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International audit of simulation use in pre-registration medical radiation science training

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Conflicts of Interest:

Dr Pete Bridge and Therese Gunn are directors of “medspace.VR”; a medical imaging simulation software company

Abstract

Introduction

Simulation-based education (SBE) can replicate the challenging aspects of real-world clinical environments, while providing a safe and less intimidating setting. Literature supports its use within medical radiation science (MRS) training for safe practice of psychomotor skills, development of problem solving, team working, interpersonal and decision-making skills and embedding awareness of patient safety. This project aimed to quantify usage of SBE resources and activities internationally and to evaluate how this changed during COVID-19 restrictions.

Methods

An anonymous online survey tool gathered data relating to programme demographics, simulation resources, simulation activities and future plans. A link to the survey was distributed to programme leads via social media, professional bodies and national networks.

Results

A total of 72 responses were received from a range of countries and representing a range of programme structures. Most respondents reported up to 100 hours of SBE per student per year with low fidelity resources and image viewing software featuring most prominently. There was low reported engagement of service users within simulation activities. Respondents also indicated that COVID-19 had been a trigger for rapid uptake of simulation resources.

Conclusion

SBE forms an important aspect of MRS training internationally with low-fidelity resources being widely deployed. Where available, high fidelity virtual reality and specialised profession-specific resources were used heavily. There was a low level of reported engagement with service users or expert patients in simulation activities. Future research will identify whether the rapid uptake of SBE during COVID-19 continues and clarify the role of service users in SBE provision.

Implications for practice

Increased collaboration between MRS education providers may help to improve parity of SBE provision and identify additional opportunities to engage service users within SBE.

Introduction

Clinical placements (also known as work integrated learning, work-based learning, clinical practicums or practice placements) are an integral element of many healthcare professions programmes. Placement allows learners to translate the academic theory learned at university into practice and supports their development into competent and safe practitioners.^{1,2} This paper addresses clinical skills development of learners in medical radiation science (MRS) which comprises diagnostic radiography, therapeutic radiography and nuclear medicine. Time allocated for clinical placement

varies but comprises around 50% of some MRS programmes in the UK³ and also forms the backbone of development from graduate to accredited practitioner in other countries.⁴

There is significant variation between programmes across Europe, including curricula, duration and time allocated for clinical training.¹ Often learners will be expected to demonstrate competencies in a variety of procedural, technical and non-technical skills in order to progress on the programme and graduate as a competent radiographer eligible to practice, and provide safe, optimised, patient centred care.^{1,2} Traditionally, MRS training involves practicing on real patients in the clinical environment under the supervision of qualified staff. This, however, can present several real-world logistical challenges including availability of placements supervisors and assessors as well as restricted opportunities for learning in pressurised clinical settings. There is growing evidence⁵⁻⁷ of Simulation-based Education (SBE) being used in academic settings to prepare learners for practice placement, increasing their confidence in the application of the theory to the simulated practical. In addition, simulation including role play between staff and learners may be used within a practice placement setting to complement use of on-site resources and to enforce patient safety awareness.^{1,2} It has been argued that the traditional model of medical training using the patient as a ‘training tool’, poses ethical issues and patient safety considerations,⁸ and that SBE can address these issues for healthcare professionals such as doctors and nurses. Clearly, this can be applied to MRS, where there are similar issues of patient safety with the additional hazard of use of ionising radiation for both medical imaging and radiotherapy.⁹ Whilst learning with patients in the real clinical environment remains invaluable for radiographers and other healthcare professionals, SBE is playing an increasing role in MRS training.^{8,10} Identifying the range of simulation activities and settings internationally will help the understanding of this learning principle, potentially engage users and help to develop future simulation strategies.

