Short communication

A Delphi study to identify relevant scenarios as the first step toward an international hyperbaric medicine simulation curriculum

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Abstract
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Introduction: Evidence across healthcare specialties suggests that simulation-based education improves practices and patient outcomes. However, simulation has yet to be widely used in hyperbaric medicine education. We aimed to identify the most relevant clinical scenarios for inclusion in a simulation-based curriculum for hyperbaric medicine.
Methods: After ethics approval, we used a modified Delphi consensus method. We assembled an initial questionnaire and distributed it online in English and French to an international group of hyperbaric physicians and operators using a snowball recruitment technique. Participants rated the list of scenarios using a 5-point scale ranging from 1 (least relevant) to 5 (most relevant). Scenarios judged by at least 80% of participants to be relevant (score 4 or 5) were automatically included. Scenarios that did not meet this threshold and new scenarios suggested by participants during the first round were included in a second round.
Results: Seventy-one participants from nine countries, including both physicians and non-physicians, completed the first round and 34 completed the second. Five scenarios were identified as relevant: seizure, fire, cardiac arrest, pneumothorax, and technical deficiency such as power loss while operating the chamber.
Conclusions: Five scenarios relevant for inclusion in the simulation-based curriculum in hyperbaric medicine were identified by expert consensus.

Introduction

Simulation-based education is effective for imparting technical and non-technical skills to both individuals and teams across many specialties, particularly in acute care.[1–4] Since simulation poses no risk to actual patients, it is used across the continuum of education from undergraduate and postgraduate training to continuing professional development.[4–6] Evidence suggests that skills learned during simulation transfer to clinical settings, improve team performance and, in turn, may improve patient outcomes.[3,7]

Hyperbaric medicine is widely used to treat patients of all ages with elective and urgent conditions.[8–12] Effective medical management of hyperbaric oxygen treatment (HBOT) in the hyperbaric exposure period requires both individual and team-level clinical competencies, especially in emergency situations or when complications occur.[13] For example, HBOT can involve safety events such as hyperbaric chamber fires, acute respiratory failure or seizure, and complex cases such as patients who are mechanically ventilated.[14] When a patient is inside the hyperbaric chamber, there is an added layer of complexity as the patient cannot be immediately accessed as the chamber must first be decompressed, which may take up to several minutes. Therefore, it is imperative that healthcare professionals who provide HBOT become proficient in technical and non-technical skills; such skills include effective teamwork supported by interprofessional collaboration.

Despite the broad implementation of simulation-based education in the majority of healthcare areas, simulation has yet to be widely used in the context of hyperbaric medicine education. In fact, in our recent systematic search of the literature, we found only one anecdotal case report published in German involving simulation in hyperbaric medicine.[15,16] Without an established curriculum for hyperbaric medicine simulation, healthcare professionals may be missing out on an important opportunity to improve quality of care and patient safety.

In this study, we used a modified Delphi consensus process to identify the most relevant clinical situations in hyperbaric medicine that would benefit from simulated practice.

Methods

We obtained institutional ethics approval for this project from the Ottawa Health Science Network Research Ethics Board (OHSN-REB; Protocol #20190203-01H). Participants who volunteered to participate in the survey were presented with the informed consent document, which explained that they implied their consent by completing the survey.

STUDY DESIGN

We used a modified Delphi consensus process to identify the most relevant clinical situations that would benefit from simulated practice. The Delphi approach is a widely used, rigorous, and accepted method in healthcare for obtaining expert consensus through an iterative ranking process.[17] The Delphi survey was distributed online using SurveyMonkey rather than through an in-person consensus meeting to facilitate participation among diverse healthcare professionals who often have busy and conflicting schedules and who are located around the world.[17]

PRIORITISATION OF SCENARIOS

The initial Delphi survey containing nine scenarios was assembled by the team of co-investigators who are practicing clinicians in hyperbaric medicine, including hyperbaric medicine physicians and non-physicians (e.g., nurses, respiratory therapist, technicians – depending on the healthcare system) (Appendix 1). The survey was pilot tested with members of the target population to ensure it was comprehensible, interpreted consistently across respondents, and provided enough information to allow respondents to make informed decisions. The survey was available either in French or in English at the participant's discretion.

