Virtual Clinical Simulation Adoption and Use by Licensed Practical Nurse/Licensed Vocational Nurse Education Programs During the COVID-19 Pandemic

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Background: In the early stages of the COVID-19 pandemic, as clinical site restrictions were implemented, education programs leading to licensed practical nurse/licensed vocational nurse (LPN/LVN) degrees increasingly relied on virtual simulation-based experiences to provide clinical training to their students. However, scant evidence exists regarding the extent of this change and the various modalities employed by LPN/LVN programs across the United States. **Purpose:** We sought to identify the degree to which virtual clinical simulation was adopted by LPN/LVN education programs during the early stages of the COVID-19 pandemic to address clinical site restrictions. In addition, we hoped to identify the practices and activities that educators included under the broad umbrella definition of virtual clinical simulation. **Methods:** All active U.S. prelicensure LPN/LVN nursing education programs were contacted in September 2020. Program leaders were asked to estimate the proportion of clinical hours completed in virtual clinical simulation before the pandemic and the proportion anticipated for the fall 2020 term. Descriptive statistics were generated, with repeated measures analysis of covariance applied to evaluate the average change in virtual simulation within programs stratified by reported clinical restrictions. **Results:** Representatives from 265 LPN/LVN programs in 44 U.S. jurisdictions responded to the survey. Responding programs significantly increased the proportion of clinical hours completed in virtual clinical simulation between fall 2019 ($M = 10.7$, $SD = 15.3$) and fall 2020 ($M = 35.3$, $SD = 27.6$, $p < .001$). Furthermore, there was an interaction between clinical site restrictions and term, with a more pronounced uptick in virtual simulation usage among programs that indicated they found identifying clinical sites "very difficult" ($M = 41.1$, $SD = 28.9$) relative to those who found it "somewhat more difficult" ($M = 23.9$, $SD = 18.8$, $p < .001$). Programs adopted a range of modalities, including simply watching videos and participating in virtual or augmented reality, online software packages, or other forms of screen-based learning. **Conclusion:** As the adoption of virtual simulation increases, clear definitions of what constitutes clinical virtual simulation must be established. Additionally, rigorous inquiry to support evidence-based regulatory guidelines is needed.

Before the COVID-19 pandemic, virtual clinical simulation constituted a small but growing proportion of prelicensure nursing students' simulation-based clinical experiences. The term *virtual clinical simulation* encompasses a number of modalities, including virtual or augmented reality, online/computer-based narratives with branching logic, and screen-based learning (Kardong-Edgren et al., 2019; Foronda, 2021). The range of modalities and general categories employed by scholars to date do not readily lend themselves to systematic examination and straightforward comparisons of students' learning outcomes vis-à-vis high-fidelity simulation-based experiences or traditional in-person clinical placements. Nonetheless, the COVID-19 pandemic served as an accelerant of sorts, causing many clinical facilities to close their doors to nursing students and thereby increasing education programs'

virtual clinical simulation use. As the pandemic now recedes and enters a post-crisis phase, it is of the utmost importance to examine the degree to which licensed practical nursing/licensed vocational nursing (LPN/LVN) education programs adopted virtual simulation into their curricula and how it was deployed to support their students. By understanding how LPN/LVN programs increasingly utilized virtual simulation out of necessity during a public health crisis, scholars can begin to identify and better understand how virtual simulation has been and is currently employed. Informed by these practices, research can establish more reliable criteria that facilitate rigorous examination and comparison of students' learning outcomes to support evidence-based regulation.

Background

Simulation-based education (SBE) is broadly defined as an experiential-based education or training method during which students practice and acquire specific skills in real-life situations and enhance their transition to practice (Morse et al., 2019). It allows students to hone their skills in terms of both frequent and rare events in spaces that resemble or simulate clinical practice environments (Lavoie & Clarke, 2017). It may involve the use of high-fidelity manikins, low-fidelity manikins, standardized patients, or virtual environments (Bryant et al., 2020). The adoption of SBE has steadily increased (Smiley, 2019) since Hayden et al.'s (2014) landmark study that compared student learning outcomes conducted within in-person simulated and traditional clinical environments among prelicensure registered nursing students and since the subsequent release of NCSBN's simulation guidelines for prelicensure nursing programs (Alexander et al., 2015). The study and guidelines together suggest that high-fidelity simulated clinical experiences may be substituted for up to half of traditional clinical hours while maintaining end-of-program education outcomes and students' readiness to practice.

In parallel to the growth of SBE, virtual clinical simulation has experienced a less pronounced but similar trajectory. As early as 2018, virtual clinical simulation (VCS) was described as a "small but growing part of [prelicensure undergraduate] simulation experiences" (Aebersold, 2018). During the early stages of the COVID-19 pandemic, as many traditional clinical sites shuttered their doors to nursing students, the adoption of various SBE modalities, including VCS, accelerated rapidly (Luctkar-Flude & Tyerman, 2021; Leaver et al., 2022). Out of necessity, nursing educators and administrators were tasked with transitioning, as best as possible, to SBE while working with state regulatory boards to ensure that their programs continued to remain in compliance (Morin, 2020; Kaminski-Ozturk & Martin, 2023). In particular, nursing education programs increasingly relied on virtual modalities when traditional in-person clinical experiences were unavailable (Jeffries et al., 2022).

