Short communication

Hyperbaric medicine in Canadian undergraduate medical school curriculum

Zoé Talbot[1], Alex Lee[1], Sylvain Boet[2–7]

[1] *Faculty of Medicine, University of Ottawa, ON, Canada*
[2] *Francophone Affairs, Faculty of Medicine, University of Ottawa, Ottawa, ON, Canada*
[3] *Institut du Savoir Montfort, Ottawa, ON, Canada*
[4] *Ottawa Hospital Research Institute, Clinical Epidemiology Program, Ottawa, ON, Canada*
[5] *Department of Anesthesiology and Pain Medicine, The Ottawa Hospital, University of Ottawa, Ottawa, ON, Canada*
[6] *Department of Innovation in Medical Education, University of Ottawa, Ottawa, ON, Canada*
[7] *Faculty of Education, University of Ottawa, Ottawa, ON, Canada*

Corresponding author: *Dr Sylvain Boet, Department of Anesthesiology and Pain Medicine and Department of Innovation in Medical Education, The Ottawa Hospital, General Campus, 501 Smyth Rd, Critical Care Wing 1401, Ottawa, K1H 8L6, Ontario, Canada*
sboet@toh.ca

Keywords
Education; Hyperbaric oxygen treatment; Teaching

Abstract
(Talbot Z, Lee A, Boet S. Hyperbaric medicine in Canadian undergraduate medical school curriculum. Diving and Hyperbaric Medicine. 2023 June 30;53(2):138–141. doi: 10.28920/dhm53.2.138-141. PMID: 37365131.)
Introduction: Hyperbaric oxygen treatment (HBOT) has fourteen approved indications in the management of acute and chronic diseases in various medical specialties. However, lack of physician knowledge and exposure to hyperbaric medicine may hinder the ability of patients to access this treatment option for approved indications. We aimed to determine the prevalence and nature of HBOT-related learning objectives in Canadian undergraduate medical education programs.
Methods: Pre-clerkship and clerkship learning objectives from responding Canadian medical schools' curricula were reviewed. These were acquired through the school websites or by emailing the faculties. Descriptive statistics were used to summarise the number of hyperbaric medicine objectives taught in Canadian medical schools, and within each institution.
Results: Learning objectives from seven of the 17 Canadian medical schools were received and reviewed. From the curriculum of the responding schools, only one objective was found to be related to hyperbaric medicine. Hyperbaric medicine was absent from the other six schools' objectives.
Conclusions: Based on the responding Canadian medical schools, hyperbaric medicine objectives were mostly absent from undergraduate medical curricula. These findings illustrate a possible gap in HBOT education and the need for discussion regarding the design and implementation of HBOT educational initiatives in medical training.

Introduction

Hyperbaric oxygen treatment (HBOT) is a well-established and approved treatment modality for a range of elective and urgent conditions in North America.[1] However, the physiological and biochemical mechanisms require a deeper understanding to be able to fully appreciate the actions of oxygen as a drug under hyperbaric conditions.[2–4]

In Canada there are currently 14 approved indications for HBOT[5] in correlation to the Undersea and Hyperbaric Medical Society (UHMS) list[1] (Table 1), which relate to various medical specialities, as well as multiple other emerging indications still under study.[5,6] Despite this, evidence suggests that physicians are unaware of HBOT indications and thus may not refer patients for treatment.[7,8] This becomes critical in situations where treatment needs to be initiated urgently, such as with air/gas embolism. For patients in Canada to access HBOT, their physician must refer them to a hyperbaric medicine physician. Therefore, referring physicians must be aware of the indications for HBOT and educated on the potential benefits of this treatment modality.

The lack of physician knowledge on HBOT[7,8] and potential benefits for patients with approved indications[1] highlight the importance of exploring the barriers to HBOT education. Medical school is the foundation of physicians' training and exposes students to a large amount of information which is consolidated throughout their career. By assessing the presence of HBOT learning objectives in medical school curricula, an area of possible improvement for

Table 1
Approved indications for HBOT

Undersea and Hyperbaric Medical Society 2019 [1]	Indications in Canada [6]
Air or gas embolism	Air/gas embolism
Carbon monoxide poisoning	Carbon monoxide poisoning
Clostridial myonecrosis (gas gangrene)	Gas gangrene
Acute traumatic ischaemias	Crush injury, compartment syndrome and other acute traumatic problems where blood flow is reduced or cut off
Decompression sickness	Decompression sickness
Arterial insufficiencies: A. Central retinal artery occlusion B. Selected problem wounds	Enhancement of healing for wounds ie diabetic foot ulcers
Severe anaemia	Exceptional blood loss
Intracranial abscess	Intracranial abscess
Necrotizing soft tissue infections	Necrotizing soft tissue infections
Refractory osteomyelitis	Osteomyelitis
Delayed radiation injuries (soft tissue and bony necrosis)	Delayed radiation injury
Compromised grafts and flaps	Skin grafts and flaps that are not healing well
Thermal burns	Thermal burns
Sudden sensorineural hearing loss	Idiopathic sudden sensorineural hearing loss (ISSHL)

HBOT education could be uncovered. This report aimed to determine the prevalence of HBOT content in the pre-clerkship and clerkship learning objectives of undergraduate medical education in Canada.

