York Health Economics Consortium

NHS INNOVATION ACCELERATOR

Economic Impact Case Study: Oxford Medical Simulation

Final version: December 2022

Summary

Oxford Medical Simulation (OMS) offer virtual reality (VR) based simulations for training healthcare staff. This can be used in place of physical simulations using mannequins. Based on the assumption that the learning outcomes for both types of simulation are equivalent, this case study compares the costs of OMS simulations with physical simulation costs (found in a pragmatic literature search). Little published evidence on physical simulation was found and there is uncertainty about how comparable the course content and trainees were with the OMS simulations. As a result, only general comparisons are provided, as a context, and this case study does not constitute an economic evaluation. The results indicate costs for physical simulation training of between £23.83 to £331.48 per 'use', which compares to an equivalent, average cost of £10.15 per OMS simulation 'use'.

1. BACKGROUND

Simulation has been a part of medical and other health professional training for many years.[1] The traditional approach has been 'physical simulation' in which mannequins and/or actors are employed to give trainees the opportunity to learn and practice skills without the risk of patient harm. The costs of simulation-based training are difficult to assess and have not been well reported.[2]

1 McGaghie WC, et al. A critical review of simulation-based medical education research: 2003-2009. Med Educ. 2010 Jan;44(1):50-63. doi: 10.1111/j.1365-2923.2009.03547.x. PMID: 20078756.

2 Hippe DS, et al. A targeted systematic review of cost analyses for implementation of simulation-based education in healthcare. SAGE Open Medicine 2020 Vol 8: 1–9 DOI: 10.1177/2050312120913451

In addition to 'physical' simulations, which may use lifelike mannequins for practice, training approaches using computer-based simulations have also been available for some time. The two approaches may result in comparable learning outcomes with lower costs in the computer-based approach, as has been shown in a study of nursing students learning care of a hospital patient experiencing a chronic obstructive pulmonary disease (COPD) exacerbation.[3]

More recently, simulation training has become increasingly viable in virtual reality (VR) formats. Oxford Medical Simulation (OMS) provides VR-based training, using fully immersive computer-generated VR scenarios, rather than simple, screen-based learning or non-interactive 360-degree video. Trainees using OMS can use the system with VR headsets and it can also be used onscreen. The system is based on interactive virtual clinical scenarios requiring trainees to perform as they would in real life patient care. Trainees receive detailed feedback on their performance and can repeat scenarios as needed.

The developers indicate many areas in which OMS can be used. In nursing, for example, the uses could include:

- Training in nursing schools, including the provision of clinical placements.
- Assessing clinical competence in recruitment and selection.
- Assuring role competency in clinical onboarding and training.
- Ongoing professional development.
- Supporting staff retention by identifying potential clinical issues and providing tailored support to staff.

As of August 2021, OMS was implemented for medical training over 50 organisations in the Health Education England regions of East of England, North West, Yorkshire and Humber, East Midlands, West Midlands, Wessex, London, North East, and Oxford. It was also in use in 10 medical and nursing training institutions in universities.

There is a lack of evidence in published literature reporting the costs of physical and VR-based simulation training.[4] In addition, there are few trials reporting the outcomes of alternative training approaches comparing the learning impacts, which would permit a specific comparison in costs between physical and VR simulations. In the light of this, this case study uses evidence of the costs of physical simulation that have been identified in a pragmatic literature search. These results are used as a general comparison to the costs of VR simulation as reported by the developers of OMS. This provides the context of a range of comparators, without the assumption that they represent identical training programmes.

---

[3] Haerling KA. Cost-Utility Analysis of Virtual and Mannequin-Based Simulation. Simul Healthc. 2018;13(1):33-40. doi: 10.1097/SIH.0000000000000280.

[4] Zendejas B, et al. Cost: The missing outcome in simulation-based medical education research: A systematic review. Surgery, 2013. 153;2 160-176. doi.org/10.1016/j.surg.2012.06.025.

The analysis for this case study was developed in Summer 2022 and was based on the information and evidence available at the time. The limitations of the analysis are as follows:

- It has not been possible to identify evidence of the costs of the exact equivalents for VR simulations, i.e., physical simulations, so simple examples of the latter are used as general comparators.
- Overhead costs such as costs for training venues and personnel are very difficult to apportion to individual training sessions and it is not clear how these might change for a centre that adopts VR simulations. As a result, only variable costs per training session are compared.
- Where we have made general comparisons, we have assumed that the learning outcomes of VR and physical simulation are equivalent. There is some evidence the VR simulations can produce superior outcomes.[5]

2. COST COMPARISONS

For a full account of the costs of simulation training, both physical and VR-based, it would be necessary to identify all of the capital and running costs and apportion these to a per-training session basis. For VR-based training, this could include the purchase of computers and VR headsets as well as tutor time for presentations and feedback and the cost of the training centre itself. For physical simulation this would include costs of mannequins and technician time to prepare them between sessions (for example replacing artificial skins for intravenous or sub-cuticle interventions) as well as the tutor time and cost of the training centre, which may differ from the VR option, for example, potentially requiring greater classroom space to undertake physical simulations.