Literature Review

The terminology around SBE can be confusing and covers a variety of paradigms, facilities, and equipment. Fundamentally, simulation aims to replace a real experience,¹¹ and for the purposes of this study the definition presented by Palaganas¹² was adopted: “A technique that uses a situation or environment created to allow persons to experience a representation of a real event for the purpose of practice, learning, evaluation, testing, or to gain understanding of systems or human actions.” A 2009 study¹³ into simulation in nursing education identified four key factors that drive simulation: technical proficiency from repetition, contextual learning, assistance from experts and the understanding of the emotional element of learning. Underpinning these factors, however, are the resource availability and pedagogical framework.

There is a wide evidence base detailing a range of simulation resources including role play scenarios, virtual reality simulators, computer-based systems, simulated patients, “live” x-ray rooms, wards, theatres and departments.^{7, 14-16} Evidence supports use of SBE for teaching procedure and positioning as well as non-technical skills such as professionalism, situational awareness, and teamwork.^{10,17} Simulation has also proved helpful in alleviating stress and anxiety that learners experience in clinical placement, to provide parity of student experience, and for assessment on placement. A key reported advantage of SBE is the reduced time pressure compared to clinical practice; especially with high-pressure scenarios such as accident and emergency, or operating theatre environments.^{10,17} Pedagogical advantages include the ability to learn from mistakes safely, without threatening patient

safety and repetition of procedures to enable learning which would be problematic in a radiation environment.¹⁸

The first documented criticism of simulation suggested that it was “...a shadow of reality, capable of giving false ideas to beginners...”.¹⁹ Criticism related to poor fidelity continues but has not prevented the development and widespread use of simulation in healthcare across the world, although cost of equipment, availability of dedicated facilitators and trainers, and time can be an issue.¹¹ As such there can be diversity in the types and applications of SBE across different MRS programmes.¹⁰

Globally healthcare and education systems have recently been forced to respond to the restrictions imposed by the COVID-19 pandemic and the resulting impact on clinical placement opportunities. For some learners placements were cancelled, and SBE was used to support their continued clinical skills training. Simulation has successfully been used as a replacement for some therapeutic radiography clinical practice hours, thus increasing the capacity for more learners to be trained, reducing the shortfall of qualified staff.²⁰

In summary, the literature argues that SBE can provide effective clinical skills gain for MRS learners outside the clinical environment. Its pedagogical value lies in its ability to replicate the challenging aspects of real-world clinical environments, while providing a safe and less intimidating setting.^{8,21} This allows students to practice complex psychomotor skills and prepare for high-pressure clinical environments while optimising skills for improving safety of the patient and staff. SBE can additionally assist the development of problem solving, team working, interpersonal and clinical decision-making skills. Despite this evidence, use of SBE in MRS programmes varies considerably and the exact role of SBE remains unclear.

This project, therefore, aimed to quantify usage of SBE resources and activities for pre-registration MRS learners internationally and to evaluate how the use of resources and innovation has changed during COVID-19 restrictions. Results from this work should inform ongoing curriculum development and facilitate future collaborative partnerships and knowledge sharing within the MRS simulation community.

Methods

Data collection

A short, 16 item, survey tool was developed that comprised a mixture of multiple option, matrix and short-answer open questions. Consultation with a range of simulation users and piloting of the resulting survey was used to develop the tool and ensure that terminology encompassed regional and international variations. The same panel provided suggestions for categories of SBE activities and resources. The Palaganas¹² definition of simulation was also provided to ensure clarity of the intention of the survey. The survey comprised 4 sections that gathered data relating to programme demographics, simulation resources, simulation activities and future plans. An additional short answer question sought feedback relating to how COVID-19 restrictions had impacted on use of SBE. Ethical approval for the project was granted by the University of Liverpool Research Ethics Committee (Ref 6345). Consent to participate was required through the opening question.

A link to the survey and participant information was distributed via social media and regional networks in September 2020. A reminder to complete the survey was distributed 1 month later and it was left

open for a total of 2 months. The survey was deployed by the University of Liverpool via SurveyMonkey (SVMK Inc., San Mateo, USA) to enable anonymous online completion.