Methods

ETHICAL ISSUES

This report followed Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines[9] and was exempted from ethics review by the Ottawa Health Science Network Research Ethics Board.

SETTING

A standardised email was sent to all 17 Canadian medical schools accredited by the Committee on Accreditation of Canadian Medical Schools (CACMS).[10] It was directed to their undergraduate medical offices or to the schools' resource contact. In the email, pre-clerkship and clerkship learning objectives were requested. A search through the faculties' websites was also performed to collect the learning objectives that were reported online to the public. We followed up with a phone call to non-responders.

DATA COLLECTION

We conducted a direct content analysis. Learning objectives relevant to hyperbaric medicine were identified from the collected curricula. The 'command search' tool was used to search for the term 'hyperbaric' in the objective repository collected from the school or through their website. Several schools did not agree to share their objectives but were willing to conduct the search themselves. In these cases, confirmation emails reporting their findings were accepted. Identified learning objectives on hyperbaric medicine were extracted and included in the analysis.

DATA ANALYSIS

Descriptive statistics were used to summarise the number of hyperbaric medicine objectives taught in Canada and within each medical school. Microsoft Excel (version 16.36, Microsoft® Corporation, Redmond Washington, USA) was used for the statistical analysis.

Results

Learning objectives from seven out of the 17 Canadian medical school were reviewed for mention of hyperbaric

Table 2
Learning objectives relating to hyperbaric medicine in Canadian medical schools; East of Canada is composed of New Brunswick, Newfoundland and Labrador, Nova Scotia, Nunavut, Prince Edward Island; West of Canada is composed of Alberta, British Columbia, Manitoba, Saskatchewan, Northwest Territories, Yukon

Medical school	Location	Number of relevant learning objectives	Obtention of objectives
1	East of Canada	None	By university staff
2	Québec	Non responder	–
3	Ontario	None	By university staff
4	East of Canada	None	By university staff
5	Ontario	Non responder	–
6	Ontario	None	By university staff
7	Québec	Non responder	–
8	Québec	Non responder	–
9	Québec	One objective: "*Explain the treatments of carbon monoxide intoxication including the general indications of hyperbaric oxygen therapy*"	By university staff
10	West of Canada	Non responder	–
11	West of Canada	Non responder	–
12	West of Canada	Non responder	–
13	West of Canada	Non responder	–
14	Ontario	None	By researcher through the university's website
15	West of Canada	None	By researcher through the university's website
16	Ontario	Non responder	–
17	Ontario	Non responder	–

medicine. Objectives from 10 schools were unobtainable due to inability to access/privacy restrictions or due to lack of response from the corresponding undergraduate medical offices despite follow-up (Table 2).

Objectives from two medical school were searched online through their website while five other schools confirmed that they searched their curricula for hyperbaric medicine. Out of these seven medical schools who responded, only one of them had a learning objective regarding hyperbaric medicine. The learning objective related to carbon monoxide intoxication and the main indications for hyperbaric oxygen therapy (Table 2).

Discussion

In this report, we aimed to investigate the prevalence and nature of hyperbaric medicine objectives in the Canadian medical schools' curricula. Learning objectives from seven out of the 17 Canadian medical school were searched for mention of hyperbaric medicine. A single relevant objective at a single school was found.

The near absence of learning objectives in medical school curricula suggests that hyperbaric medicine is probably not formally taught to medical students in Canadian institutions. This may be surprising given its use for decades as an approved treatment modality for several illnesses. However, access to HBOT is still limited in many parts of Canada, as well as in regions around the world. According to the Canadian Undersea and Hyperbaric Medical Association (CUHMA) only 14 Canadian cities have hyperbaric chambers, half of these being in Ontario. In fact, two territories and four provinces do not have a single hyperbaric facility.[11] The lack of wide availability of HBOT to most patients may be a reason for the absence of this topic in undergraduate medical education.

The next step may be to determine the best time, location and instructional design for teaching basic understanding of HBOT and its indications to trainees and physicians. Medical school is where physicians learn the most common and life-threatening diseases as well as their main treatments. Indications such as gas embolism or decompression sickness may fall under life-threatening disease management, while others may fall under common elective conditions, such as

delayed radiation-induced injury or diabetic foot ulcers.[5,6] Indications of HBOT are diverse and are relevant to many different medical practices/specialities. Additionally, medical school is the only time in the continuum of education where all (future) physicians are exposed to a common base of knowledge. Therefore, one may consider that HBOT, with its overlap on a variety of specialities, should be included in the undergraduate medical school curricula. However, with the obvious exceptions of decompression sickness and gas embolism, hyperbaric medicine remains a supplemental treatment in most of its indications.[1] It is also possible that HBOT exposure is more suited to post-graduate medical education or continuing professional development as this is where learners enhance the basic skills learned in medical school to better treat a certain population of patients. Learning at this stage also considers the resources available in their location of practice. Therefore, physicians who will likely work with patients who could access and benefit from HBOT would be exposed to it.