It is extremely complex to estimate and apportion each of these costs and there is a notable lack of robust evidence in the published literature on attempts to estimate these costs for physical simulations.[6] In addition, the costs will vary according to the type of trainee and the course subject, making a detailed, specific comparison of the two modalities prohibitively difficult.

As a result, this case study considers only the variable costs of providing training sessions, using costs and usage levels reported by the developers of OMS from implementation in three nursing schools in England. These are compared with the few accounts of the costs physical simulation that have been identified in a pragmatic review of the published literature. The training content and trainees are different between the OMS and comparator examples, so these are only presented as a general comparison of training modalities.

[5] Judd T, Aquilina AL & Hunter I. Virtual Reality Medical Training: A Non-Inferiority Randomised Controlled Trial of VR vs Face-to-Face Training. J Medic Educ Training 2020; 4:044

[6] Zendejas B, et al. op cit.

2.1 Costs of VR simulation

OMS provides clients, such as medical or nursing schools, with a library of scenarios which are created for specific topics and trainee types, that learners can access. The service is provided under a software as a service (SaaS) model. The library of scenarios can be provided under various costing approaches, the most common of which is a set licence fee per learner, with no limit on the number of scenarios that are accessed. In addition to the licence costs, the developers indicate that there are minimal setup costs.

The developers have provided cost and usage data from three UK nursing schools where OMS is currently implemented. Each school has a different number of learners and scenarios and therefore a different contract cost. A summary of the data is shown in Table 2.1.

Table 2.1: Costs and activity for use of OMS in three nursing schools over one year

Nursing School	Number of learners [a]	Number of scenarios used [b]	Annual cost [c]	Number of scenarios used per learner	Cost per learner	Cost per scenario used
Nursing School A	222	1,931	£23,306	8.7	£104.98	£12.07
Nursing School B	346	7,242	£52,896	20.9	£152.88	£7.30
Nursing School C	340	3,371	£37,312	7.4	£109.74	£11.07

Notes:
a These are learners signed up to use OMS in each nursing school.
b The numbers for a full year are extrapolated from part-year figures for Nursing School C, based on usage by signed up learners across a part-year.
c The proportion of the contract cost related to this group of users. For Nursing School A, the full contract cost is higher than shown here, but a proportion of that cost is allocated to uses of OMS not related to the nursing school, so only the relevant proportion is used in these calculations.

These values from implementation give an average annual cost per learner of £122.53 and an average annual cost per scenario used of £10.15. Data was also provided for an additional nursing school, but only covering four months of use. This showed very high usage of 12,862 scenarios run, by 413 users, since the start of the contract. This would result in cost per scenario used of £1.86, when extrapolated over a full year. While note is taken of this example, it is not used in the following analysis, in order to maintain a conservative approach to the analysis and avoid the lack of robustness in extrapolating from such a short period.

2.2 Costs of physical simulation

It is challenging to cost an alternative to a VR-based simulation training system, partly because there are multiple options. These include lecture and seminar-based learning; textbook or online information-based learning; physical simulation-based training, using mannequins and/or actors in place of patients and staff; clinical training on the wards, treating real patients, with tutors and preceptors. For the purpose of this case study the second scenario – physical simulation – is used as the comparator most closely resembling the type of training provided by OMS.

A second difficulty is to define the costs of physical simulation, due to the complexity of apportioning all costs to individual training sessions. For example, the cost of a mannequin may be apportioned across the usable life of the item. Physical simulators may be 'full patient' or only body parts, such as a plastic arm, used for training IV catheter insertion. In addition, 'consumables' such as synthetic body fluids, replacement skins, bandages, syringes, and other supplies can be costed on a per use basis. However, the training space or classroom may be more difficult to apportion to individual cohorts of students. It is also unclear, across a range of course types, how much course content and structure may vary.

As a result, only the variable costs of physical simulation are presented here, reflecting the approach to costing OMS, above. Four papers have been identified, which report usable costs of training, from which variable costs can be identified. The first of these is an abstract for a poster presentation which estimated the variable costs of simulation training to be $311 per hour (at 2006 prices).[7] This excluded the costs of setting up a training facility and purchasing equipment. The training topic and the type of physical simulation were not specified.

