

Mobile healthcare simulation units: a narrative review

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Abstract

For healthcare professionals working and living in geographical isolation, there are few opportunities to maintain skills and knowledge, and to update themselves with recent advances in care compared to their city-dwelling peers. It is known that within a short period and limited practice, clinical skills erode. A mobile healthcare simulation unit provides high-quality, technologically-enhanced, convenient, and affordable training for healthcare professionals under expert supervision in any remote setting. The current narrative review was planned to summarise the outcomes and challenges related to developing and effectively utilising mobile healthcare simulation units as experienced globally. A literature search was performed on PubMed, Google Scholar and Cochrane databases for relevant articles published between 2000 and 2020, which resulted in 18 articles that were shortlisted and three major themes. The identification of common strengths, weaknesses and challenges will be a starting point for those engaged in planning and operating such a centre in any location.

Keywords: Mobile healthcare simulation unit, Simulation-based education, Continuous medical education, Healthcare professionals, Rural, Remote.

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Introduction

Healthcare professionals (HCPs) working and living in remote and rural areas have fewer opportunities to maintain their skills and knowledge compared to their city-dwelling peers, and within a short period of limited practice, their clinical skills deteriorate¹⁻³. Simulation-based education (SBE), although it can be expensive, is an effective solution to tackle the issue of skill decay. However, it is rarely available outside of specialised centres⁴, presenting barriers of cost, convenience, and

time to professionals in rural areas wishing to retain their skills. A mobile healthcare simulation unit (MHSU) can provide a solution, with high-quality technologically-enhanced education under expert supervision potentially available in any remote setting, making training convenient and affordable^{5,6}.

Healthcare simulation serves as an alternative to practice on real patients, maintaining patient safety, avoiding risks of possible litigation, psychological damage, and loss of confidence should an adverse event occur⁷. SBE has become a fundamental part of healthcare education as it provides students and clinicians an authentic learning experience within which they develop their skills and improve their competence^{8,9}. It boosts confidence and improves patient outcomes^{10,11}, while allowing qualified professionals from different backgrounds an opportunity to work cohesively as a unit¹² working through commonly encountered scenarios, developing communication skills, critical thinking and teamwork. Where SBE has been mandated within continuous medical education (CME), it has been shown to maintain the currency of knowledge and practice, and helps close any gap in professional services¹³.

The current narrative review was planned to assess the emergence and use of MHSU globally while investigating the value of SBE to those remote and rural HCPs who have benefitted from having access to their services, and gauging their satisfaction. It also aimed at identifying common challenges and limitations faced during their establishment and operation. In doing so, the review planned to identify pros and cons of developing an MHSU, to indicate which of the approaches are more efficient and effective than the others, to identify key performance indicators (KPIs) and outcome measures to indicate value and worth of an MHSU. As such, the narrative review can serve as an aid in rational decision-making required in the planning and development of an MHSU.

Methodology

Data sources: The narrative review comprised literature search on PubMed, Google Scholar and Cochrane databases for relevant articles published between 2000 and 2020.

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Only those studies published in English, with accessible abstracts and full texts were included. Articles focusing on medical education and training provided through mobile simulation were sought. Original research articles were searched, but reports, commentaries, reflections, and book chapters were also included. Systematic reviews, poster presentations and narrative articles that discussed in-situ simulation were excluded.

Results

Of the initially found 2,673 articles, 1927(72%) were selected for further investigation after evaluating their titles and abstracts. Subsequently, 134(7%) articles

qualified for full-text assessment, and after a thorough evaluation, 18(13.4%) fully relevant articles were shortlisted (Figure 1)¹⁴ and the relevant data was summarised (Table)^{1,2,4,6,15-28}.

The review identified three major themes: development of a prototype MHSU; learners’ experiences of an MHSU; and challenges and recommendations.