Data Analysis

All data was exported to Excel (Microsoft Corporation, Redmond, USA) to facilitate further analysis. Quantitative data was collated and analysed using descriptive statistics. Responses to the open-ended question were analysed using an approach adapted from Giorgi.²² All responses were initially read in order to make sense of the participant responses. The data was subsequently interrogated more closely to identify codes from common words, phrases or sentiments. Codes were then arranged into broader categories in order to better facilitate discussion. In order to eliminate bias and aid in the objective interpretation of the responses, the data was analysed by three independent researchers and the resulting themes were then compared for consistency. Minor changes were made to derive four overarching themes. Qualitative data was triangulated against the quantitative findings to help identify underlying rationale for responses.

Results

Demographics

Overall, 72 responses were received from respondents representing MRS programmes internationally. The geographical distribution of these can be seen in Figure 1.

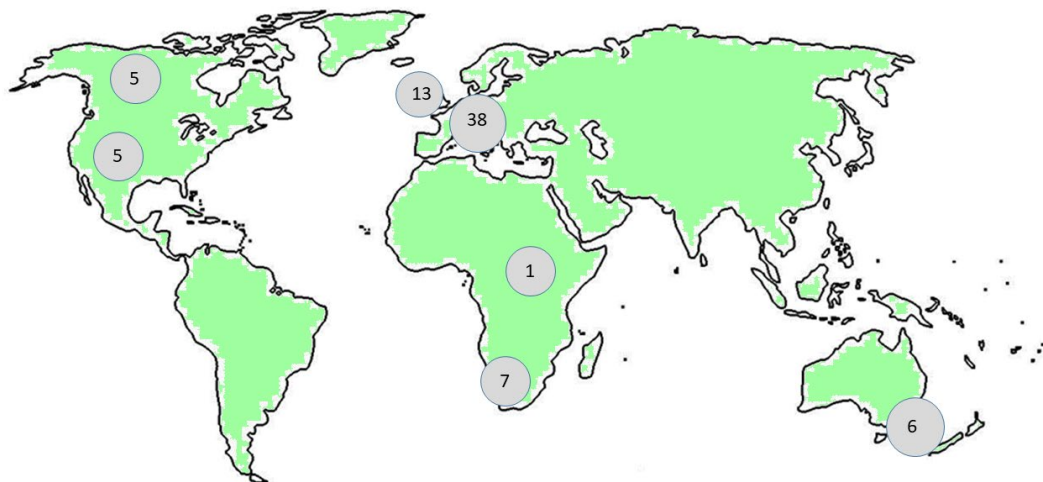


Figure 1. Respondents per geographic region

From these respondents, a range of programme types were identified with 'Diagnostic' (Diagnostic radiography / Medical imaging) most common (n=34; 47.2%). This was followed by 'MRS' (diagnostic, radiotherapy and nuclear medicine) (n=25; 34.7%) and then discipline-specific programmes as seen in Figure 2.