However, the rapid adoption of VCS in nursing education has not been without growing pains. The term *virtual simulation* is often employed to describe a variety of interchangeable learning modalities, including three-dimensional learning environments (Hansen, 2008), virtual or augmented reality (Kardong-Edgren et al., 2019), game-based learning, and screen-based learning (Foronda, 2021). In *Onward and Upward: Introducing the Healthcare Simulation Standards of Best Practice*, the International Nursing Association of Clinical and Simulation Learning (INACSL) Standards Committee and Board of Directors acknowledged that although there had been a "massive" shift toward VCS during the pandemic, at the moment, VCS will fall under the banner of simulation (Watts et al., 2021). However, the committee added, "advancing technology may have a profound effect and change this decision for future iterations of the Standards" (Watts et al., 2021, p. 2).

Scholars have consistently lamented the unstandardized approach to VCS (Jeffries et al., 2022) and have called for a clearer understanding of what constitutes VCS (Kardong-Edgren et al., 2019; Luctkar-Flude & Tyerman, 2021). Recent efforts have sought to more clearly delineate virtual simulation through a digital learning environment and virtual reality simulation, which allows for a 360-degree immersion (Foronda, 2021). Regardless, concerns have emerged that some nursing programs exceeded the recommended limits put forth by NCSBN (Alexander et al., 2015) on general high-fidelity SBE usage, substituted unproven VCS modalities for traditional clinical hours, and strayed from the few foundational elements of VCS (Dolan et al., 2021).

Compounding these issues further, most of the literature to date has primarily focused on prelicensure registered nursing education programs, with few studies examining the role of VCS in LPN/LVN programs (Williams et al., 2020; Kalisch et al., 2015). As nursing homes and long-term care facilities were among the hardest hit by COVID-19 ("Nearly one-third of U.S. coronavirus deaths are linked to nursing homes," 2021), many LPN/LVN programs were unable to send their students directly into these facilities. Now, as the pandemic recedes and enters a new post-crisis phase, VCS, which requires fewer resources (e.g., space, faculty, time) compared with more established in-person clinical placements and high-fidelity SBE, appears to be, at least to some degree, an established component of the nursing educational landscape (Brown et al., 2021). Furthermore, as VCS holds a distinct cost advantage (Haerling, 2018), broader adoption seems inevitable.

Preliminary research has found that VCS yields results comparable to those of manikin-based simulation in terms of students' perceptions of learning (Padilha et al., 2019; Foronda et al., 2020; Fogg et al., 2020; Badowski et al., 2021). However, to date, there has been no study to our knowledge paralleling Hayden et al.'s 2014 landmark study examining the efficacy of VCS thresholds and clear parameters on reliable modalities relative to other vetted approaches (i.e., in-person experiences and high-fidelity SBE). Hence, a constellation of factors, ranging from the rapid uptake of virtual simulation during the pandemic to its low-cost implementation, poorly understood definitions, and general uncertainty regarding its efficacy, necessitate a closer examination of the current state of VCS use to inform future work on this topic. Therefore, the current study is guided by two primary research questions:

1. To what degree was VCS adopted by LPN/LVN education programs during the early stages of the COVID-19 pandemic to address clinical site restrictions?
2. What practices and activities do educators include under the broad umbrella definition of VCS, and are there common modalities around which nursing education programs have begun to coalesce?

Methods
Study Design

To better understand the degree to which VCS was adopted during the early stages of the pandemic, the extent of clinical site restric-

tions, and how program administrators currently use VCS, program deans and directors representing all active prelicensure LPN/LVN programs were contacted to participate in this survey-based study in September 2020. The objective of this outreach was to determine the pre-pandemic ratio between traditional and simulated clinical experiences and the anticipated shift from traditional clinical experiences to VCS environments during the fall 2020 term. Additionally, respondents who indicated their program utilized high-fidelity SBE were asked about activities or formats faculty used or planned to use during the fall 2020 term. For any changes reported, participants were asked to identify any additional funding or training they received to implement or support the transition. Prior to any outreach, the study was reviewed and granted exempt status by the Western Institutional Review Board.

Study Sample

Drawing on an NCSBN contact list used to elicit nurse candidate projections, a total of 1,133 deans and directors, each representing all active LPN/LVN prelicensure programs in the United States, were contacted via e-mail (Appendix A.1) and prompted to complete a survey comparing past and anticipated VCS usage via Qualtrics (Provo, UT). The survey was initially deployed in late September 2020, with reminders sent out each week for 2 weeks to respondents who had yet to complete the survey. A total of 265 respondents representing 44 nursing jurisdictions (Figure 1) provided a complete response (i.e., answering at least one item), resulting in a 23.5% response rate.