Of the 18 studies shortlisted, 5(27.7%) focused on development of an MHSU prototype, 5(27.7%) concentrated on learners’ experience, and 2(11.1%) covered both the themes. There was 1(5.55%) study that focused on the development of an MHSU prototype along

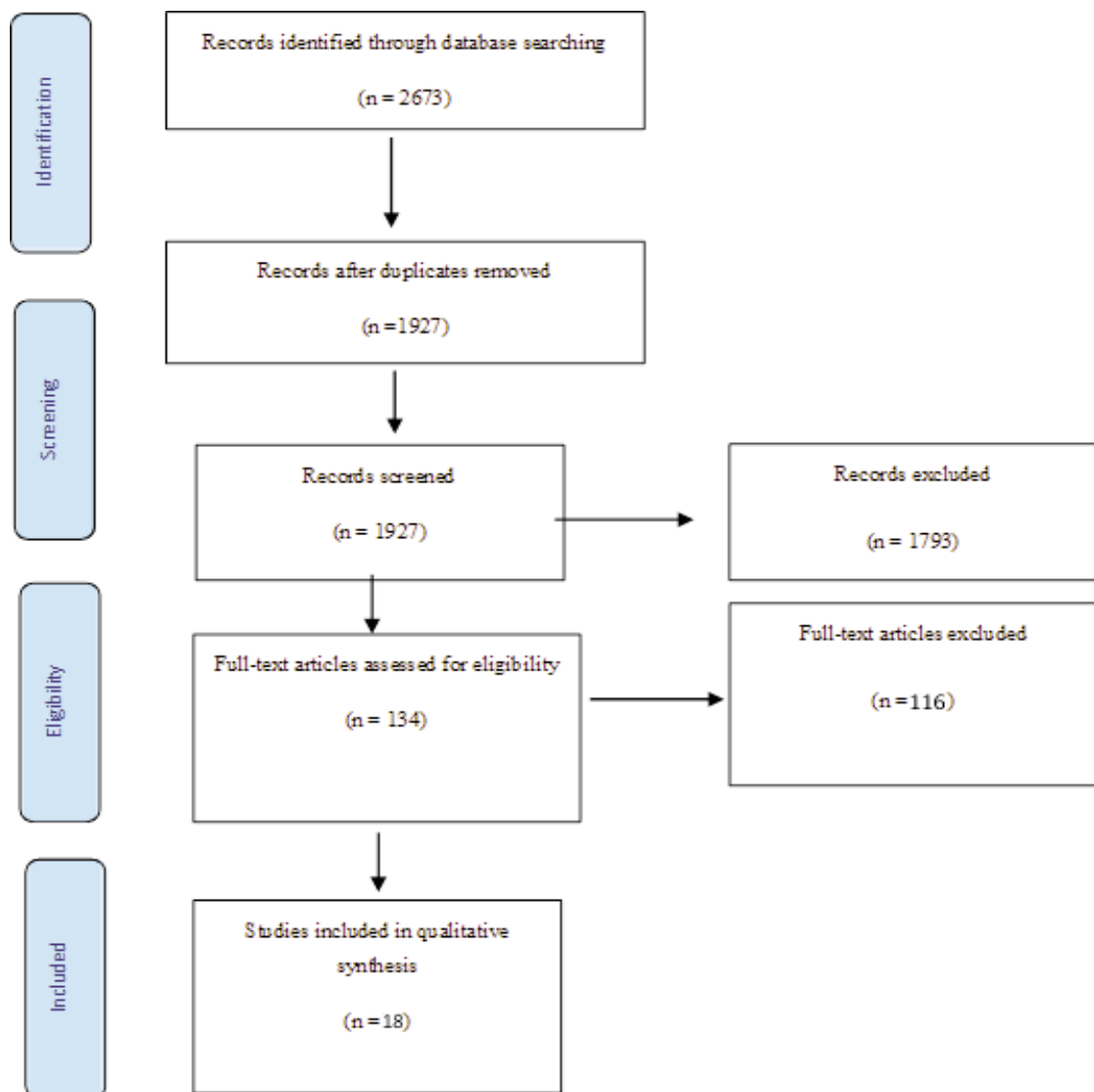


Figure-1: Study flowchat adapted from literature¹⁴.

Table-1: Summary of the selected studies.