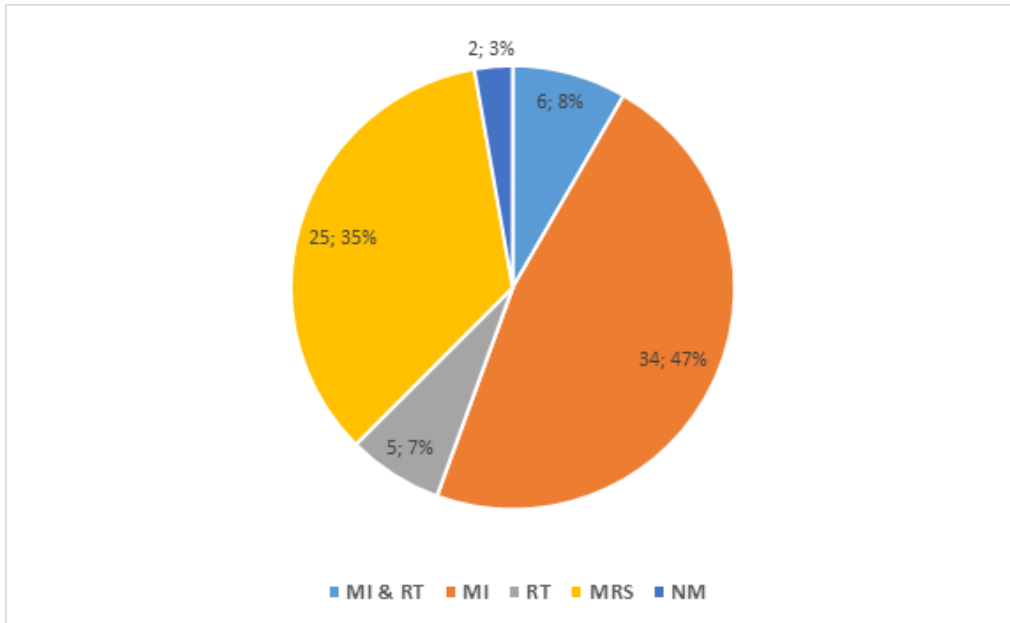


Figure 2. Programme type

Figure 3 shows the class sizes for these programmes, based on annual student intake to first year. These ranged from less than 20 students (n=12; 16.7%) to over 70 students (n=18; 25.0%).

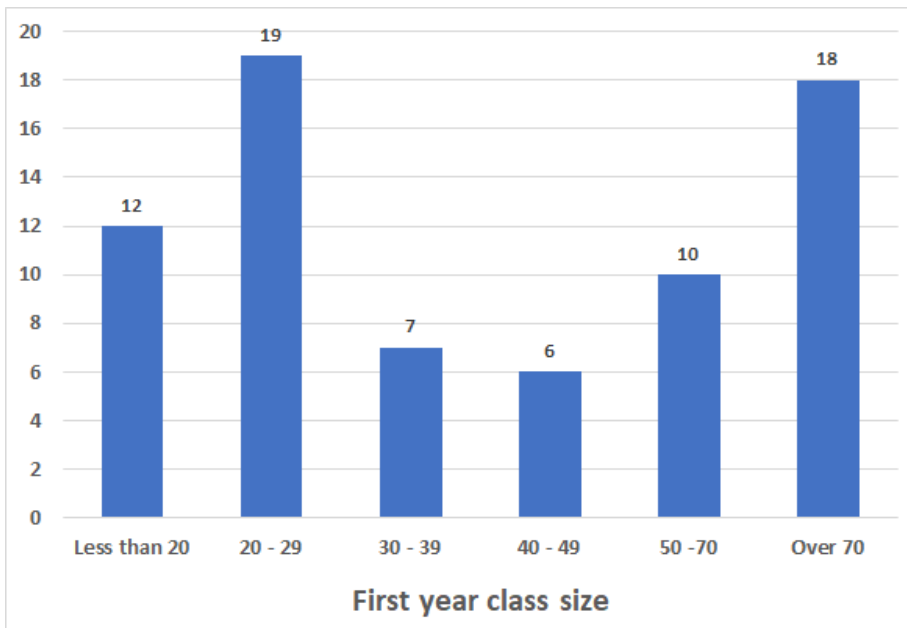


Figure 3. Class size by annual first year intake

Simulation resources

Table 1 illustrates the responses concerning course access to simulation resources and frequency of use during the course. In this case, "frequency" counted the specific occasions the simulation activity was used per student, as opposed to the number of days spent on each activity.

