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Title Page

The Impact of Virtual Simulation on the Recognition and Response to the Rapidly Deteriorating Patient among Undergraduate Nursing Students

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Abstract

A major patient safety challenge is recognition and response to deteriorating patients since early warning signs are often not detected in a timely manner. Nursing students typically learn the skills for early identification through clinical placement, but clinical placements are not guaranteed to provide exposure to deteriorating patients. Nursing students require practice with emergency scenarios to develop their competency and confidence to act in this area. This study aimed to explore the impact of a virtual simulation intervention on the recognition and response to the rapidly deteriorating patient among undergraduate nursing students. A mixed methods study involving a quasi-experimental pre/post design and focus groups. The participants were third or final year undergraduate nursing students from five university sites across four countries (Canada, England, Scotland and Australia, n=88). Students were randomly assigned to a treatment or control group. The treatment group received a virtual simulation intervention and participated in a focus group. The virtual simulation intervention had a significant effect on improving nursing student knowledge and clinical self-efficacy in the recognition and response to the rapidly deteriorating patient. Students reported that the virtual simulations decreased anxiety, helped them prioritize, filled gaps in their learning, and encouraged autonomous learning within a safe 'low risk' environment. Virtual simulation is an effective strategy for improving knowledge and confidence in recognizing and responding to the rapidly deteriorating patient among undergraduate nursing students.

Introduction and Background

A major patient safety challenge is the ability of nurses and other health professionals to recognize and quickly respond to the rapidly deteriorating patient since early warning signs are often not detected in a timely manner (Haddeland et al., 2018). Early identification is critical since patients experiencing cardiopulmonary arrest typically exhibit symptoms one to eight hours prior to arrest (Lee et al., 2019). Implementation of effective initial interventions can prevent adverse events such as cardiac arrest (Sparkes et al., 2016). Failure to recognize early signs and symptoms and initiate timely clinical interventions results in poor patient outcomes and this failure has been attributed to registered nurses' (RN) lack of knowledge and confidence (Lee et al., 2019). However, it has also been suggested that Registered Nurses (RN) do have relevant knowledge, but fail to respond appropriately to patient deterioration because they are not able to recognize and act upon abnormal vital signs (Butler, 2018; Clayton, 2019; Duff et al., 2020; Sterner et al., 2020).

Nurses fulfill a vital role in recognition and response to the deteriorating patient and the ability to develop sound interventions in a high stress work environment. The deterioration of a patient's condition is not always predicted and can occur at any time (Moteri et al., 2019). Ideal responses to the deteriorating patient include: a targeted assessment, initiating help from others in a timely manner, effective communication, and confident technical skill abilities (Kelly et al., 2014). To assist with the management of a deteriorating condition, student nurses need exposure to common patient scenarios to enhance their current knowledge and build skills and confidence for practice.

Preparing undergraduate nursing students to be safe practitioners can be a significant challenge within our current health care systems. The shortage of quality clinical placements is compounded by worsening nursing shortage, nursing faculty shortage, increasingly acute patients, and competition for clinical placements (Smith et al., 2013). Furthermore, nursing students and newly graduated nurses are likely to care for patients with multiple complex co-morbidities, but there is no guarantee that nursing students will have exposure to a deteriorating patient during their clinical placements. Currently, these novice professionals are relying on limited skills and knowledge, while caring for patients with complex illnesses. This situation is exacerbated if the patient's condition deteriorates. Thus, it is imperative that student nurses are provided with the opportunity to develop and refine their assessment skills so they can recognize key early warning signs that a patient's condition is deteriorating, including the common signs that indicate failing respiratory, cardiovascular and/or nervous systems (Merriman et al., 2014).