Author/Year	Type of study	Objective	MHSU Prototype	Outcome
Adam ²¹ /2020	Book chapter: Mobile Simulation Training and Teaching Overview.	This chapter describes the benefits of the mobile simulation unit. It reports the designs, facilities, and logistics that were required by 20 different MHSUs across the USA and Canada	Mobile Trucks.	The author of this chapter concludes that the idea of creating a Mobile Simulation Unit is found to be successful across multiple centres and has been proven to be worth the cost and effort. There should be dedicated staff for the MHSU and separate from the simulation centre staff. The MHSU programme should be self-sustainable after the initial phase is completed. Custom-built units are suggested for mobile simulation to be successful.
Brown et al. ¹⁸ /2013	Research Article	The objective of this study was to assess the satisfaction of the clinical staff that was trained in the Mobile Medical Unit (MMU) before deployment.	Mobile Truck used as a training area before MMU	45% of the participants reported daily simulations as the most valuable part of the programme as it prepared these novice HCPs to work in large-scale events.
Jewer et al. ¹ 2018	Research Article	This paper defines the development and use of mobile tele-simulation in training rural and remote HCPs. It also discusses the challenges faced in the development including the satisfaction of the trainees	Mobile Tent with telecommunication set-up for mentor's supervision	The MTU is an effective way of providing SBE to remote HCPs. There was no statistically significant difference found in the beliefs and attitudes of trainees regarding remote training versus face-to-face. However, this study highlighted some challenges associated with this kind of mobile simulation including air leaks in the tent, noise because of inflation of the tent during simulation, and low-bandwidth availability in the rural area.
Ker, et al. ²⁷ / 2016	Conference abstract	This abstract offers an assessment of participants' experience at three different community sites visited by the MHSU.	Mobile Truck	This abstract reports the benefits of MHSU from the perspective of 155 participants. It reported skills development in emergency scenarios in multi-professional teams. The MHSU also provided opportunities for the public to learn new skills.
Ker et al ²⁸ /2016	Conference abstract	This abstract offers an insight into the MHSU that visited rural areas of Scotland to build resilience to deal with emergencies in rural communities.	Mobile Truck	The MHSU helped to enhance the resilience of the participants during emergencies such as distillery explosions. It helped to build their confidence and effectively involve them in teamwork. They were trained to be skillful at multitasking and interdependency was created to cater to emergencies that can occur in rural areas.

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Author/Year	Type of study	Objective	MHSU Prototype	Outcome
Kimenkowski et al. ^{22/}	Reflection	This paper discusses the use of a quick response vehicle (QRV) as a mobile training unit as well as an emergency response field hospital.	Mobile truck(three clinical areas and a waiting room)	The Quick Response Vehicle (QRV) is an ideal space to train emergency personnel. It provides flexible training schedules within low-cost budgets as the equipment necessary for providing education is already built in. The QRV also provides real-life data that can help to create authentic simulation scenarios. Personnel from different backgrounds (Police, Bomb Squad, Firefighters) can come together and make informed decisions regarding crisis management in different fields utilizing the mobile simulation concept.
Kneebone et al. ^{19/2010}	Research Article	This paper aims to propose that simulation can be offered using a lightweight, low-cost, and self-contained setting that is portable and not necessarily be fixed. This approach can ensure simulation to be more widely available.	Inflatable and portable environment taken to various hospitals and clinics	This paper describes the creation of a portable simulation environment that can be constructed in a tent and is supported by various technologies and equipment to provide an authentic simulation experience. The authors are further evaluating the model for its implication in different clinical settings.
Lockhart et al. ^{2/2020}	Book Chapter: Mobile Simulation Training and Teaching Overview.	This chapter provides examples of different successful MHSU. It also provides guidelines regarding the common training that can be performed inside the unit.		This chapter concludes that as the number of medical schools and hospitals increase in rural areas, MHSU was found to be an efficient use of resources for providing simulation-based training. This chapter also reports successful creations of MHSU.
Martin et al ^{6/2017}	Research Article	This paper evaluates the rural Canadian HCPs' satisfaction with high-fidelity emergency simulation training in a modified motorhome as an MHSU	Motor Home	The Canadian rural HCPs were taught emergency simulation on the MHSU. The respondents reported that the MHSU was a believable working environment. As their previous access and experience with high fidelity mannequins were inadequate, a higher level of satisfaction was reported amongst the rural HCPs.
Pena et al. ^{15 /2015}	Research Article	This paper describes the development of a Mobile Simulation Unit (MHSU) that provides participants an experience of modern simulation equipment. This unit can be tailored to the needs of the learner at the trainee's workplace.	Mobile Truck	The MHSU provides SBE in surgery which is feasible and practical. The training is provided to the participants regardless of the location. It has also been reported to increase participation in simulation workshops.