While this report suggests a lack of education on HBOT, some limitations should be noted. First, only seven out of the 17 medical schools participated. Therefore, we cannot know whether the missing schools have learning objectives related to hyperbaric medicine, although it seems plausible that they do not. A different approach may be necessary to further explore undergraduate medical education related to HBOT. Perhaps, the use of surveys sent to students, or a qualitative approach is needed. Second, while learning objectives are the most specific information we can retrieve on curricula, they may not be comprehensive. Many topics are covered during medical school lectures without being explicitly stated in learning objectives. Therefore, our approach could underestimate the presence of this topic in undergraduate medical education. Finally, there may have been inconsistencies to the methodology as some schools opted to conduct their own search for hyperbaric medicine within their learning objectives. However, the keyword 'hyperbaric' is quite specific to HBOT in learning objectives.

Conclusions

Hyperbaric medicine was mostly absent from the undergraduate medical education learning objectives of the sample of Canadian medical school curricula reviewed. These findings may represent a potential barrier for patients to benefit from HBOT when indicated. Given its effectiveness for approved indications, the identified educational gaps related to HBOT should warrant meaningful objectives incorporation and effective educational design and implementation.

References

1 Moon RE, editor. Undersea and Hyperbaric Medical Society hyperbaric oxygen therapy indications. 14th ed. North Palm Beach (FL): Best Publishing Company; 2019.

2 Kirby JP, Snyder J, Schuerer DJE, Peters JS, Bochicchio GV. Essentials of hyperbaric oxygen therapy: 2019 review. Mo Med. 2019;116:176–9. PMID: 31527935. PMCID: PMC6690283.

3 Weaver LK. Hyperbaric medicine for the hospital-based physician. Hosp Pract (1995). 2012;40:88–101. doi: 10.3810/hp.2012.08.993. PMID: 23086098.

4 Thom SR. Hyperbaric oxygen: its mechanisms and efficacy. Plast Reconstr Surg. 2011;127(Suppl 1):131S–41S. doi: 10.1097/PRS.0b013e3181fbe2bf. PMID: 21200283. PMCID: PMC3058327.

5 Health Canada. Hyperbaric oxygen therapy [Internet]. 2004. [cited 2022 Nov 29]. Available from: https://www.canada.ca/en/health-canada/services/healthy-living/your-health/medical-information/hyperbaric-oxygen-therapy.html.

6 Bennett MH, Mitchell SJ. Emerging indications for hyperbaric oxygen. Curr Opin Anaesthesiol. 2019;32:792–8. doi: 10.1097/ACO.0000000000000773. PMID: 31343466.

7 Magri K, Bigeni S, Azzopardi CP, Camilleri L, Matity L, Muscat S, et al. Hyperbaric oxygen therapy awareness within a doctor population. Undersea Hyperb Med. 2020;47:39–50. doi: 10.22462/01.03.2020.5. PMID: 32176945.

8 Melamed Y. Hyperbaric oxygen therapy (HBO) for radiation necrosis – physician awareness is required. Harefuah. 2018;157:517–9. PMID: 30175568. Hebrew.

9 von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61:344–9. doi: 10.1016/j.jclinepi.2007.11.008. PMID: 18313558.

10 Committee on Accreditation of Canadian Medical Schools. Accredited Programs: 17 Canadian Faculties of Medicine [Internet]. 2021. [cited 2022 Nov 29]. Available from: https://cacms-cafmc.ca/about-cacms/accredited-programs.

11 Canadian Undersea and Hyperbaric Medical Association. Hyperbaric facilities [Internet]; 2022. [cited 2022 Nov 29]. Available from: https://cuhma.ca/hyperbaric-facilities.html.

Acknowledgements

The authors thank Manon Denis-LeBlanc, Michelle Anawati, Laurie McLean, Chloé Desjardins, and Cole Etherington for their review and comments on the protocol and the manuscript.

Conflicts of interest and funding

Dr Boet was supported by The Ottawa Hospital Anesthesia Alternate Funds Association and the Faculty of Medicine, University of Ottawa with a Tier 2 Clinical Research Chair. We received administrative assistance from Chaima Fanaki, who was employed by the Francophones Affairs, Faculty of Medicine, University of Ottawa, to contact the faculties of Medicine. No conflicts of interest were declared.

Submitted: 1 December 2022
Accepted after revision: 18 February 2023

Copyright: This article is the copyright of the authors who grant *Diving and Hyperbaric Medicine* a non-exclusive licence to publish the article in electronic and other forms.