Survey Instrument

The survey instrument (Appendix A.2) consisted of 12 items, which were divided into three domains: (a) clinical landscape, (b) SBE, including VCS, and (c) lecture-based didactic courses, along with several broader items regarding resources received to implement changes to the curriculum. Within the clinical landscape domain, respondents were specifically queried on the program's difficulty in obtaining clinical site placements during the fall 2020 term compared to the fall 2019 term. This item ranged from very difficult (coded as -2) to very easy (coded as 2), with "about the same as fall 2019" serving as a neutral response (0). For respondents who indicated that it was either somewhat more difficult or very difficult, a follow-up question eliciting responses on the various strategies used to address clinical site restrictions was employed. Next, respondents were asked to report the proportion of clinical hours completed in simulation prior to the COVID-19 pandemic (fall 2019 term) along with the anticipated proportion of clinical hours to be completed in simulation during the early stages of the COVID-19 pandemic (fall 2020 term). Most germane to this study, respondents were asked if they planned to offer virtual simulation instruction during the fall 2020 term. Given the unstandardized nature of virtual simulation coupled with the current lack of evidence-based guidelines, respondents were purposefully given a range of options (e.g., computer-based simulation, virtual reality, augmented reality, etc.) regarding delivery format. Those respondents who answered affirmatively

FIGURE 1

Survey Response Distribution

Response N ☐ No data ☐ 1–7 ☐ 8–15 ☐ 16–23 ■ 24+
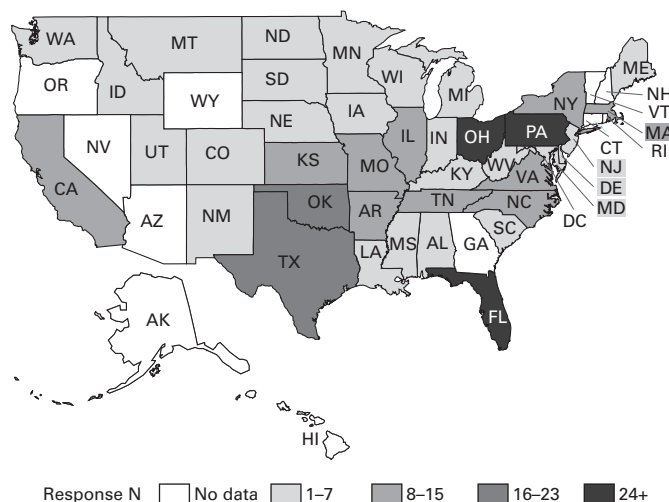
were then asked to report the percentage of clinical hours offered via virtual simulation and the formats they planned to utilize (e.g., watching videos, online software packages, augmented reality, etc.).

As supplemental information, the third domain focused on lecture-based courses. Respondents were asked to indicate the percentage of lecture-based courses occurring online before the COVID-19 pandemic (fall 2019 term) and the planned use of online lecture-based courses during the COVID-19 pandemic (fall 2020 term).

For any changes to the curriculum (whether didactic, SBE, or VCS), respondents were queried as to whether they received assistance to implement these changes (e.g., financial, additional training, or extra-resource allocation). Resource allocation was then coded as a binary figure, with 1 representing resources received and 0 indicating no resources received to make changes during the fall 2020 term.

Statistical Analysis

Summary descriptive statistics were generated for collected demographic information. Frequencies and proportions were generated for relevant categorical values. Continuous variables were assessed for normality using the Kolmogorov-Smirnov test and for sphericity using Mauchly's test. Repeated measures and two-way analysis of covariance were used to examine the influence of clinical site restrictions and resource allocation on the adoption of VCS between fall 2019 (pre-pandemic) and fall 2020 (during the early stages of the pandemic). Model results included Bonferroni-adjusted pairwise comparisons and select interaction terms determined a priori. Analyses were conducted using Python programming language (Python Software Foundation, Willmington, DE). Visualizations were generated in Tableau (Tableau, Seattle, WA), and $p \leq .05$ was established as a benchmark for statistical significance. Item nonresponses were examined for a pattern of bias and found to be missing completely at random.

TABLE 1

Survey on LPN/LVN Use of Virtual Clinical Simulation: Descriptive Information

Survey Items	% (*n*) or Mdn (IQR)
1. Degrees offered[a]	
Diploma	7.1% (19)
LPN/LVN	93.2% (248)
Other	19.9% (53)
2. LPN/LVN Enrollment	
Fall 2019 enrollment	39 (24, 66)
Estimated fall 2020 enrollment	36 (23, 60)
4. Compared to the fall 2019 term, how difficult has it been to obtain clinical sites for students during the fall 2020 term?	
Very difficult	63.9% (145)
Somewhat more difficult	31.3% (71)
About the same as fall 2019	3.1% (7)
Somewhat easier	0.4% (1)
Very easy	1.3% (3)
4a. How do you plan to address this shortage of clinical sites?[a] (*n* = 216)	
Delay graduation	11.1% (24)
Take fewer students	20.4% (44)
Appeal to the state board of nursing	13.4% (29)
Complete more clinical in simulation	84.7% (183)
Adjust term length	15.7% (34)
Other	39.8% (86)
6. With regard to your clinical courses, do you plan to offer high fidelity virtual simulation instruction (e.g., computer-based simulation, virtual reality, virtual simulation, virtual reality simulation, augmented reality, etc...) during the fall 2020 term?	
Yes	83.9% (188)
No	16.1% (36)

Note. IQR = interquartile range; LPN/LVN = licensed practical nurse/licensed vocational nurse.
[a] "Select all that apply" survey item.