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Author/Year	Type of study	Objective	MHSU Prototype	Outcome
Pena et al. ²⁶ /2014	Reflection	This paper describes the development of MHSU in Australia	Mobile Van	The MHSU was deployed at five sites and trained 84 participants. The trainees provided a positive response (educational content, environment, cost reduction, and easy access to the unit) regarding the unit as a teaching facility.
Poplas et al. ²⁴ /	Research Abstract	This paper defines the development of an MHSU in Slovenia.	Mobile Van	The paper reports that the MHSU was very comfortable and provided an authentic learning environment as suggested by the participants. They further reported that MHSU was an effective way to prepare before the interaction with real patients. 60% of the participants reported an increase in knowledge after the simulation experience. However, some drawbacks were also reported such as the high-stress level of participants, incoordination amongst the team that led to delay in response time, and inadequate resuscitation.
Rowney et al. ²² /2009	Conference Abstract	This abstract highlights the importance of delivering Simulation-based skill education (SBSE) in rural and remote areas of Scotland.	Mobile Van	This MHSU has trained HCPs around 143 locations around Scotland on the management of critically ill children. The van is equipped with a High-fidelity simulator, task trainers, and other mannequins. The MHSU successfully ran through 2 years.
Sadideen H et al. ²⁰ / 2014	Research Article	This paper discusses the development of portable and simulated burns suite	Inflatable Igloo	This paper describes an inflatable environment to recreate 'The Burns Suite' (TBS). This was in the shape of an Igloo, providing sufficient space for simulation. 16 participants were recruited out of which 8 were experts and eight were a novice. However, no significant difference was found between the ratings of the two groups. It can be concluded that the participants had increased confidence in managing burns patients. They believed that TBS can be a vital tool for learning both technical and soft skills.
Shaikh et al ⁴	Research Article	This paper describes the response provided by the students regarding the MHSU	Mobile Van	The royal college of surgeons in Ireland created the MHSU to allow surgical trainees to learn surgical skills in their hospitals by their trainers.

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Author/Year	Type of study	Objective	MHSU Prototype	Outcome
Skinner et al ^{16/} 2015	Research Article	This paper defines the creation of an MHSU that aims at training the rural HCPs regarding chest drain insertion.	Mobile Van	The MHSU travelled to seven centres and trained more than 200 participants. All the trainees were satisfied with the skills taught at MHSU. The MHSU provided training to 1700 rural HCPs of Scotland. The survey reports that there was an urgent need for such training and MHSU was a cost-effective way to train the rural HCPs. The paper emphasizes that refresher courses should also be updated annually.
Smith et al ^{17/} 2020	Research Article	This paper aims to discuss the creation of a nurse-led mobile simulation for teaching rural nurses.	Mobile Van	A financial model where the beneficiary hospitals would buy simulation hours for their HCPs was adopted by this nurse led MSHU to make this programme cost-efficient. This model turned out to be a sustainable option for the programme as the paper reports that there was a 22% increase in the utilization of the van since its inception. The nurses' liaisons reported that there was a significant increase in the confidence of the participants.
Yu et al ^{25/} 2013	Research Abstract	The purpose of this abstract is to highlight the importance of MHSU.	Mobile Van	Fifty paediatric residents had participated in the SBE provided in the MHSU. The participants reported that there was an increase in the level of comfort to perform resuscitation skills. And it was cost-effective, convenient, and more realistic than traditional simulation centres.
Zafošnik et al ^{23/} 2019	Research Abstract	This abstract explains the development of MHSU in Slovenia	Trailer	This MHSU was sent to 20 different locations to train 100 HCPs. All the participants reported that the environment of the MHSU was comfortable. Only 10% of the participants said that they have access to simulators. However, they are old and not realistic.

with challenges and recommendations, while 2(11.1%) studies focused on learners' experience alongside challenges and recommendations. There were 3(16.7%) studies that addressed all the 3 themes.