Enhancing Competency in Recognition of Deterioration

Recent research by Goldsworthy et al. (2019) and Kinsman et al. (2021) demonstrated that the management of deteriorating conditions and reduction in clinical errors can be influenced by simulation education. These studies found that simulation education did not only improve

student performance in managing clinical deterioration; it also provided a safe opportunity for students to apply theory to practice with simulation cases that enabled them to care for a 'patient' in a simulated clinical setting, using and developing multiple skills, including prioritization and communication behaviours (Goldsworthy et al., 2019; Kinsman et al., 2021). Multiple other studies have also examined the ability of undergraduate nursing students to assess, identify, and respond to patients' deteriorating conditions or at risk of deterioration in simulated environments (Haddeland et al., 2018). Their findings also showed significant increases in student nurses' knowledge, skills performance, confidence, and perception of teamwork following simulation experiences in laboratory settings (Cooper et al., 2015; Liaw et al., 2017). This study, by comparison, investigates the impact of virtual simulation, rather than laboratory-based simulated case studies on student nurse knowledge, confidence, and competence in this critical area of patient care.

Virtual Simulation

The use of virtual simulation within pre-registration nurse education has expediated during the COVID-19 pandemic when the traditional experiential learning via clinical supervision in clinical nursing environments became problematic or not possible (Prion et al., 2021). Virtual simulation is defined as the "the use of partial immersion through a digital learning environment (e.g., computer, tablet, phone, screen, etc.) to foster a perceived lived experience for an intended outcome (i.e. learning, entertainment)" (Foronda, 2021 p.8).

In an exploratory study of theoretical and applied learning in response to a virtual simulation program - FIRST2ACT WEB^{TM}, investigators found enhanced knowledge and skills, improved virtual clinical performance, and increased confidence and competence in final year nursing students (Bogossian et al., 2015; Kinsman et al., 2021). The benefits of the face-to-face approach during these simulation events were the ability to work as a team, receive face-to-face briefings, and offer in-depth feedback (Connell et al., 2016). Combining structured education curriculum with simulation training has also been found to improve nursing students' performance in recognizing and responding to clinical deterioration (Hart et al., 2014).

The impact of virtual simulation as a 'COVID-19 proof' teaching and learning strategy may be an important component in acceleration of mastery of competency in responding to clinical deterioration. Virtual simulation is beneficial for students since it is easily accessible and can be completed at the location and time of the student's choice. Virtual simulation is inherently different than face-to-face human simulation learning since the learner 'drives' the scenario versus in the simulation lab, the facilitator 'drives' the simulation. Virtual simulation is often completed asynchronously and the students meet on a virtual platform such as Zoom® to participate in a facilitated synchronous debrief or a guided self-debrief. Foronda et al. (2018), suggests that 77% of students identify that virtual simulation can be effective in enhancing their learning, more particularly as a use to 'make up' for missed clinical hours.

This research explores the impact of using only virtual simulation to enhance recognition and response to the rapidly deteriorating patient among undergraduate nursing students. The current study had initially been planned as a hybrid approach (high fidelity simulation + virtual simulation), but the COVID-19 pandemic led to the team quickly pivoting the research design to

a fully virtual simulation intervention. This research builds on a previous pilot research conducted in 2019 using the original hybrid intervention design which included six face to face high fidelity simulation scenarios and two virtual simulations (Goldsworthy et al., 2019).

Early Intervention is Critical

Even before the pandemic, preparing undergraduate nursing students to be safe practitioners presented a significant challenge as already discussed. Novice professionals are prepared to manage patients with complex illness or injury however, it seems that when transferring this knowledge to practice in situations where a patient is rapidly deteriorating, signs and symptoms are not always detected in a timely manner resulting in poor outcomes for the patient (Stayt et al., 2015). The pilot study by Goldsworthy et al. (2019) found that virtual simulation combined with high fidelity simulation, as a pedagogy, could be used as an effective strategy for addressing this issue. However, social distancing and lock-down measures since the pandemic severely impeded opportunities for nursing students to engage in face-to-face, high fidelity simulation education. This expedited a need for educators to seek alternative measures, such as virtual simulation, for preparing nursing students for this vital aspect of clinical practice and safe patient care. As already stated, nurses fulfil a vital role in recognition and response to the deteriorating illness and their ability to develop sound interventions in a high stress work environment is crucial. Concerningly, previous research has demonstrated that although RNs have knowledge and may document the 'red flag' vital signs assessments and know how to use the Early Warning Scoring systems, they may fail to act to prevent further patient decline (Grant & Crimmons, 2018) and could result in death (Kang et al., 2020; Moteri et al., 2019)