TABLE 2

Survey on LPN/LVN Use of Virtual Clinical Simulation: Learning Modality Shifts

Survey Item	M (SD)	df	MS	F	p
5. What is the percentage of clinical hours completed/anticipated in simulation?					
Fall 2019	18.8 (20.4)	224	935.7	2.0	<.001
Fall 2020	38.9 (27.9)	1	45261.2	97.8	<.001
6a. What is the percentage of clinical hours completed/anticipated in virtual simulation?					
Fall 2019	10.7 (15.3)	185	870.9	2.0	<.001
Fall 2020	35.3 (27.6)	1	56001	131.3	<.001
7. What is the percentage of didactic courses completed/anticipated online?					
Fall 2019	11.8 (20.8)	219	1649.3	1.7	<.001
Fall 2020	50.9 (37.5)	1	167369.5	176.6	<.001

Note. LPN/LVN = licensed practical nurse/licensed vocational nurse.

Results

Descriptive Summary

As depicted in Table 1, nearly all respondents (93.2%, *n* = 248) indicated that their programs offer an LPN/LVN program, and a small minority offered either diplomas (7.1%, *n* = 19) and/or other degrees (19.9%, *n* = 53), which included mostly associate degrees in nursing. Overall, respondents reported that typical enrollment fell slightly between fall 2019 (*Mdn*: 39, interquartile range: 24, 66) and fall 2020 (*Mdn*: 36, interquartile range: 23, 60).

The vast majority of programs (95.2%, *n* = 216) indicated they found obtaining clinical sites in the fall of 2020 either very difficult or somewhat more difficult compared to their experience in the fall of 2019. Most respondents (84.7%, *n* = 183) also indicated they planned to complete more of their clinical instruction in simulated environments. A majority of programs (83.9%, *n* = 188) noted they planned to offer virtual SBE during the fall 2020 term.

Learning Modality Shifts

Respondents broadly indicated there was a significant shift toward more remote learning modalities during the fall of 2020 for both didactic and clinical instruction (Table 2). Overall, there was a statistically significant shift in the average percentage of didactic or lecture-style courses completed online when comparing terms ($F_{(219, 218)} = 1.7$, $p < .001$, $n^2 = 0.64$). Bonferroni-adjusted pairwise comparisons confirmed that the percentage of didactic courses completed online was higher in fall 2020 ($M = 50.9$, $SD = 37.5$) relative to fall 2019 ($M = 11.8$, $SD = 20.8$, $p < .001$). A similar shift was identified for programs completing their clinical hours in simulation ($F_{(224, 223)} = 2.0$, $p < .001$, $n^2 = 0.67$). As before, a review of all pairwise comparisons illustrated that the percentage of clinical hours completed in simulation was higher in fall 2020 ($M = 38.9$, $SD = 27.9$) than in fall 2019 ($M = 18.8$, $SD = 20.4$, $p < .001$). This same trend was observed for clinical hours completed in virtual simulation ($F_{(185, 184)} = 2.0$, $p < .001$, $n^2 = 0.67$). The average proportion of clinical hours completed in virtual simulation was significantly higher in fall 2020 ($M = 35.3$, $SD = 27.6$) relative to fall 2019 ($M = 10.7$, $SD = 15.3$, $p < .001$).

Clinical Scarcity and Virtual Simulation Adoption

Participants indicated they utilized a variety of methods under the umbrella of VCS (Table 3). Most participants (98.6%, *n* = 161) reported they used online software packages, such as web-based branching narratives in which students are evaluated on the decisions they make. More than half of respondents (58.0%, *n* = 109)

utilized videos, including online videos, to support VCS, and a smaller proportion (33.0%, n = 62) indicated that faculty conducted simulations with instructions from students who view the screen remotely. Despite the uptick in VCS usage, fewer than half of respondents (40.6%, n = 108) indicated their programs received additional resources, including more funding (32.3%, n = 86), to enact such changes to the curriculum.

Notably, while the interaction between clinical site restrictions (item 4) and term (ie, fall 2019 vs. fall 2020) was found to be significant ($F(4, 179)$ = 4.64, $p < .001$), whether a program received assistance, financial or otherwise, was not (p = .66) (Table 4). Bonferroni-adjusted pairwise comparisons revealed that the mean percentage of VCS adoption was significantly different in fall 2020 between respondents who indicated they found confirming clinicals site placements very difficult (M = 41.1, SD = 28.9) relative to those who found it somewhat more difficult (M = 23.9, SD = 18.8), $p < .001$.

