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**Quantification of opportunities for early-stage paramedicine students to practice
clinical skills during clinical placements compared to an equal dose of simulation-based
workshops**

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ABSTRACT

Introduction

A reported advantage of simulation-based learning environments (SLE) over clinical placements (CP) is the former can provide of a greater number and breadth of opportunities to practice level-appropriate clinical skills compared to the random patient presentations provided during the latter. Although logical and widely accepted as fact, we find no published evidence to demonstrate the magnitude, nor indeed veracity, of this assumption. We therefore sought to quantify the clinical skills practiced by entry-level paramedicine students attending a well-selected CP compared to an equal dosage of SLE.

Methods

N=37 first-year paramedicine students completed activity diaries during three days' CP and three days' SLE. Opportunities to practice clinical skills were quantified and coded as either: level-appropriate, beyond-level, or of non-discipline relevance.

Results

During SLE the average student was exposed 226 times to 11 level-appropriate clinical procedures. During CP the average student was exposed 48 times to 24 clinical procedures, most relevant to paramedicine (63%) but a minority level-appropriate (38%). Students' opportunities for supervised, 'hands on' practice represented only 10% of exposures in either SLE or CP but in terms of raw numbers of level-appropriate opportunities, SLE provided more than CP (n=23 v. 2).

Discussion

Our results confirm SLE provides substantially more opportunities than CP for students to practice level-appropriate skills and is therefore more appropriate for repetitive practice. However, CP is likely to remain useful to students for practicing interpersonal skills and contextualisation of knowledge within the broader health system. Educators should therefore carefully articulate learning objectives before choosing between SLE and CP.

Quantification of opportunities for early-stage paramedicine students to practice clinical skills during clinical placements compared to an equal dose of simulation-based workshops

Experiential learning is an essential component of health services education that allows students to practice clinical skills and integrate theory. This is usually achieved through clinical placements (CP) that provide students access to real patients, exposure to real work environments and opportunities for inter-professional learning.[1–3] Some educators believe this should occur as early as possible in students' education and advocate 'vertical integration' of CP across all years of undergraduate training.[4, 5] However, others counter that there is no clearly articulated case for vertical integration, nor empirical evidence in its favour.[6] Others, still, point out that simply sending students on CP does not assure learning or improved clinical competency[7] and CP should be carefully aligned to an environment relevant to students' current stage of learning.[8] Thus, emphasis should be placed upon providing appropriate CP 'at the right time' to allow practice to complement students' current theoretical understanding.[9] This is especially relevant to early-stage students who can be expected to have only limited theoretical knowledge and clinical skills practice. To some extent this can be controlled by sending students to health settings primarily dealing with patient cases of an appropriate level, but the vagaries of random patient presentations mean luck plays some role in whether students receive exposure in alignment with their current level of theoretical and practical capacity.[10, 11] For instance, an audit of CP for second- and third-year paramedicine students in Victoria, Australia suggested many students were not receiving adequate case exposure linked to level-appropriate theoretical concepts and learning objectives, resulting in insufficient opportunities to practice clinical skills.[12] This mirrors common student complaints about CP that they are often relegated to purely

observation roles, unproductive downtime, and are provided only limited opportunities to practice patient care.[13, 14]

This provides some justification for using simulation-based learning environments (SLE) for teaching clinical skills, especially to entry-level students. SLE can be tailored to align with level-appropriate theoretical knowledge and skill and allow exposure to a wide variety of clinical encounters—some rarely encountered during CP.[15, 16] Thus, an obvious attraction of SLE is that students can be more assured of practice in a variety of clinical skills ‘at the right level’ with minimal downtime, without placing undue risk to patients being treated by students with limited experience.

There is ongoing debate about the educational merit of SLE in comparison to CP.[17] Some dislike reliance upon SLE as it limits students’ emotional investment, opportunities to practice interpersonal communication and exposure to other health disciplines and facilities.[18] However, the results of a recent, large-scale, randomised, controlled, longitudinal study of US nursing students seems to suggest SLE and CP are functionally equivalent in terms of long-term educational outcomes.[19]

A further disadvantage of providing students clinical skills training via SLE is that it can be relatively resource intensive compared to CP.[20, 21] Some justify this additional expense by arguing SLE provides more opportunities for students to practice clinical skills of a direct and level-appropriate nature compared to the somewhat random nature of CP encounters.[18, 22] However, being in the form of discussion and position papers, it is difficult to ascertain from the current literature any magnitude of the differences between SLE and CP. Some studies provide empirical data demonstrating the effectiveness of SLE in clinical skills acquisition,

few provide similar data for CP, and none provide a direct comparison between SLE and CP.[17]

Thus, although logical and widely accepted as fact, we find no published evidence to demonstrate the magnitude, nor indeed veracity, of the assumption that SLE provides better-targeted teaching of clinical skills than CP. We therefore sought to quantify the clinical skills practiced by entry-level paramedicine students attending a well-selected CP compared to an equal dosage of SLE training.