Research Aim and Questions

The aim of the research was to explore the impact of a virtual simulation intervention on the ability of undergraduate nursing students to recognize and respond to a rapidly deteriorating patient. The research builds on an earlier pilot study (Goldsworthy et al., 2019). In the pilot project, the study protocol was tested at a single site among 48 undergraduate students. In the current study, the protocol was revised to include six virtual simulations due to the COVID pandemic. The original pilot research included six high fidelity simulations and two virtual simulations. This study builds on the previous pilot by providing greater insight to this protocol from a multi province and country perspective and a larger sample size of nursing students (88). The research questions for this study were:

1. Did participants in the treatment group have higher levels of self-efficacy in recognizing and responding to clinical deterioration compared with the control group, post virtual simulation intervention?

2. Did participants in the treatment group have increased levels of knowledge in recognizing and responding to clinical deterioration compared with the control group post virtual simulation intervention?

3. What were perceived impacts of the virtual simulation intervention on clinical practice with rapidly deteriorating patients?

Method & Design

This is a mixed methods study consisting of a quasi-experimental pre/post design and focus groups. Pre/post test data will inform research questions 1 and 2 and focus group data research question 3.

Sample/Setting

The target sample was 24 third or final year undergraduate nursing students at each site with a plan to allocate half of the students into the treatment group and half of the students into the control group. The total convenience sample recruited for this study was 88 undergraduate nursing students from five university geographically diverse sites in four countries (Canada, England, Scotland and Australia).

We speculate that the COVID pandemic made it difficult to attain our original target sample size of 120 students since many students were in remote locations attending classes virtually and not attending labs or clinicals on site. In addition, the recruitment process took place virtually versus in person and this may have had an impact on total recruitment numbers. Once recruited, students were randomly assigned to a treatment group or a control group. The setting where the study took place was at the location of the student's choice for the asynchronous completion of the virtual simulations and online through the Zoom® platform for each of the synchronous facilitated debriefing sessions and the 30-minute focus group.

Measures

The measures used in the study included a clinical self-efficacy (CSE) 10-item survey where students rated their confidence from 0 to 100 in specific competencies related to the deteriorating patient (i.e. confidence in recognition of a patient without a pulse and confidence in responding to a patient without a pulse). The CSE has previously reported high internal consistency of 0.91 (Goldsworthy et al., 2019). The second measure used in the study was a 20-item multiple choice knowledge test related to evidence-informed guidelines and best practices related to the care of a rapidly deteriorating patient. The knowledge test was created by subject matter nurse experts and was peer reviewed for accuracy and applicability. Analysis of quantitative data collected using these measures were used to answer research questions 1 and 2. Qualitative data gathered from the focus groups would inform research question 3.

Ethics Considerations

Ethical approvals were received from each of the five universities prior to the study start.

Procedure

Once ethics approval was received from all universities, students were recruited through common class rosters. The treatment group completed six medical surgical nursing case study virtual simulations over three weeks (two per week). Two virtual simulations were debriefed each week for a total of three, one-hour debriefing sessions. Best practices for simulation (INASCL, 2016) were followed including student preparation, pre-briefing prior to the virtual simulations and debriefing each week after the completion of each pair of virtual simulations. Guided self debriefing was provided after the completion of the virtual simulation for students who could not attend the facilitated synchronous debrief session on Zoom®. The students were asked to repeat the virtual simulations as many times as they liked to achieve mastery of the competencies in the scenario.

Virtual Simulation Case Study Intervention

The virtual simulation cases included in the study focused on patients experiencing the following acute deteriorating medical/surgical health challenges: angina/cardiac arrest; anaphylaxis; acute exacerbation of asthma; COPD/pneumothorax, pulmonary embolism; and blood transfusion reaction. These virtual simulations were selected from the VSim® medical surgical suite (Wolters Kluwer Publishers and Laerdal Medical).

Debriefing was conducted by experienced debriefers using an adapted PEARLS method (Bajaj et al., 2018; Eppich et al., 2015) at the conclusion of each week (two virtual simulations debriefed per week). Any students unable to attend the debriefing session were provided with guided self reflection debriefing questions that were extracted from the VSim® program cases.