Table 1: Availability and usage of SBE resources

Technical resources

	NA*	0	1-2	Ann	Sem	Mult	N	Course
3D Immersive VR hardware	43	1	3	6	1	11	65	MI,RT,NM
Biometry measurements	54	0	3	3	1	4	65	MI
Communication skills VR environment	30	3	7	9	5	10	64	MI,RT,NM
Decommissioned equipment	25	7	3	6	7	16	64	MI,RT,NM
Haptic feedback equipment	46	0	6	2	4	7	65	MI,RT,NM
Image viewing software	10	1	5	5	8	36	65	MI,RT,NM
Image viewing station / library	12	1	4	4	8	36	65	MI,RT,NM
Injection / cannulation	18	8	16	7	5	10	64	MI,RT,NM
Mannequin-based simulation	9	1	11	8	4	32	65	MI,RT,NM
Manual handling equipment	3	0	14	13	10	25	65	MI,RT,NM
Patient archiving system	23	4	3	5	7	23	65	MI,RT,NM
Video feedback	16	13	17	6	7	6	65	MI,RT,NM
Virtual reality (VR) software	30	2	8	5	4	16	65	MI,RT,NM
Wearable simulation / moulage	43	3	8	4	4	2	64	MI,RT,NM

People based' activities

	NA*	0	1-2	Ann	Sem	Mult	N	Course
Clinical staff (own profession)	11	1	12	12	8	21	65	MI,RT,NM
Clinical staff (other professions)	23	10	10	6	7	7	63	MI,RT,NM
Role play scenarios	1	4	10	12	13	25	65	MI,RT,NM
Simulated patients (professional)	35	4	6	6	5	8	64	MI,RT,NM
Simulated patients (service users)	34	8	9	3	5	6	65	MI,RT,NM
Simulated patients (staff/student)	7	2	10	8	9	29	65	MI,RT,NM

Live activities

	NA*	0	1-2	Ann	Sem	Mult	N	Course
"Live" CT scanner	49	0	3	1	1	10	64	MI & RT
"Live" MR scanner	53	0	5	3	0	4	65	MI & RT
"Live" X-ray lab	17	0	2	3	6	37	65	MI
Ultrasound machine	21	6	8	10	5	15	65	MI
Image intensifier	40	2	4	6	4	9	65	MI
Mobile imaging equipment	24	0	8	9	10	14	65	MI
"Live" Gamma camera	52	1	1	1	0	10	65	NM
"Live" PET scanner	55	0	3	1	2	3	64	NM
Radiopharmacy laboratory	48	1	2	4	0	10	65	NM

RT specific

	NA*	0	1-2	Ann	Sem	Mult	N	Course
Lasers / positioning aids	33	0	3	2	5	22	65	RT
Treatment planning system	31	1	4	3	7	18	64	RT
Mould room / shell making	43	1	3	4	5	9	65	RT

*Key: NA = 'Don't have'; 0 = 'Never used'; 1-2 = 'Once or twice'; Ann = 'Annually (once per year)'; Sem = 'Once per semester'; Mult = 'Multiple times per semester'; N = 'Total number'; MI = 'Medical imaging / diagnostic radiography'; RT = 'Radiation therapy / therapeutic radiography'; NM = 'Nuclear medicine'

Simulation activity

Guidance given to respondents stated that 50 hours equates to half a day per fortnight for 30 weeks; 100 hours approximately half a day per week for 30 weeks; 200 hours approximately 1 full day per week for 30 weeks and so on. As shown in Figure 4, of the 60 who responded to this question, the majority of programmes included 100 hours or less of simulation in Year 1 (n=37; 61.7%) and Year 2 (n=37; 61.7%). Of the 52 respondents for Year 3, again the majority included 100 hours or less of simulation (n=34; 65.4%). Finally, for the 22 respondents for Year 4, again a majority of 68.2% (n=15) included 100 hours or less of simulation. At the other end of the spectrum where more than 200 hours of simulation was included per year, this only applied to 10 programmes for Years 1 (16.7%), 2 (16.7%), and 3 (19.2%) respectively, and two programmes (9.1%) for Year 4.