Participants rated which HBOT scenarios they considered to be relevant to simulation-based education, based on two criteria. First, the clinical scenario should be either high stakes (i.e., if an optimal course of action is not implemented in a timely manner, the patient may suffer severe consequences) or lower stakes but with a high potential for becoming critical if the optimal actions are not followed (e.g., intubated and ventilated child who undergoes HBOT). Second, training on the clinical scenario should be best done with the use of a full-body mannequin versus other potential educational modalities.

During Round 1, participants were also invited to suggest additional scenarios at the end of the survey. We collected participants' institutional email addresses to ensure their participation could be tracked across each survey round and to enter them into a draw for a gift card valued at $200. Email addresses were unlinked from specific survey responses to preserve privacy.

RECRUITMENT

Our target population was hyperbaric physicians and operators. We recruited participants from hospitals internationally across a range of hyperbaric medicine units using a snowball sampling technique. Each participant was invited to forward the survey to their colleagues.

To facilitate international recruitment, we obtained endorsement of our project from several hyperbaric medicine international organisations (e.g., Canadian Undersea and Hyperbaric Medicine Association [CUHMA]; Association Internationale des Centres Hyperbares Francophones [ICHF]), which distributed the initial recruitment email to their members. Through this network we also assembled a group of international volunteer centres who committed to assist with recruitment and participation.

SAMPLE SIZE

When using the Delphi process, the appropriate sample size depends on the characteristics of the target population. A smaller sample size (20–30) can result in stable response, provided that the population is homogenous, such as participants with similar training and expertise.[18] Since this was the case in our population, we aimed to recruit a minimum of 30 participants who would complete both rounds. Assuming a 50% response rate, we planned to sample at least 60 healthcare professionals in the first round (60 x 0.50 = 30). We determined a priori to stop recruitment after we have collected the sample size targeted at each round (Round 1 – 60 participants; Round 2 – 30 participants).

ANALYSIS AND CONSENSUS

Scenarios rated as relevant (score of 4 or 5) by at least 80% of participants were automatically included for curriculum development; scenarios that did not meet this threshold and new scenarios that were suggested by participants during the first round were included in the second round. The survey for the second round included the median rating each scenario received in the first round.

Results

PARTICIPANTS

Seventy-one hyperbaric medicine professionals from nine countries completed the first round of the survey, and 34 completed the second round. Participants included hyperbaric medicine clinicians, both physicians and non-physicians. The vast majority of respondents were on staff as opposed to trainees. Detailed demographics of participants are reported in Table 1.

RELEVANT SCENARIOS

One scenario, 'Seizure in the hyperbaric chamber', met the prespecified threshold to be included after the first round. Eight main new scenarios were suggested by participants during round one. The co-investigators reviewed all the suggested scenarios and combined similar scenarios, resulting in five new scenarios added to round two (Table 2).

At the end of the second round, four more scenarios met the threshold for inclusion in the final list of scenarios: 'Cardiac arrest in the chamber'; 'Fire in or immediately outside of the chamber'; 'Pneumothorax in the chamber'; and 'Technical deficiency such as power loss while operating the hyperbaric chamber'.

The detailed scores for each scenario across each round are presented in Table 2.

Table 1
Characteristics of study participants

Characteristics	Round 1 (*n* = 71)	Round 2 (*n* = 34)
Profession		
Physician	31 (44%)	15 (44%)
Non-physicians	40 (56%)	19 (56%)
-Registered nurse	28	12
-Respiratory therapist	4	2
-Hyperbaric operator	4	4
-Licenced practical nurse	2	0
-Clinical healthcare technician	1	0
-Hyperbaric therapist	1	0
-Hyperbaric safety director	0	1
Trainee status	6 (8%)	1(3%)
Country of practice		
Australia	4	0
Belgium	8	6
Canada	8	3
France	28	11
New Zealand	1	0
Switzerland	12	13
Tanzania	1	0
Tunisia	1	0
United States	7	1
Not specified	1	0
Years in practice		
Mean	13.6	15.6
Median	12	11
Interquartile range	7–19	7–25

Discussion

Via expert consensus this Delphi study identified five scenarios relevant for inclusion in a future simulation-based curriculum in hyperbaric medicine.