Psychological safety of students was promoted through several strategies: co-debriefers signed on twenty minutes early and welcomed each student as they arrived and provided a preview of the debriefing process so students knew what to expect. A prebrief of each patient case study to be debriefed was also given to refresh memory of the cases, review learning objectives and encouragement and inclusivity was promoted throughout the process in line with best practice guidelines (INASCL, 2016). The specific co-debriefing method will be presented in another paper related to this research study.

Each simulation was co-debriefed by three or four facilitators including the lead investigator who debriefed at all sites. The international co-debriefing team was prepared through multiple planning meetings, the use of a co-debriefing checklist (Eppich et al., 2015) and a debriefing workshop provided to the research sites by the lead investigator. The debriefer preparation process assisted in standardizing the debriefing at all research sites and providing consistency. In addition, the debriefers with less experience in debriefing co-debriefed with a team and this served as a mentorship strategy to further develop debriefing skills. A debriefing of the debriefers was conducted among all debriefers at the conclusion of each debriefing session with the aim of determining, what went well, what to improve upon and refinements to be made for the next debriefing session.

Students in both the control and treatment groups completed a pre-test and a post-test that included 20 knowledge questions and 10 self-efficacy items. In addition, the treatment group attended a 30-minute focus group after the final debrief session.

Results Relevant to Research Questions 1 and 2:

Quantitative Data: Quasi Experiment Pre/Post Design Data Analysis Strategy

Statistical analysis was performed using SPSS version 26, and p values < 0.05 were considered statistically significant.

Sample

There were 88 students from 5 universities who consented to be part of this study; of these 88, 34 (39%) were randomized to the control group and 54 (61%) to the simulation treatment group.

To evaluate the effect of the intervention on clinical self-efficacy (CSE) and knowledge test scores, we performed analysis of covariance, using the respective baseline measurements as covariates. We found that after adjusting for the baseline levels, there were still significant differences between the control and simulation groups in knowledge test scores, for both CSE and knowledge scores, with $p=0.008$ and $p=0.001$, respectively (see Table 1).

We also explored if there was any linear association between CSE and the knowledge scores and found none both at baseline and post-study. We found no correlation between CSE and knowledge at baseline ($r=0.004$, $p=0.970$), which improved slightly post-intervention ($r=0.140$, $p=0.280$) but it still remained statistically nonsignificant.

Research Question # 1

Did participants in the treatment group have higher levels of self-efficacy in recognizing and responding to clinical deterioration compared with the control group, post virtual simulation intervention?

There was observed improvement in the mean CSE scores. The mean CSE score in simulation group before intervention was 65.34 and this increased to 80.12 post study. On the other hand, the mean CSE score in the control group was 62.59 and 70.73 before and after intervention respectively. The measure of internal consistency, Cronbach's alpha, for CSE at baseline was 0.90. Table 2 presents the scores of each scale item from the CSE scale, before and after simulation intervention, for each group. The top five scores were observed for (i) recognizing a patient that is not breathing, (ii) recognizing a patient with no pulse, (iii) recognizing a patient with dangerously low blood pressure, (iv) performing high quality CPR in the adult patient and (v) responding to a patient that is not breathing. All these items were scored 84 points and higher. Therefore, participants in the treatment group had statistically significant higher levels of clinical self-efficacy from pre to post survey scores compared to the control group.

Research Question # 2

Did participants in the treatment group have increased levels of knowledge in recognizing and responding to clinical deterioration compared with the control group post virtual simulation intervention?

There was also marked improvement in the mean knowledge scores post-intervention. The mean knowledge score in simulation group before intervention was 11.30 and this increased to 13.17 post study. On the other hand, the mean knowledge score in the control group was 10.33 and 9.92 before and after intervention respectively. Table 3 presents the knowledge test question items and the percentage of correct answer before and after intervention, for each group. Therefore, the participants in the treatment group had significantly increased levels of knowledge in recognizing and responding to the deteriorating patient scores from pre to post survey in comparison to the control group.

Results Relevant to Research Question 3:

Research Question 3

What were perceived impacts of the virtual simulation intervention on clinical practice with rapidly deteriorating patients?