METHODS

Participants

First-year students enrolled in the Bachelor of Science (Paramedical Science) course at Edith Cowan University (ECU) in Western Australia were recruited for voluntary participation in the study. Approval for the study was granted by the ECU Human Ethics Committee. Of 55 enrolled students, 43 agreed to participate, representing a 78% consent rate.

Materials

Curriculum

All participants were enrolled in a semester-long clinical skills unit comprising weekly, online, clinical theory modules, three days of external CP and a three-day SLE workshop. These experiential components of the course were to help students learn practical application of four learning objectives: physical assessment, therapeutic communication, medical documentation and dosage calculations, and therapeutic team work.

Clinical placements

Students undertook three days' external CP within primary health care clinics around metropolitan Perth. Ruston and Tavabie suggest primary health care clinics provide a good introduction to clinical practice for early-stage paramedics allowing more time to develop and practice skills in comparison to on-road ambulatory placements that often involve emergency situations,[23] the latter which at ECU are reserved for students in their second and third years. As per the nature of CP, student experiences were dependent upon random patient presentations and staff interactions and could not be standardised. However, the 'typical' student experience involved opportunities to observe and/or assist registered nurses undertaking health assessments, assist with medical documentation, arrange follow-up appointments with patients, and sort medical supplies.

Simulation-based learning environments workshop

A three-day SLE workshop, held on campus during the mid-semester teaching break, provided students the opportunity to practice clinical skills relating to the primary and secondary survey, vital signs survey, sphygmomanometry, pulse oximetry, blood glucose analysis, tympanic measurement, respiratory assessment, pupil reactivity and assessment of the Glasgow Coma Scale. In addition, students practiced basic electrocardiograph interpretation. Students were guided in small groups to take it in turns to practice these skills. Two clinical instructors moved between groups to provide supervision as necessary. The instructors held bachelor degrees in paramedical science with 7 and 12 years' operational experience as field paramedics and 3 and 6 years' experience as tertiary educators.

Measures

Clinical placement diaries

Participants were asked to complete a paper-based activity diary whilst attending their CP. The diaries were split into three days and each day into one-hour blocks. Students were instructed to record in an open-ended manner all activities and clinical skills to which they were exposed each hour throughout the day. For each activity they were asked to specify whether they observed the skill being performed by a supervisor or undertook the procedure themselves either with or without direct supervision.

Simulation Workshop

During the SLE workshop an independent observer quantified student groups' opportunities to practice various clinical skills, and categorised each students' role as observed, supervised, or unsupervised. The standardised group, turn-based nature of the SLE workshop meant all students had minimal variation in opportunities to practice each clinical skill.

Analysis

Paramedicine teaching staff coded all recorded clinical skills into one of three categories: (1) level-appropriate (i.e. relevant paramedicine skills appropriate to the students' current level of learning), (2) beyond-level but still relevant to broader paramedicine (i.e. relevant but likely too advanced for students' current level of learning), and (3) peripheral to paramedicine (i.e. skills unlikely to be taught at any stage of a paramedicine undergraduate degree). Both the quantity and variety of clinical skills practiced by students on CP were analysed using one-sample *t*-tests using the quantity and variety undertaken in the SLE workshop as the basis of comparison. Paired sample *t*-tests were used to compare between

observed, supervised, or unsupervised categories within CP. The Benjamini-Hochberg procedure was used to reduce risk of Type I error when making multiple comparisons.[24]

RESULTS

Five students failed to return completed activity diaries, reducing the final sample to n=37, representing a final sampling rate of 67% of students enrolled in the unit and a completion rate of 86% of those agreeing to participate. The sample was 54% female with an average age of 24.6 years (range 18–43).

Clinical skill encounters during CP and SLE

Whilst on CP, the average student recorded involvement 48 times in 24 different clinical skills, equating to approximately 16 opportunities to practice clinical skills per day or just over 2 per hour. A majority of these (n=30, 63%) were skills relevant to paramedicine but only a little over a third (n=18, 38%) were level-appropriate for the students. In addition, most clinical skill encounters were observed by students (n=38, 78%), rather than undertaken by the students themselves, either under supervision (n=5, 10%) or unsupervised (n=6, 12%).