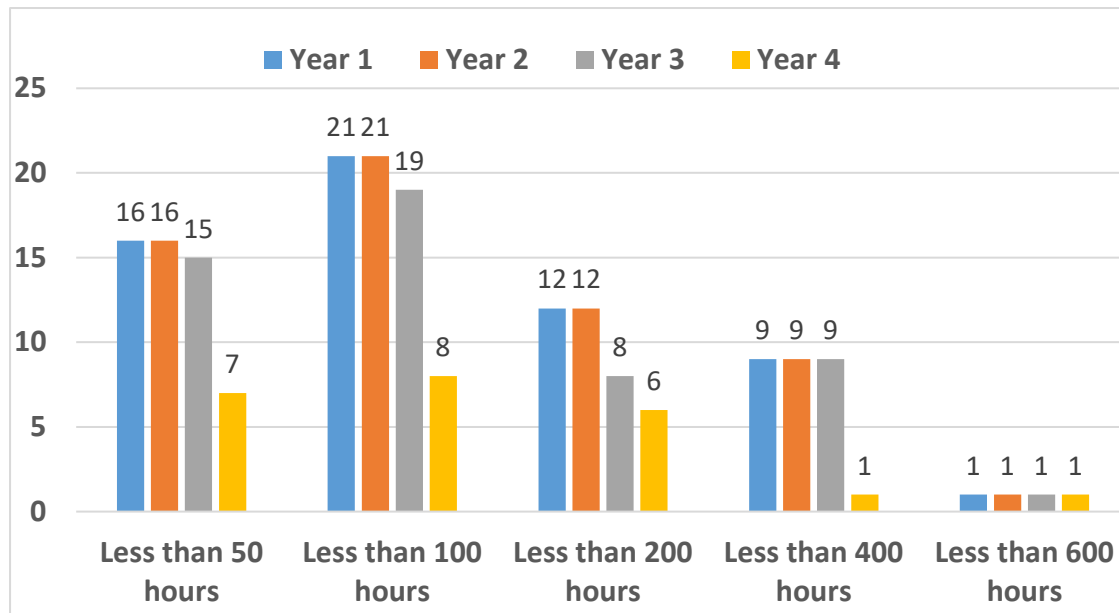


Figure 4: Hours of SBE per year

Qualitative Findings

Responses to the open question: "How has your COVID-19 experience changed your future plans for use of simulation" elicited over 40 comments. Themes arising from this were mostly positive with many examples of reflection and learning gained through rapid uptake of SBE. It was also clear that some respondents had faced barriers and a lack of support for simulation, while others had perceived little impact or uptake of SBE.

Discussion

SBE resources and activities

The findings indicated that a wide range of SBE resources were being utilised across the various courses. The most commonly used resources were generally person-based, including mannequins, role play, use of staff or students as patients and manual handling resources. This aligns well with the findings supporting increased non-technical skills development arising from SBE.^{17,20,24} A surprising finding, therefore, was the low levels of reported usage of service users or expert patients, despite the current drive towards service-user involvement in MRS education.^{15,24,25} Perhaps this represents a perception that SBE should focus on those skills and experiences that are most challenging to experience in clinical placement, yet many papers have reported great value in engaging service users in SBE.^{20,26} Alternatively this may represent the logistical challenges presented by COVID-19 restrictions in terms of accessing these individuals.

Of the “technical” resources, image viewing software was very commonly utilised; this was clearly influenced by the strong prevalence of diagnostic radiography education in the responses. High fidelity virtual reality training^{23,27} was not used by many courses, yet where available it was used to a large extent with almost 50% of respondents using it multiple times per semester. The same finding was true of profession-specific resources such as radiotherapy treatment planning systems and ultrasound equipment.

Not many of the courses reported access to “real” functioning clinical equipment, with the exception of X-ray laboratories which were well-used within SBE (48 out of 65). Again, this is influenced by the dominance of diagnostic radiography in the responses. Some important barriers and restrictions were identified with several respondents highlighting a desire to employ more simulation but acknowledging barriers such as funding, access to resources (including the simulation lab and real people as patients) and recent social distancing restrictions (for face to face techniques). These logistical and financial barriers have also been reported in previous studies^{2,17,20} and clearly there is still a need for additional investment.