Focus Group Method

Students in the treatment group (n=54) were invited to share their virtual simulation experiences in a focus group after all the six virtual simulation case studies had been completed. The discussion was audio-recorded and transcribed verbatim. Manual thematic analysis following Braun & Clarkes (2013) steps in a reflexive qualitative process was completed. The purpose of the focus groups was to enable the student perspective of the experience of using virtual simulation to recognize and respond to a deteriorating patient to be gathered, as it was thought this may allow for more in-depth understanding of its impact on their learning.

The questions asked in the focus group were as follows:

1. What were the benefits of this experience?
2. What would you like to see improved about this simulation experience?
3. How do you think virtual simulation might impact your clinical performance?
4. Did this experience make you feel more confident to care for patients that are rapidly deteriorating?
5. Would you like to see more simulation, less simulation, or the same amount in your undergraduate program?
6. Additional comments.

Focus Group Data Analysis

Following data familiarization, the initial coding of each question was undertaken as advised by Braun & Clarke (2013). Afterwards, thematic identification was completed for each focus group question, and then a thematic review was done for the overall focus group question set to ensure that the key themes had been identified. Next, a review was carried out with the focus group leaders to ensure that the codes and themes identified were representative of what they heard.

Findings of Focus Groups:

The main codes (key themes) extracted from the focus groups related to

- student confidence (decreased stress, increased critical thinking, flexibility of learning, and self-awareness regarding areas to improve),
- increased confidence when in clinical, contextual, and cultural cohesion, realism in practices (including the use of ancillary objects such as x-rays, appropriate sounds and having procedures as realistic as possible such as having a second nurse check for high-risk medication), and
- repetition for familiarity in more complex scenarios and broader skill development.

Nursing students at all universities in the study reported positive learning outcomes from the virtual simulation, and felt it added to their learning, especially during unusual or different times such as a pandemic. The intensity of the scenarios was appreciated by students who felt they learned not only what they did know, but also what they needed to know. The repetitive nature decreased stress about experiencing these types of deteriorating patient clinical events for real as did the opportunity to work through the case studies independently without risk to their patients or fear of judgement when they made mistakes. Students also identified that simulation is a mastery skill, which can take many tries and is not necessarily a type of assessment that should be graded.

Verbatim extracts from some of the students' comments are included in Table 4. Repetition and practice were seen by the students as an effective means by which to "increase confidence in caring for a deteriorating patient" when they experienced these situations this in future practice. Students also felt there "was more learning in a scenario and it was as realistic as possible".

Some students also identified areas that they would like included in the virtual simulation. For example, common practices such as "having a second nurse button to check those high-risk medications as required in real practice", or "maybe a have further question…like, would you like pain relief?". They also suggested scaffolding of the virtual simulation scenarios within the undergraduate curriculum because this would give them the opportunity to increase their critical thinking and decision-making skills. Overall, students affirmed that virtual simulation of this type and intensity do belong in an undergraduate curriculum and are helpful in building confidence for clinical practice and exams. All students confirmed that they would like to see more simulation in their undergraduate programmes when asked. They did not feel, however, virtual simulation could be used solely for developing mastery in this aspect of clinical practice as perhaps the following comments illustrate "I would like to see this alongside face to face

sessions so we can explore in more detail" and "I feel we don't get the opportunity to explore a large number of scenarios due to lack of time in skills sessions. More simulation would definitely benefit learning further."

Discussion

The findings in this study demonstrate that a virtual simulation intervention that included six rapidly deteriorating patient medical/surgical cases significantly improved knowledge and confidence among undergraduate nursing students in the recognition and response to deteriorating patients. The results of this study conform with previous research and demonstrate the potential of virtual simulation to enable students to recognize key early warning signs to indicate that a patient's condition is rapidly deteriorating and raising their awareness of the common signs that indicate failing respiratory, cardiovascular and/or nervous systems. The findings are also aligned with research literature on the topic of using virtual simulation to improve student knowledge and confidence (Borg Sapiano et al., 2018; Goldsworthy et al, 2019; Stayt et al, 2015). The current study adds new knowledge to the simulation literature by demonstrating the impact of a solely virtual simulation intervention on knowledge and confidence of undergraduate nursing students from geographically diverse areas. Furthermore, the results of this study demonstrate a novel approach to nursing education during a pandemic that may also be used as a teaching and learning strategy post pandemic.