Discussion

Despite a lack of standardization (Jeffries et al., 2022) and ambiguity regarding what constitutes VCS (Kardong-Edgren et al., 2019; Luctkar-Flude & Tyerman, 2021), there was a pronounced and significant shift toward SBE and, in particular, VCS during the early stages of the COVID-19 pandemic among LPN/LVN prelicensure nursing programs. Deans and directors of these programs indicated that more of their lecture-style courses were completed online and that more clinical hours were completed in simulation and virtual simulation environments. In addition, as was the case with registered nursing prelicensure programs (Kaminski-Ozturk & Martin, 2023), this shift to simulation and virtual simulation occurred against the backdrop of pandemic-driven emergency orders issued by each jurisdiction's board of nursing. The current analysis confirms the pandemic acted as an accelerant of sorts with clinical site restrictions driving a significant uptick in more remote learning modalities (Luctkar-Flude & Tyerman, 2021; Leaver et al., 2022).

Early in the pandemic, many clinical facilities closed their doors to nursing students (Dewart et al., 2020). Furthermore, research on employer hiring trends (Martin & Kaminski-Ozturk, 2023) also found that most healthcare facilities did not allow prelicensure nursing students onsite, often despite acute staffing shortages. In addition, nursing homes and long-term care facilities were among the hardest hit by COVID-19 ("Nearly one-third of coronavirus deaths are linked to nursing homes," 2021), complicating an already difficult landscape for LPN/LVN programs seeking to secure clinical site placements. Therefore, and not surprisingly, for the clinical portion of students' training, the shift toward VCS was most pronounced among programs that experienced the greatest difficulty in securing in-person clinical placements. While preliminary research on students' perception of learning suggests somewhat comparable efficacy relative to manikin-based simulation (Padilha et al., 2019; Foronda et al., 2020; Fogg et al., 2020; Badowski et al.,

TABLE 3

Survey on LPN/LVN Use of Virtual Clinical Simulation: Simulation Modalities and Resources

Items	% (n)
6b. Which format(s) for virtual clinical simulations have your faculty utilized?[a] (n = 188)	
Watching videos	58.0% (109)
Perform simulations with instructions from students who view the screen remotely	33.0% (62)
Augmented reality with technology like Google Glass	7.4% (14)
Augmented reality with a computer screen	6.4% (12)
Online software packages	98.6% (161)
Other	25.0% (47)
None	2.7% (5)
8. Have you received additional funding or resources to enact these changes during the fall 2020 term?[a]	
Yes, we received additional funding	32.3% (86)
Yes, we received additional resources	40.6% (108)
No, we have not received any additional funding or resources	27.8% (74)
No, we have not enacted any pandemic-related changes for the fall 2020 term	4.5% (12)
Other	8.3% (22)

Note. LPN/LVN = licensed practical nurse/licensed vocational nurse.
[a] "Select all that apply" survey item.

TABLE 4

Repeated Measures Analysis of Covariance Type III Maximum Likelihood Fixed Results

Predictor	df Numerator	df Denominator	F	p
Clinical Site Restrictions	4	178	3.6	<.001
Year	1	179	1.9	.2
Help	1	178	0.2	.7
Clinical Site Restrictions and Year	4	179	4.6	<.001

2021), more evidence to support effective VCS thresholds and clear parameters on reliable modalities is necessary.

Given the relatively low cost and comparatively minimal faculty and space requirements of VCS, it inevitably will present an attractive alternative to in-person clinical experiences for nursing education programs beyond the pandemic. Currently, questions as to what even constitutes VCS (e.g., computer-based simulation, virtual reality, augmented reality, etc.) persist (Kardong-Edgren et al., 2019; Foronda, 2021) due to the lack of standardization. Indeed, LPN/LVN nursing education program administrators indicated

they used a variety of methods under the umbrella term *virtual simulation*. These include videos, virtual or augmented reality, online software packages, etc. To date, none of these approaches have been evaluated in the same rigorous manner as high-fidelity SBE (Hayden et al., 2014). Taken together with related studies on the topic (Kaminski-Ozturk & Martin, 2023; Martin et al., 2023), it is clear that there are inconsistent definitions and implementations of VCS, as well as limited clarity as to whether these models are within best practices, resulting in inconsistent learning outcomes. To ensure students achieve consistent learning outcomes, it is imperative to more closely examine how, when, and to what extent VCS is used in prelicensure nursing education (Kardong-Edgren et al., 2019) to support the establishment of evidence-based regulation.