Reported levels of SBE usage were relatively consistent, with most of the respondents reporting up to 100 hours; this equates to half a day per week for 30 weeks of campus-based teaching. Only ten programmes reported using over 200 hours; this equates to one day per week. It will be interesting to see if this changes due to more widespread uptake of simulated placements in response to placement pressures and the drive to expand the MRS workforce.

Impact of COVID-19

The timing of this study coincided with widespread social distancing and reduction in clinical placement opportunities. Additional questions were added relating to the impact of COVID-19 and this revealed widespread uptake of virtual simulation as a solution to remote clinical skills training for most respondents. Many comments referred to the pandemic as a trigger for rapid adoption of SBE or an accelerant for wider usage of existing resources. In many cases, creative approaches to the use of SBE while maintaining social distancing had evidently been developed with great success.

“Thinking out of the box has opened a whole new way to present and enhance our program bringing it out of the dark ages and old model of teaching into a new model that will help the new generation of trainees” (P1)

“We are looking into expanding options and making more use of existing simulation where we can” (P2)

Respondents experienced an increased appreciation and awareness of the use of simulation in education and some also felt that teaching in a pandemic had taught them increased adaptation and flexibility. Some have found that their previous misconceptions of the value of online simulation had been challenged. It was also clear that making global connections and sharing ideas (e.g. via social media) had also been a positive benefit of COVID-19.

“Sharing ideas via Twitter and online platforms has been a huge bonus of COVID 19” (P3)

There was a reflective theme within the data with some of the respondents expressing a desire to put the lessons learned during the pandemic to use in the future (for example, more innovative teaching). This finding correlates with reported feedback from a recent conference related to SBE during the pandemic.²⁸ Many respondents additionally wanted to continue with more simulation in the future, including online, virtual and face to face methods. There were also some comments indicating that for some respondents the pandemic had not affected plans. This either reflected the lack of plans to use simulation pre-COVID-19, or that plans were already in place.

“Face to face simulation is not being supported by university for diagnostic radiography, although still supported for some other professions” (P4)

“It has not changed anything because there was (sic) no plans for future use of simulation” (P5)

The limitation themes identified in the qualitative data do reflect the need for social distancing or are related to logistical constraints such as limited laboratory availability, restricted space, the need for staff training and the cost of equipment. These are common themes, supported well by the existing evidence base.^{17,20} It will be interesting to repeat this study in the future to identify how the uptake of SBE changes in response to the evidence base and post-pandemic pedagogical developments.

Limitations

As with any survey-based study, respondent bias is prevalent and with a small sample, generalisability of these findings is challenging. The findings here are likely to over-represent usage of SBE as those with less interest and as infrequent users are less likely to have responded to the invitation to participate. A previous international survey of simulation use²⁷ also reported this issue. Recruitment methods relied on professional body and national networks to distribute and again engagement with this could have influenced the results. Geographically there was poor representation from many regions and future work should attempt to gather data from these to provide a well-rounded picture of international SBE usage. While this study does provide data concerning time spent on SBE, it does not address the pedagogical value of this and again future work could aim to identify this. The impact

of COVID-19 on this data should also be considered; in some cases this and other logistical issues may have restricted the extent and format of SBE that could be delivered.

Conclusions

Based upon this study, the role of SBE within MRS education varies greatly. Whilst the majority use less than 100 hours per year, a proportion use considerably more than this. This comprises a wide range of activities with an emphasis on person-based resources and image viewing technology. Where high fidelity virtual reality and profession-specific simulation resources were available, they were used heavily. There was a low level of reported engagement with service users or expert patients in simulation activities and additional research is needed to identify whether this is due to COVID-19 restrictions or some other reason. In many cases, COVID-19 restrictions have acted as a trigger for increased uptake of SBE resources and sharing of practice via virtual platforms. Future iterations of this study are planned to identify the long-term impact of this.

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