Development of a Prototype MHSU

Among the 12(66.67%) pieces of literature that addressed the first theme, 8(66.67%) were original articles^{1, 6,15-20,}

2(16.67%) were book chapters^{2,21,} and 2(16.67%) were conference abstracts^{22, 23.}

Most of the studies were conducted in high-income countries, like the United States, the United Kingdom, Canada, Australia and Slovenia. A common goal within these studies was to develop MHSU as a means of offering training opportunities to HCPs in remote and rural areas.



Figure-2: Different approaches to mobile healthcare simulation unit (MHSU).

Many described processes of refurbishing a van or truck; processes of equipping with simulators and task trainers; and development of a team of trainers. There were differences in approach, as some used inflatable structures to recreate a simulation environment, while others became hybrids, being used for both training and provision of care (Figure 2).

Adapted trucks: Adam²¹ and Lockhart and Paulman in 2020² described various approaches to mobile units. Each observed that as the number of medical schools and hospitals increased in rural areas, MHSU was found to be an efficient use of resources for providing simulation-based training (SBT). Preceding introduction of an MHSU, trainers transported mannequins in trunks of cars, resulting in excessive wear and tear. Some locations could

not guarantee an electrical supply for re-charging mannequins, leading to decreased operation and fidelity of simulation. Learning spaces to conduct SBT were frequently inadequate for briefing, practice and debriefing. The introduction of an MHSU resolved these issues and, through efficiency, allowed training in more than one location on any one day.

Shaikh et al, in 2011⁴ described a project by the Royal College of Surgeons in Ireland (RCSI) that involved using an MHSU to provide surgical skills training within community hospitals in seven regional centres of Ireland, serving more than 200 basic surgical trainers (BSTs). The cost of creating and developing an MHSU was approximately US\$920,000. However, annual operating cost was about US\$285,000 which included staff salaries, cost of travel, equipment and simulators. At a time, a unit could accommodate 10 participants and 2 mentors in a space 10.5m long and 4m wide. The MHSU would visit the centres twice a month to provide training in basic surgical techniques as well. The study concluded that MHSU proved to be a viable solution to professional and geographical resource issues. The central statistics office reported that within the country more than 50% of BSTs were trained outside large cities, demonstrating potential demand for a mobile unit. It was also established that after initial high setup costs, a project can be self-reliant.

Skinner et al. in 2014¹⁶ described a similar project. The goal was to provide training for a high-risk and less-frequently performed skill, such as insertion of a chest drain, to physicians in rural areas of Scotland using a purpose-built MHSU. This unit was expandable and contained task trainers as well as medium-fidelity

simulators supported with audio-visual (AV) technology. During pilot study, this unit provided training to 1,700 practitioners in remote and rural areas. Participants reported that theory combined with simulation enhanced their learning. The authors further suggested these uncommonly performed skills can only be retained with annual refresher courses offered using MHSU. However, further work is needed to analyse the cost and benefit ratio.

Martin, Bekiaris and Hansen in 2017⁶ described how the Shock Trauma Air Rescue Service (STARS), a Canadian non-profit helicopter air ambulance organisation, converted a motorhome into an MHSU. This unit carried high-fidelity simulators to train participants for effective teamwork, communication, resource management, and problem-solving in a critical situation. About 87% participants agreed that the environment was believable.