During the equivalent three days' SLE workshop, the average student practiced 11 different clinical skills a total of 226 times; equating to approximately 75 opportunities to practice clinical skills per day or just over 9 per hour. By default, all were directly relevant to paramedicine and level-appropriate. As with CP, the majority of opportunities (n=155, 69%) were observed by students rather than 'hands-on' either under supervision (n=23, 10%) or unsupervised (n=48, 21%). In total, a statistically greater number of hands-on skills, both supervised and unsupervised, were undertaken in SLE compared to CP both overall (10 vs. 73

respectively, $t(39)=-38.228, p<.001$) and when isolating only level-appropriate skills (7 vs. 73 respectively, $t(39)=-42.918, p<.001$). Statistical comparisons are presented in Table 1.

Table 1: Comparison of level of involvement and quantity of clinical skill encounters undertaken by students during three days' clinical placement (CP) vs. three days' in the simulated learning environment (SLE)

		Quantity			
		CP	SLE	<i>p</i>	
Total	Observed	37 (78%)	155 (69%)	<.001	*
	Unsupervised	6 (12%)	48 (21%)	<.001	*
	Supervised	5 (10%)	23 (10%)	<.001	*
	Total	48 (100%)	226 (100%)	<.001	*

* denotes a statistically significant difference at $\alpha=.05$

CP provided students consistently fewer opportunities to practice clinical skills compared to SLE, although CP provided exposure to a broader range of clinical skills compared to SLE (24 vs. 11 respectively, $t(39)=6.645, p<.001$). In all, 51 different clinical skills were recorded by various students in their CP diaries, overlapping with 9 skills undertaken in SLE (e.g. sphygmomanometry, chest auscultation, blood glucose analysis), 2 level-appropriate skills not undertaken in the SLE workshop (wound dressing, nebulised medication administration), 10 different skills appropriate for paramedic but not level-appropriate (e.g. intra-muscular injections, spinal management, oral medication administration) and 30 clinical skills peripheral to paramedic (e.g. International Normalisation Ratio (INR), self-care management, ear irrigation, hearing test, body mass index, suturing).

Relevance of CP skill encounters

On CP, students were exposed to nearly twice the skills relevant to paramedicine than those deemed peripheral to paramedicine (31 vs. 17, $t(40)=4.493$, $p<.001$) but were exposed to many more clinical skills beyond their current level of learning or of only peripheral relevance to paramedicine, compared to level-appropriate skills (29 vs. 19, $t(40)=-2.979$, $p=.005$). However, these differences could wholly be attributed to observational encounters (see Table 2).

Table 2: Frequency of clinical skills undertaken on CP by relevance to students' current stage of learning and the broader undergraduate paramedicine degree, separated by level of involvement

<i>Frequency</i>		Appropriate?		
		Yes	No	<i>p</i>
Level-appropriate	<i>Observed</i>	13	24	<.001 *^
	<i>Supervised</i>	2	3	.148
	<i>Unsupervised</i>	4	2	.101
	Total	19	29	.005 *^
Broader paramedicine	<i>Observed</i>	24	14	<.001 *^
	<i>Supervised</i>	3	2	.208
	<i>Unsupervised</i>	4	1	.089
	Total	31	17	<.001 *^

* denotes a statistically significant difference at $\alpha=.05$

^ remains statistically significant after undergoing the Benjamini-Hochberg procedure for multiple comparisons

DISCUSSION

Completed diaries were collected from a large majority of students enrolled in the unit and so it is reasonable to assume our data are fairly representative of most students' experiences on CP. These data suggested the average early-stage paramedicine student was kept reasonably

well occupied during CP, being exposed to approximately two clinical skill encounters per hour over their three days and exposed to two dozen different clinical conditions. It is reassuring that the majority of students' clinical skill exposures (65%) were relevant to broader paramedicine, suggesting primary health care clinics are a reasonable choice for a paramedicine student's CP. However, less than half (40%) of these encounters were level-appropriate, suggesting most were not 'at the right level' for the entry-level students, implying they lacked sufficient knowledge to contextualise these clinical experiences with their current theoretical underpinnings. The present study is not the first to discuss the limitations of CP with respect to providing *relevant* clinical skill exposures.[10–12, 25] We wish to stress that these results do not suggest CP is of no educational value; research clearly supports the inclusion of CP in undergraduate health education through its value in providing opportunities to practice patient interaction and learn from role models.[1, 26, 27] Indeed, with specific regard to early-stage students, a systematic review by Littlewood *et al.* suggested there is sufficient evidence to conclude that CP works to contextualise and integrate current theoretical knowledge and to provide a social context and familiarity with the broader healthcare system.[6] Our results certainly support this contention as the students were exposed to a variety of clinical skills beyond the scope of paramedicine, and it remains likely that they would be able to retrospectively contextualise those procedures to which they were exposed beyond their current level of theoretical understanding. Although beyond the scope of our study, it is quite possible, and even likely, that such experiences served to broaden our students' knowledge of the social context of the broader healthcare system in which they will eventually work.