Limitations

All data were self-reported by respondents in September 2020. Given the complex, dynamic, and rapidly evolving nature of the pandemic during these early stages, it is possible that the actual proportion of virtual simulation adoption could differ, to some degree, from what was reported. Additionally, as documented in other research (Kaminski-Ozturk & Martin, 2023), emergency orders issued by BONs or state governing bodies may be an influential factor in programs' decisions to increase the percentage of clinical hours completed in virtual simulation. State-based COVID-19 restrictions, especially those issued during the early stages of the pandemic, varied considerably by region both in terms of their reach and timing. This variability and the resulting durability of the observed trends reported in this analysis were difficult to capture in the modeling. Finally, all of the trends documented in this study are correlational and do not support causal inference.

Conclusion

Out of necessity, LPN/LVN nursing education programs significantly increased their reliance on virtual simulation during the early stages of the COVID-19 pandemic. Given its relatively low cost and promising but preliminary evidence on students' self-reported perceptions of learning, VCS will inevitably present an attractive alternative to traditional in-person clinical placements and even more resource-intensive high-fidelity SBE beyond the pandemic for nursing education programs. However, the lack of standardization and ambiguity regarding what constitutes VCS underscore the need for high-quality research that rigorously examines and compares students' learning outcomes and clinical preparedness to support evidence-based regulatory guidelines to ensure continued excellence in patient-safety standards.

References

Aebersold, M. (2018). Simulation-based learning: No longer a novelty in undergraduate education. *OJIN: The Online Journal of Issues in Nursing*, *23*(2). https://doi.org/10.3912/OJIN.Vol23No02PPT39

Alexander, M., Durham, C. F., Hooper, J. I., Jeffries, P. R., Goldman, N., Kardong-Edgren, S., Kesten, K. S., Spector, N., Tagliareni, E., Radtke, B., & Tillman, C. (2015). NCSBN simulation guidelines for prelicensure nursing programs. *Journal of Nursing Regulation*, *6*(3), 39–42. https://doi.org/10.1016/S2155-8256(15)30783-3

Badowski, D., Rossler, K. L., & Reiland, N. (2021). Exploring student perceptions of virtual simulation versus traditional clinical and manikin-based simulation. *Journal of Professional Nursing*, *37*(4), 683–689. https://doi.org/10.1016/j.profnurs.2021.05.005

Brown, K. M., Swoboda, S. M., Gilbert, G. E., Horvath, C., & Sullivan, N. (2021). Integrating virtual simulation into nursing education: A roadmap. *Clinical Simulation in Nursing, 72*, 21-29. https://doi.org/10.1016/j.ecns.2021.08.002

Bryant, K., Aebersold, M. L., Jeffries, P. R., & Kardong-Edgren, S. (2020). Innovations in simulation: Nursing leaders' exchange of best practices. *Clinical Simulation in Nursing*, *41*, 33–40. https://doi.org/10.1016/j.ecns.2019.09.002

Dewart, G., Corcoran, L., Thirsk, L., & Petrovic, K. (2020). Nursing education in a pandemic: Academic challenges in response to COVID-19. *Nurse Education Today, 92*, Article 104471. https://doi.org/10.1016/j.nedt.2020.104471

Dolan, H., Amidon, B. J., & Gephart, S. M. (2021). Evidentiary and theoretical foundations for virtual simulation in nursing education. *Journal of Professional Nursing*, *37*(5), 810–815. https://doi.org/10.1016/j.profnurs.2021.06.001

Fogg, N., Kubin, L., Wilson, C. E., & Trinka, M. (2020). Using virtual simulation to develop clinical judgment in undergraduate nursing students. *Clinical Simulation in Nursing*, *48*, 55–58. https://doi.org/10.1016/j.ecns.2020.08.010

Foronda, C. L. (2021). What is virtual simulation? [Letter]. *Clinical Simulation in Nursing*, *52*, 8. https://doi.org/10.1016/j.ecns.2020.12.004

Foronda, C. L., Fernandez-Burgos, M., Nadeau, C., Kelley, C. N., & Henry, M. N. (2020). Virtual simulation in nursing education: A systematic review spanning 1996 to 2018. *Simulation in Healthcare*, *15*(1), 46–54. https://doi.org/10.1097/SIH.0000000000000411

Haerling, K. A. (2018). Cost-utility analysis of virtual and mannequin-based simulation. *Simulation in Healthcare*, *13*(1), 33–40. https://doi.org/10.1097/sih.0000000000000280

Hansen, M. (2008). Versatile, immersive, creative and dynamic virtual 3-D healthcare learning environments: A review of the literature. *Journal of Medical Internet Research*, *10*(3), e26. https://doi.org/10.2196/jmir.1051

Hayden, J. K., Smiley, R. A., Alexander, M., Kardong-Edgren, S., & Jeffries, P. R. (2014). The NCSBN National Simulation Study: A longitudinal, randomized, controlled study replacing clinical hours with simulation in prelicensure nursing education. *Journal of Nursing Regulation, 5*(2), S3–S40. https://doi.org/10.1016/S2155-8256(15)30062-4

Jeffries, P. R., Bushardt, R. L., DuBose-Morris, R., Hood, C., Kardong-Edgren, S., Pintz, C., Posey, L., & Sikka, N. (2022). The role of technology in health professions education during the COVID-19 pandemic. *Academic Medicine*, *97*(3S), S104–S109. https://doi.org/10.1097/ACM.0000000000004523

Kalisch, B. J., Aebersold, M., McLaughlin, M., Tschannen, D., & Lane, S. (2015). An intervention to improve nursing teamwork using virtual simulation. *Western Journal of Nursing Research*, *37*(2), 164–179. https://doi.org/10.1177/0193945914531458

Kaminski-Ozturk, N., & Martin, B. (2023). Prelicensure nursing clinical simulation and regulation during the COVID-19 pandemic (in press). *Journal of Nursing Regulation*.