A state-of-the-art MSHU was created in Slovenia which provided SBT to HCPs. This trailer was 16 meters long and had two simulation spaces that had high-fidelity simulators for teaching and training purposes. There were 20 healthcare teams (100 participants) that were trained on this MHSU. The participants reported the physical environment of MHSU was very comfortable and they reported a 60% increase in their level of knowledge after simulation²³.

In 2011, an MHSU was launched by the University of Missouri to provide high-tech training in rural areas. A 30-foot-long vehicle housed 4 high-fidelity mannequins along with virtual reality (VR) simulators. The programme offered a menu of 110 medical scenarios and was equipped with video recording and data storage for later analysis. The Shelden Clinical Simulation Centre allowed one to book interactive simulation sessions to be run on MHSU in the vicinity of Missouri state. Mobile simulation training proved to be a useful method in improving skills and knowledge of HCPs in rural and remote areas, and the technique was likely to continue to grow as technology advances and so does its utility².

Smith, Thompson and Sims in 2020¹⁷ described a nurse-managed mobile simulation programme initiated in North Carolina, USA, by Coastal Carolinas Health Alliance (CCHA). A grant of \$1.1m funded a truck, simulators and a nurse educator. A successive grant sponsored purchase of a van to facilitate staff transport to rural areas. Utilisation of the unit, increasing by more than 20% every year, was an indicator of success.

In Scotland in 2008, an MHSU was developed to provide paediatric intensive care training to HCPs in remote

islands and highlands. The unit was equipped with a baby simulator, task trainers, and a debriefing system. It provided training in 143 different settings in Scotland²².

Hybrid MHSUs for staff training and care provision:

Adams in 2020²¹ described how an MHSU was used effectively as a facility for treatment of real patients in times of emergency. Another useful example came from Pennsylvania where director of an MHSU reported that their unit was re-purposed as a command centre during the 9/11 attacks.²¹

In 2010 Vancouver Winter Olympics, a mobile medical unit (MMU) was provided for surgical and medical support. This 15.9-meter trailer could be expanded to 90 square meters, housing 12 beds which also included one operating room table. The MMU was equipped with resources and a team to deliver healthcare, but also served as a simulation-based learning environment to rehearse scenarios aimed at enhancing teamwork, refreshing clinical knowledge and psychomotor skills. SBT for simple to complex scenarios, such as code blue, was held in the MMU followed by formative debriefing which helped to increase the confidence of the team in a new environment. The study further reported that MMU was now used in many ad hoc situations, such as natural disasters and other sports events. Original training staff appointed for the Winter Olympics was subsequently appointed as permanent staff for the MMU¹⁸.

Inflatable mobile simulation environments:

An inflatable setup consists of a self-contained space, portable operating lamps, pull-up banners, speakers and cameras. Kneebone et al. in 2010¹⁹ explained the creation of a portable simulation environment which can be set up by as few as 2 people, essentially a self-contained tent that could be inflated by an electric pump. The tent was 2 meters tall with an area of 20 square meters. Appropriate lighting, background sounds, and pull-up banners provided appropriate fidelity to support a range of different scenarios, and cameras provided evidence for debriefing. The authors reported that further evaluation of the model was being done to understand its implementation in various clinical applications. However, they agreed that initial work had been perceived as of high value considering that the concept had already gained interest from professionals and public alike.

Sadideen et al. in 2014²⁰ described a similar inflatable environment to recreate The Burns Suite (TBS). This was in the shape of an igloo, providing sufficient space for simulation. Changeable backdrops, clinical equipment and technologies to provide patient data successfully

simulated burns scenarios using simulated patients.

Jewer et al. in 2018¹ described an inflatable tent as a mobile tele-simulation unit (MTU). This provided a simulated experience to participants through a remote mentor. The participants, located in remote areas but with access to this tent, were recorded in simulated practice and given feedback from a distance. The tent provided computing and AV technologies, internet access, and simulators with medical supplies. The MTU was an effective way of providing SBE to remote HCPs. There was no statistically significant difference found in beliefs and attitudes of trainees regarding remote training versus face-to-face training. However, the study highlighted some challenges associated with this kind of mobile simulation which included air leaks in the tent, noise because of inflation of the tent during simulation, and low-bandwidth availability in rural areas. It was concluded that despite initial challenges, the MTU may become an asset to provide equitable delivery of knowledge and skills training across healthcare systems.