It was clear from the treatment group participants results in this study that the virtual simulations addressed 'gaps' in their learning, increased their confidence, and ability to prioritize, while the experience decreased anxiety and allowed them to work toward achieving mastery through repetition of the scenario in a low risk, safe learning environment. With a global pandemic and the change in the educational environment in which students learn from what is traditional (i.e.: clinical practice and observation on a floor for these types of cases), to what is achievable (using virtual simulation only), it is heartening to know students have been able to engage in meaningful learning.

Conclusions

Virtual simulation is an effective strategy for improving knowledge and confidence in recognizing and responding to the rapidly deteriorating patient among undergraduate nursing students. Since clinical placements can be unpredictable at best in providing students with exposure to situations where patients are rapidly deteriorating, virtual simulation offers a novel approach to preparing students to manage emergency situations in a timely manner. More research is needed in this area to explore the sequencing and titration of the dose of virtual simulation to prepare students and enhance learning for competency in clinical practice.

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Table 1. *Outcome Measures at Baseline and Post-Study and Results of Analysis of Covariance*

Outcome	Group	Statistic	Baseline	Post-study	F-test	df	p-value
Clinical Self-efficacy	Control	n	34	28	7.558	1	**0.008**
		Mean	62.59	70.73			
		SD	18.234	13.76			
	Simulation	n	54	38			
		Mean	65.34	80.12			
		SD	14.547	12.019			
Knowledge Score	Control	n	33	26	11.500	1	**0.001**
		Mean	10.33	9.92			
		SD	2.116	3.285			
	Simulation	n	53	42			
		Mean	11.30	13.17			
		SD	2.554	3.363			

Note: significance = $p<0.05$

Table 2. *Clinical Self-Efficacy Scores at Baseline and Post-Study*

Clinical Self-Efficacy		Baseline		Post-study	
		Control	**Simulation**	**Control**	**Simulation**
CSE1 - Recognizing a patient with no pulse	N	34	54	28	39
	Mean	78.03	82.94	81.29	**89.44**
	SD	19.999	17.995	19.354	13.492
CSE2 - Responding to a patient with no pulse	N	34	54	28	38
	Mean	66.79	72.50	70.32	**84.37**
	SD	27.003	19.060	20.688	14.716
CSE3 - Recognizing a patient that is not breathing	N	34	54	28	38
	Mean	83.18	83.06	83.93	**91.71**
	SD	18.339	18.385	19.463	12.121
CSE4 - Responding to a patient that is not breathing	N	34	54	28	38
	Mean	71.29	70.17	74.29	**84.39**
	SD	23.717	20.443	18.063	16.582
CSE5 - Recognizing a patient with dangerously low blood pressure	N	34	54	28	38
	Mean	75.29	78.94	85.43	**86.45**
	SD	20.486	17.845	16.399	14.663
CSE6 - Responding to a patient with dangerously low blood pressure	N	34	54	28	38
	Mean	67.26	63.78	74.82	80.21
	SD	21.987	19.652	17.990	16.293
CSE7 - Performing high quality CPR in an adult patient	N	34	54	28	38
	Mean	64.41	69.39	78.00	**84.89**
	SD	25.280	20.884	17.864	17.875
CSE8 - Inserting an oropharyngeal airway and using a manual resuscitation bag on adult patient	N	34	54	28	38
	Mean	31.12	40.80	40.25	58.82
	SD	26.018	28.416	26.802	27.957
CSE9 - Recognition of a major hemorrhage	N	34	54	28	38
	Mean	49.59	51.13	65.82	72.95
	SD	25.597	23.127	23.989	19.423
CSE10 - Responding to a major hemorrhage	N	34	54	28	38
	Mean	38.91	40.67	53.14	67.47
	SD	24.912	22.968	24.767	19.436

Note: bolded numbers= top 5 skills most confident with.