In contrast to their experiences on CP, students were exposed to a narrower range of clinical experiences during SLE, but these were far more numerous and all were level- and discipline-

appropriate. In terms of repetitive practice of clinical skills, SLE clearly provided the students with greater level-appropriate opportunity as well as practice opportunities in general. This result goes some way to justifying the greater expense involved in providing SLE over CP,[20, 21] particularly if the primary goal of early-stage experiential learning is to acquire repetitive practice in clinical skills of a level-appropriate nature.

However, the quality of skill exposures is equally as important as students' repeated opportunities to practice. Thus, it is interesting to note that a similarly small proportion of students' practice in both CP and SLE was under the direct supervision of a clinical supervisor (10% each), with the majority of students' clinical exposure being observatory in nature (78% and 69% respectively). This is consistent with previous research suggesting early-stage students are oftentimes relegated to observatory roles during CP.[10, 12] For example, Hayden *et al.* found nursing students only participated in active nursing roles on average once a day for 15–30 minutes, with the rest of the time being spent as an active observer.[19] We are unaware of any previous literature reporting similar results for SLE. Although perhaps obvious, it highlights the fact that SLE can also involve a great deal of 'down time' as students take turns to practice. In terms of proportions, the main difference between CP and SLE lay in unsupervised practice, which compared to CP, was nearly twice as common in SLE (12 vs. 21%). This unsupervised practice during the SLE workshop was undertaken with other students in the group and involved no patient risk. However, it begs the question of why students on CP were practicing clinical skills unsupervised with real patients at all, especially when on average two of the six times this occurred the tasks were classified as not level-appropriate. A closer examination of those skills revealed that most corresponded to low patient risk, such as oral medication administration, compression stocking removal and self-care management. However, others involved potentially invasive procedures, such as ear

irrigation, and clearly invasive procedures, such as taking blood samples for INR assessment, and even suturing. It is likely (we hope) that in these rare cases students first observed a preceptor undertaking the skill prior to attempting it themselves, and help was never far away if needed. However, it is also a reminder of the importance of constant vigilance by educational institutions to ensure strict supervision protocols for CP are adhered to at all times.

We are fortunate the results of the present study work to defend the rapid inclusion of SLE in undergraduate health curricula. However, the present study was not without limitations; we relied upon students to complete their CP diaries and had no mechanism to independently validate their reports. Therefore, our data may have been prone to recall and social desirability biases. Furthermore, we only sampled a single enrolment of students from one unit using a single type of health institution for their CP. As such, our data may have suffered cohort effects that limit the generalisability of our results. It would be of interest to replicate our study with a variety of cohorts and health disciplines, at different stages of learning, and with different health providers, as well as monitoring what effects—if any—horizontal integration of multiple health disciplines in CP and SLE has on clinical skill opportunities and, perhaps more importantly, contextualisation to the broader health system. However, none of these are fatal flaws and it is difficult to envisage how they could have significantly impacted upon our final conclusions, especially given the magnitude of the differences found between CP and SLE.

Furthermore, our study was not without strengths too, foremost being it is the first to directly compare clinical skills exposure for exactly equal doses of CP and SLE. Thus, it is with some confidence that we conclude our data support the hypothesis that SLE provides more

opportunity than CP to practice clinical skills of a nature directly relevant to paramedicine and of an appropriate level to the students. However, students were exposed to a broader array of clinical skills during CP, albeit most not directly relevant to paramedicine, that potentially provided them with a broader understanding of the health care system. Educators' choice of experiential learning mode for early-stage students should therefore be guided by the learning goal, be it clinical skills practice or exposure to the broader health care system. Should it be exposure to basic clinical skills, providing such exposure first via SLE can be expected to expedite learning of the physical skill through increased opportunities for repeated practice. Sending students on subsequent CP should then work to broaden contextualisation of the skill in real-life settings, with additional (albeit it less) opportunities to practice on real life patients. We urge other health researchers and educators to undertake similar audits at their own and other institutions as further evidence is needed to justify the increased implementation of SLE as an educational modality,[28, 29] particularly if we seek to follow good practice of 'evidence-based education.'

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BM planned the study, was responsible for data collection and analysis, write-up and submitted the study. OC aided in the planning of the study, oversaw data analysis and write-up. CR aided in the planning of the study and oversaw write-up. JM aided in data collection and analysis. NR aided in analysis and write-up. JR aided in data collection and write-up.

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