Learner's Experience

The second theme identified was the experience of MHSU learners. Of the 12(63.2%) publications that touched the theme, there were 6(50%) original research publications^{1,4,6,15,17,20}, 5(41.7%) conference proceedings^{23, 25}, and 1(8.3%) commentary/reflection.²⁶

Learner satisfaction with the extent to which MHSU provided effective learning: A high level of participant satisfaction was reported. Jewel et al. in 2018¹ reported positive feedback from participants about tele-mobile simulation. It helped in improving their clinical skills in comfort of their hometown. This response was supported by overall level of satisfaction reported by these trainees which were 4 or higher on a 5-item Likert scale. Pena et al. in 2014²⁶ also reported that participants who trained in MHSU were satisfied with the state-of-the-art education facilities that would otherwise be unavailable to them. Teaching faculty also provided positive feedback after experiencing a new environment of teaching in MHSU. The developers of MHSU were in the process of funding procurement to further expanding the programme all over Australia as they saw this as a promising strategic tool of surgical simulation training. Participants of a Slovenian study agreed that MHSU provided them an opportunity to be better prepared for practice, with a significant 60% improvement in skills and knowledge reported following simulation activities^{23,24}. Participants who got trained in motorhome-turned-MHSU reported improved clinical reasoning, decision-making, recognition of patient deterioration, and self-reflection (median response of 5 on 5-point Likert scale) as a

learning experience as many of them were not previously trained on high-fidelity simulators⁶.

Yu, Grogan and Kelly in 2013²⁵ described how an MHSU van was designed to provide high-fidelity SBT to paediatric residents. During the study, 50 residents were trained to provide resuscitation and mock codes using a high-fidelity mannequin and associated technologies. The participants reported that MHSU was more convenient and economical than a simulation centre.

Inter-professional experience: One of the benefits widely reported, in addition to ease of access, was the inter-professional nature of much of the training provided by MHSU²⁷. This was perceived as beneficial in acquiring a fuller understanding of context within which skills were expected to be performed. This helped in the practice of multiple skills and enhanced team performance²⁸. Participants also learned crisis resource management (CRM), a concept that was new for many⁶. Novice learners who experienced simulation activity in TBS reported that they often felt intense pressure to multi-task and work as a team. Before the availability of MHSU, they had little opportunity to simulate practice and receive feedback on their performance. They reported high-fidelity experience of MHSU as effective, as their decision-making skills came under scrutiny for the first time²⁰.

Cost-effective and time-efficient: There was little factual evidence in literature of cost-benefit analysis or return on investment (ROI) calculations. It is tacitly accepted that benefits are qualitative and not measurable on a balance sheet. However, many publications expressed views on the matter. The RCSI study reported that MHSU was cost-effective as neither trainees nor trainers were required to leave their workplace or their patient commitments to travel for learning or teaching skills. This convenience or 'efficiency' factor overcame a barrier to partake of training opportunities that would otherwise not be possible⁴. Yu, Grogan and Kelly in 2013²⁵ and Smith, Thomson and Sims in 2020¹⁷ supported the notion that MHSU was an economical substitute for standard simulation centres. Factors such as long working hours, fatigue and traveling can decrease a clinician's motivation for training. MHSU was seen as providing convenient training opportunities with potential to reduce the cost of simulation¹⁵.

Challenges and Recommendations

The third theme identified was challenges and recommendations. Of the 6(33.3%) studies that touched the theme, 3(50%) were original papers^{1,15,17}, 1 was a book chapter²¹, a conference abstract²⁴, and a reflection.²⁶

Funding: The first category under the theme was funding challenges. Adam in 2020²¹ summarised some important issues and challenges faced by MHSU developers. The biggest issue was continuity of funding. It was a major reason why many mobile units were not sustainable. Units were typically purchased through grants and once start-up money became depleted, the centre required to decrease the size of the project or to close it altogether. To make MHSU financially viable, Mount Carmel Hospital displayed advertisements on mobile unit which provided revenue to repay the establishment cost in under 10 years, although for some, this might raise issues of ethics. Another effective solution for cost-saving is to spread benefits across different institutions and share costs.