Table 3. *Knowledge questions before and after intervention*

Knowledge Questions	Baseline		Post-study	
	Control (n=33)	**Simulation (n=53)**	**Control (n=26)**	**Simulation (n=42)**
Which represents initial signs and symptoms of a patient in respiratory distress?	6%	25%	0%	55%
What is the priority action by the nurse when a patient experiences sudden respiratory distress?	88%	92%	92%	**90%**
The patient experiencing an anaphylactic reaction may experience which of the following signs and symptoms?	12%	21%	4%	52%
When a patient develops respiratory distress, what is the appropriate first action for the nurse to take?	76%	85%	73%	**95%**
When the nurse discovers a patient visibly not breathing, the nurse knows which of the following is an immediate priority?	27%	58%	19%	62%
The nurse recalls for adult CPR the correct compression to ventilation ratio is what?	97%	91%	88%	**95%**
During CPR how often should the nurse assess for return of spontaneous circulation?	67%	77%	73%	86%
When a patient is experiencing angina, the nurse administers nitroglycerine sublingual at which frequency	61%	70%	73%	83%
Interpret the following Arterial Blood Gas pH 7.30, PC02 55mmHg, HC03 22 P02 62?	48%	53%	62%	76%
11. In a patient experiencing blood loss during surgery, which direction would the nurse anticipate the hemoglobin levels changing to postoperatively?	94%	87%	81%	88%
When a suspected blood transfusion reaction occurs, what would be the nurse's immediate first intervention?	94%	92%	92%	**93%**
During the first 15 minutes after initiating a blood transfusion, the nurse maintains the transfusion at what rate?	27%	30%	31%	43%
he nurse knows that a patient with a pneumothorax would exhibit which of the following signs and symptoms?	73%	74%	42%	86%
A patient who has a chest tube insitu suddenly becomes short of breath with tracheal deviation. What does the nurse suspect has occurred?	61%	66%	58%	88%
Which of the following in initial assessments are potential signs and symptoms of a pneumothorax?	91%	91%	88%	**98%**
The patient has had a hemicolectomy. The nurse would expect to find which type of bowel sounds 4 hours postoperatively?	24%	36%	35%	52%
Is the following statement true of false? The most frequent symptom of a developing pulmonary embolism is tachypnea and dyspnea?	85%	81%	81%	74%

Table 4. *Student Experience with Virtual Simulation: Sample Comments*

Focus Group Question	**Sample Student Comments**
Benefits of virtual simulation?	Sometimes you may not be able to practice some of these skills in clinical placements. …gain the experience in a safe environment learned prioritization of care The more times you did the scenario you understood how to react and this moved your confidence up. It identified knowledge gaps. It built confidence. It allowed for autonomous decision-making. It was more productive than group sims at Uni due to reduced anxiety (no-one is watching). low risk learning Sim in general is good but Vsim can be done in your own time without judgement from others Being able to repeat the cases Being able to identify gaps in my knowledge and being able to improve on these "I feel so much more confident now" helped me to prioritize and consolidate my knowledge
Areas of improvement for virtual simulation?	I don't feel there was anything to improve, but if there were even more different scenarios I could learn more If there was a quick tutorial on where the buttons were located before starting the scenarios that would be helpful a multidisciplinary team within the scenario would be helpful A package that allows you to manage more than one patient at a time**.** better is to be able to hear the heart and lung sounds when you auscultate during the scenario more cultural diversity in the scenarios
How will this virtual simulation experience	I will be able to use what I learned and will look more closely for blood transfusion reactions in future. Just learning the process of doing things, knowing what you have to do and in what order will be

transform your clinical practice?	helpful It will increase my confidence in recognizing deterioration and questioning what could be happening Made me study blood gases and some of the medications It has added depth and confidence to my knowledge but also identified gaps to improve Definitely gave the opportunity to experience scenarios that I have not seen before in practice, I can use this information and experience in real situations Helps me to be more confident going in to clinical You feel you have the knowledge now instead of second guessing yourself, now you know it is correct.
Other comments?	Group debrief improves clarity and depth of learning improves when discussed with debriefers. The shared debriefing with other students helped to understand others perspectives feel more prepared for the exams