility criteria and negotiation of oxygen provider contracts.

Table 2 shows the percentage of VCH clients with specific disease. Note how the percentage of palliative oxygen-dependent clients increased from 10% in 2004 to 22% at present. Although it is difficult to pinpoint the reasons for this trend, it could be due, in part, to the encouragement of more home deaths for palliative clients rather than hospitalization. Supporting this trend, we understand that a drop in our client’s length of stay due to the increasing number of palliative clients on home oxygen. In comparison, in 2010, it took 165 days before 50% of new clients were discontinued and, in 2006, it was 450 days.

CONCLUSIONS AND RECOMMENDATIONS
BC’s experiences in the redevelopment of the HOP shows how considerable effort from the health authorities and cooperation from oxygen providers can result in long-lasting and profound positive changes in how home oxygen is delivered. This model also shows how RRTs can provide improved client care, service, access, responsiveness, continuity of care, communication and program control in a highly cost-effective manner. As a result of the outstanding work performed by HOP managers, RRTs and contract support staff across BC to redesign services, review eligibility criteria and regularly assess clients, financial trends and other measurements mentioned in the present review were generally realized across all of BC’s HOPs. Although the HOP has been successfully operating in this manner for 18 years (counting the pilot project), the present article does not intend to suggest that our model is the best practice in providing publicly funded home oxygen programs in Canada.

A more in-depth review of VCH’s client enrollment in the HOP is needed for long-term planning of the program due to the growth of the elderly population in our society and the prevalence of COPD, cancers and other diseases causing hypoxemia.

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REFERENCES

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<th>Diagnosis</th>
<th>Home Oxygen Program clients, %</th>
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<tr>
<td>Chronic obstructive pulmonary disease</td>
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<td>Cardiac-related illness (eg, heart failure)</td>
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<tr>
<td>Other (eg, pneumonia, fibrosis)</td>
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**REFERENCES:**