A similar financial model where beneficiary hospitals would buy simulation hours for their HCPs was adopted by a nurse-led MSHU, and it turned out to be a sustainable option as there was a 22% increase in the utilisation of the van since its inception.¹⁷

Staffing: Having appropriate workforce to run a mobile simulation centre was a challenge that was frequently mentioned. In general, funding was provided for unit only, and not for staff. Simulation centre staff contributed time and expertise to the unit at the expense of their work²¹. The nurse-led mobile unit exemplified these difficulties, reporting that lack of dedicated staff resulted in conflicting priorities and inadequate attention to scheduling, creating ineffective communication, and unpredictable attendance by participants¹⁷. A mobile unit should have dedicated staff and access to subject-matter expertise, as required²¹. Besides, there should be well-planned, dedicated consumable supplies, simulator inventories, and robust supply lines for re-stocking of the unit¹⁵. Smith et al in 2020¹⁷ also recommended that liaison hospitals identify specific roles to avoid communication and scheduling problems, and that there should be a feedback mechanism for stakeholders and frequent evaluation of the programme and its organisation.

Design: As most of the units were original conceptions, there was no template that the developers could follow. Most were built based on earlier produced designs, featuring inflexible floor plans and layouts. Specific areas tailored for one type of activity could not be used for another, and the range of participants who could train concurrently was 5-10. The learners were frequently scheduled for day-long events. Re-purposing mobile homes as an MHSU was reported. These underwent many modifications, but were found not to provide an

authentic simulation experience for the participants. Repairs owing the lack of durability of recreational vehicle (RV) modifications made them inappropriate for long-term use. For all designs, weather conditions increased maintenance cost as the units were stored outside during winters, and equipment was exposed to a cold environment²¹.

Temporary, inflatable units similarly faced challenges during their pilot testing. During some sessions, air leaks in the tent led to noise and a chilled environment inside, with disruption to sessions caused by a continuous need to re-inflate. Some projects found that the bandwidth was inadequate for effective communication and access to online media, compromising smooth running of sessions¹.

The mobile units built on new chassis are initially expensive, but have many benefits. Custom-built MHSU aids in the success of the programme. Design should be flexible for moving equipment along passages and doorways, and should be made of pliable material to repurpose spaces as and when needed. Making floor plans according to specific environments cannot provide flexibility for other simulation activities. Pop-out extensions are another way to increase internal space and create room for more simulation activity. The number of participants can be increased by adding different experiences in adjacent rooms, allowing teams to rotate. In efforts to prevent weather damage to MHSU, stakeholders restricted the use of unit during winters. For example, MHSU in North Dakota had instructions of travelling under 30 degrees Fahrenheit. It was also recommended to store unit in garages and buildings and attached them to electricity to prevent damage²¹. MSHU has been tested in weather conditions from 10 degrees Celsius to 30 degrees and users appraised that it was a comfortable environment for learning and practising^{24, 26}.

MHSUs for Pakistan

The current narrative review could serve as a guide to create an 80,000-square-foot MHSU by the Aga Khan University, Karachi. As evidence suggests, an MHSU can be a worthy and valuable venture, and it can also be argued that it holds benefits especially for developing countries, such as Pakistan, where scarce, high-quality educational resources could be more equitably and efficiently made available to professionals who would otherwise struggle to maintain the currency of their practice. The current review would serve as a guideline for anyone who plans to create an MHSU. Informed decisions can be made regarding the planning and development of the MHSU, and strategies can be developed to avoid the

many barriers to success.

Conclusion

An MHSU provides trainees with a platform to learn regardless of their geographical location. It offers HCPs access to state-of-the-art simulation-based education in their backyard. It could be a cost-effective initiative as it divides costs that would be incurred by each of the beneficiary organisations if they were to design, build and operate their simulation centres.

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