This is the first step toward the creation of an evidence-based international hyperbaric medicine simulation curriculum. Our prespecified thresholds allowed us to make clear decisions on the most relevant scenarios to hyperbaric medicine based on participants' clinical experience and expertise. The Delphi technique also allowed for suggestions of possible relevant scenarios directly from participants. This is an important advantage of the Delphi method as it may improve the buy-in from participants when the time comes to implement the simulation-based curriculum.

Identifying relevant scenarios is only the first step for creating and implementing a simulation-based curriculum. Following the same consensus-based approach, future steps should include the design of the five identified scenarios, and the pilot test of the simulations in several centres with various degrees of simulation experience. Scenarios will need to include human factors and the possibility to use cognitive aids in order to best adapt to local practices. Finally, debriefing is crucial for effectiveness of learning in simulation-based education.[19,20] Solid debriefing guides will be required to maximise the learning opportunities for all, regardless of simulation expertise in centres.

Our study has several limitations. First, we had a limited number of participants. However, we reached our target sample size. Also, given the range of professions and countries of practice among our participants, we are confident in the external validity of our findings. Second, we recognise that the threshold to include or exclude a scenario from the curriculum is arbitrary. We suggest considering the five scenarios identified in this study as a starting point for a curriculum development in hyperbaric medicine and certainly not an end point. Finally, in the clinical setting, scenarios often present with a 'symptom', e.g., sudden onset hypotension, or hypoxaemia, or a combination of symptoms rather than a clear definitive diagnosis. It will be key to design simulation scenarios that account for the uncertainty over the diagnosis and the need to simultaneously diagnose and treat the problem.

Table 2
Decision process and final decisions for proposed clinical scenarios

Clinical scenario	Round 1			Round 2		
	Number of votes	Score 4 or 5 (%)	Decision	Number of votes	Score 4 or 5 (%)	Decision
Seizure in the chamber	69	81.2	**Final Inclusion**	Already included in Round 1		
Fire in or immediately outside of the chamber	68	76.5	Included for Round 2	34	97.1	**Final Inclusion**
Cardiac arrest in the chamber	70	71.4	Included for Round 2	34	82.4	**Final Inclusion**
Pneumothorax in the chamber	70	71.4	Included for Round 2	34	82.4	**Final Inclusion**
Intubated and ventilated patient in the chamber	71	64.8	Included for Round 2	32	78.1	Exclusion
Chest pain in the chamber	72	58.3	Included for Round 2	34	73.5	Exclusion
Shortness of breath in the chamber	72	52.8	Included for Round 2	11	54.6	Exclusion
Onset of (non-seizure) neurological symptoms such as anxiety or hypoglycaemia while in the chamber	70	47.1	Included for Round 2	34	50.0	Exclusion
Newborn patient in the chamber	68	32.4	Included for Round 2	30	23.3	Exclusion
Technical deficiency such as power loss while operating the chamber	Scenario suggested during round 1			34	85.3	**Final Inclusion**
Haemodynamic instability while in the chamber	Scenario suggested during round 1			30	63.3	Exclusion
O_2 problem in the chamber such as O_2 breakdown	Scenario suggested during round 1			28	57.1	Exclusion
Ear pain while in the chamber	Scenario suggested during round 1			34	52.9	Exclusion
Nausea while in the chamber	Scenario suggested during round 1			34	17.7	Exclusion

Conclusions

Relying on a well-established and rigorous Delphi method, this study identified five scenarios relevant for inclusion in an evidence-based, simulation-based curriculum in hyperbaric medicine. Next steps should include designing these scenarios and implementing them into a simulation curriculum for hyperbaric medicine that will allow teams to train and optimise their practices.

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