Another published source details the 'implementation costs' of simulation training for intravenous catheterisation training (also excluding facilities and equipment costs). The estimated cost was $227.50 for each two-hour use (at 2014 prices).[8] A third study from the US compared the costs of physical simulation with VR simulation for nursing students treating a patient with an exacerbation of COPD in hospital. In both cases the training was 30 minutes long. Excluding the overhead and 'durable equipment' costs such as mannequins, the cost per trainee for the physical simulation group was $27.85 (at 2018 prices).[9]

A study from Spain in 2007 compared the costs of using a conventional mannequin or a more advanced mannequin for Adult Life Support (ALS) training.[10] The training was for 20 hours over four days, with half of that being lectures and half practical sessions. The costs for each course were estimated and, from this, we have subtracted what appear to be the overhead costs, referred to as 'structural costs' in the report.

Adjusting these costs for US[11] and Spanish[12] inflation, then converting to GB pounds (GBP) at the current rate of exchange,[13] gives an estimation of the current equivalent costs per use (i.e. per training session, per person) shown in Table 2.2.

7 McIntosh C, et al. Simulation: What does it really cost? Abstracts presented at the 6th Annual International Meeting on Medical Simulation: Abstract # 1473. 2006 Society for Simulation in Healthcare

8 Isaranuwatchai W, et al. Comparing the cost-effectiveness of simulation modalities: a case study of peripheral intravenous catheterization training. Adv in Health Sci Educ (2014) 19:219–232. DOI 10.1007/s10459-013-9464-6

9 Haerling KA. 2018. ibid.

10 Iglesias-Vázquez JA et al. Cost-efficiency assessment of Advanced Life Support (ALS) courses based on the comparison of advanced simulators with conventional manikins. BMC Emergency Medicine 2007, 7:18 doi:10.1186/1471-227X-7-18

11 Federal Reserve Economic Data. Economic Research Division. Federal Reserve Bank of St. Louis: https://fred.stlouisfed.org

12 https://www.inflation.eu/en/inflation-rates/spain/historic-inflation/cpi-inflation-spain.aspx Accessed 26/07/22

13 https://www.bankofengland.co.uk/statistics/exchange-rates Accessed 26/07/22

Table 2.2: Costs per use of physical simulation at 2022 GBP prices

Source	Year of publication	Course content	Metric	Cost in 2022 GBP
McIntosh et al.	2006	Unspecified 'health care education'	Cost per course hour per participant	£331.48
Isaranuwatchai et al.	2014	Intravenous catheterization skills for medics	Cost per 2-hour trial per participant	£206.48
Haerling	2018	COPD exacerbation for nurses	Cost per 30-minute simulation per participant	£23.83
Iglesias-Vázquez et al.	2007	ALS training with a conventional mannequin	Cost per 20-hour course per participant	£25.63
Iglesias-Vázquez et al.	2007	ALS training with an advanced mannequin	Cost per 20-hour course per participant	£194.23

3. CONCLUSION

The results presented in this case study show estimates of the variable costs of providing training, as described in a number of published papers. These vary from £23.83 to £331.48 per 'use'. The data from OMS indicate that the cost per scenario run (interpreted to mean 'use') is £10.15.

These results are based on examples of physical simulation from the published literature which are not directly comparable to the OMS example used, in terms of the structure and content of the training. None of the papers used are from UK studies, which introduces additional uncertainty about comparability. It has been noted that there is no standardised framework for calculating and reporting the costs of simulation training.[14] The examples used here represent the only alternatives for which usable costs were available, from a pragmatic literature search, and they present a range of options. They should be understood only as examples providing context, rather than a rigorous comparison. For these reasons, this case study does not constitute an economic evaluation.

Different examples of training using physical simulation may also have varying cost profiles. For example, physical simulation using mannequins may require a full-body mannequin or only body part models. The training for intravenous catheterization skills, for example, may use only a plastic arm.[15] The use of a VR-based training system such as OMS, would however, remove the need to have multiple body-part mannequins for different uses, as only the software-based scenario would need to change.

The full costs of setting up and running a training centre are not included in this analysis. The difficulties of apportioning these to individual training sessions are substantial and it is not clear how they would vary between physical and VR-based simulation. Some physical overheads would still be necessary, as would preparation and feedback, probably requiring some face-to-face time between trainers and trainees. Whilst the use of only the variable costs of training courses provides an incomplete picture, it is potentially a more robust comparison for the purposes of this case study.

[14] Zendejas B, et al. op cit.
[15] Isaranuwatchai W, et al. op cit.