Kardong-Edgren, S., Farra, S. L., Alinier, G., & Young, H. M. (2019). A call to unify definitions of virtual reality. *Clinical Simulation in Nursing*, *31*, 28–34. https://doi.org/10.1016/j.ecns.2019.02.006

Lavoie, P., & Clarke, S. P. (2017). Simulation in nursing education. *Nursing*, *47*(7), 18–20. https://doi.org/10.1097/01.NURSE.0000520520.99696.9a

Leaver, C. A., Stanley, J. M., & Veenema, T. G. (2022). Impact of the COVID-19 pandemic on the future of nursing education. *Academic Medicine*, *97*(3S), S82–S89. https://doi.org/10.1097/acm.0000000000004528

Luctkar-Flude, M., & Tyerman, J. (2021). The rise of virtual simulation: Pandemic response or enduring pedagogy? *Clinical Simulation in Nursing*, 57. https://doi.org/10.1016/j.ecns.2021.06.008

Martin, B., & Kaminski-Ozturk, N. (2023). A preliminary examination of healthcare facilities' nurse staffing strategies to address COVID-19 surges. *Journal of Nursing Regulation, 14*(1), 64–72.

Martin, B., Kaminski-Ozturk, N., Smiley, R., Spector, N., Silvestre, J., Bowles, W., Alexander, M. (2023). Assessing the impact of the COVID-19 pandemic on nursing education: A national study of prelicensure RN programs. *Journal of Nursing Regulation, 14*(1S), S1-S68.

Morin, K. H. (2020). Nursing education after COVID-19: Same or different? *Journal of Clinical Nursing*, *29*(17–18), 3117–3119. https://doi.org/10.1111/jocn.15322

Morse, C. J., Fey, M., Kardong-Edgren, S., Mullen, A., Barlow, M., Barwick, S. (2019). The changing landscape of simulation-based education. *American Journal of Nursing, 119*(8), 42–48. https://doi.org/10.1097/01.naj.0000577436.23986.81

Nearly one-third of U.S. coronavirus deaths are linked to nursing homes. (2021, June 1). *New York Times.* https://www.nytimes.com/interactive/2020/us/coronavirus-nursing-homes.html

Padilha, J. M., Machado, P. P., Ribeiro, A., Ramos, J., & Costa, P. (2019). Clinical virtual simulation in nursing education: A randomized controlled trial. *Journal of Medical Internet Research*, *21*(3), Article e11529. https://doi.org/10.2196/11529

Smiley, R. A. (2019). Survey of simulation use in prelicensure nursing programs: Changes and advancements, 2010–2017. *Journal of Nursing Regulation*, *9*(4), 48–61. https://doi.org/10.1016/S2155-8256(19)30016-X

Watts, P. I., Rossler, K., Bowler, F., Miller, C., Charnetski, M., Decker, S., Molloy, M.A., Persico, L., McMahon, E., McDermott, D., & Hallmark, B; INACSL Standards Committee. (2021). Onward and upward: Introducing the Healthcare Simulation Standards of Best PracticeTM. *Clinical Simulation in Nursing, 58*, 1–4. https://doi.org/10.1016/j.ecns.2021.08.006

Williams, D., Stephen, L. A., & Causton, P. (2020). Teaching interprofessional competencies using virtual simulation: A descriptive exploratory research study. *Nurse Education Today*, *93*, Article 104535. https://doi.org/10.1016/j.nedt.2020.104535

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APPENDIX

A1. Survey Invitation

Subject Line:
Assessing the impact of the COVID-19 pandemic on nursing education
Body:
Dear Colleagues:

We hope you are well as you prepare for fall. The National Council of State Boards of Nursing (NCBSN) would like to hear from you about how the pandemic has impacted if at all, your licensed practical nurse (LPN) or vocational nursing (VN) program's plans for the upcoming academic term. Specifically, we ask that you take a few minutes to complete the following survey to help us learn more about the impact of COVID-19 on your planned didactic and clinical instructional formats.

Follow this link to the Survey:
[LINK]

The survey will remain open for two (2) weeks and close on September 8th. Thank you in advance for your participation. We appreciate your tireless effort to provide the highest quality nursing education.

Sincerely,
Brendan Martin, PhD | Associate Director, Research | bmartin@ncsbn.org
National Council of State Boards of Nursing (NCSBN) | 111 E. Wacker Drive, Ste. 2900, Chicago, IL 60601-4277
www.ncsbn.org

A2. Survey Instrument

Dear Colleagues:

The following survey will take 5–10 minutes to complete. All results will be reported in the aggregate and no identifying information will be disseminated or reported in any way. We very much appreciate your participation in the survey.

Sincerely,
Brendan Martin, PhD | Associate Director, Research | bmartin@ncsbn.org
National Council of State Boards of Nursing (NCSBN) | 111 E. Wacker Drive, Ste. 2900, Chicago, IL
www.ncsbn.org

1. **Please indicate below which prelicensure nursing programs your school offers:**
   ○ Diploma
   ○ Licensed Practical Nurse/Vocational Nurse (LPN/VN)
   ○ Other (please specify) _____

2. **Please provide your LPN/VN enrollment information:**
   ○ Fall 2019 enrollment: _____
   ○ Estimated fall 2020 enrollment: _____

3. **Please provide your state, city, county, and zip code below:**
   State (e.g. NV, IL) _____
   City _____
   County _____
   Zip code _____

4. **Compared to the fall 2019 term, how difficult has it been to obtain clinical sites for students during the fall 2020 term?**
   ○ Very difficult
   ○ Somewhat more difficult
   ○ About the same as fall 2019
   ○ Somewhat easier
   ○ Very easy

4a. **[If 4. = Very Difficult/Somewhat more difficult, item displayed] How do you plan to address this shortage of clinical sites?**
   (please select all that apply)
   ○ Delay graduation
   ○ Take fewer students
   ○ Appeal to the state board of nursing
   ○ Complete more clinicals in simulation
   ○ Adjust term length, to allow for more clinical experiences over time.
   ○ Other (please describe) _____
   _____
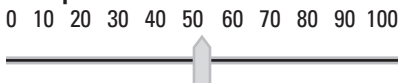   _____
   _____

Clinical Course Curriculum

The following items focus on the percentage of clinical hours offered through simulation.

5. **With regard to your clinical courses, what percentage of clinical hours were completed in simulation during the fall 2019 term and what percentage of clinical hours in simulation are anticipated during the fall 2020 term.**

   During the fall 2019 term, the percentage of clinical hours in simulation was:

   0 10 20 30 40 50 60 70 80 90 100

   During the fall 2020 term, the percentage of clinical hours in simulation are anticipated as:

   0 10 20 30 40 50 60 70 80 90 100

6. **With regard to your clinical courses, do you plan to offer high fidelity virtual simulation instruction (e.g. computer-based simulation, virtual reality, virtual simulation, virtual reality simulation, augmented reality, etc...) during the fall 2020 term?**
   ○ Yes
   ○ No

6a. **[If 6. = Yes] With regard to your clinical courses, what percentage of clinical hours were completed in virtual simulation during the fall 2019 term and what percentage of clinical hours in virtual simulation are anticipated during the fall 2020 term.**

   During the fall 2019 term, the percentage of clinical hours in virtual simulation was:

   0 10 20 30 40 50 60 70 80 90 100

   During the fall 2020 term, the percentage of clinical hours in virtual simulation are anticipated as:

   0 10 20 30 40 50 60 70 80 90 100

6b. **[If 6. = Yes] With regard to completing clinicals in virtual simulation, which (if any) of the following formats have your faculty utilized?**
   (please select all that apply)
   ○ Watching videos
   ○ Perform simulations with instructions from students who view them from a screen in another location
   ○ Augmented reality, with technology like Google Glasses
   ○ Augmented reality, with multidimensional computer screens
   ○ Online software packages, such as web-based branching narratives, where students make decisions
   ○ Other (please explain) _____
   _____
   _____
   _____

   ○ None of these
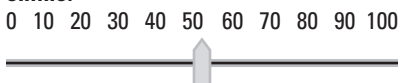
Didactic course curriculum

The next questions are related to the percentage of online instruction associated with your didactic course curriculum.

7. **With regard to your didactic (lecture-style) courses, what percentage of the didactic curriculum was completed online prior during the fall 2019 term, and what percentage is anticipated to be completed online during the fall 2020 term.**

   During the fall 2019 term, the percentage of lecture hours completed online was:

   0 10 20 30 40 50 60 70 80 90 100

   During the fall 2020 term, the anticipated percentage of lecture hours completed online:

   0 10 20 30 40 50 60 70 80 90 100

8. **Have you received additional funding or resources to enact curricular changes during the fall 2020 term?**
   (please select all that apply)
   ○ Yes, we received additional funding.
   ○ Yes, we received additional resources (e.g., formal training, new and/or updated software or equipment)
   ○ No we have not received any additional funding or resources.
   ○ No we have not enacted any pandemic-related changes for the fall 2020 term.
   ○ Other (please specify) _____
   _____
   _____
   _____

9. **Do you have any comments or concerns you would like to add?**
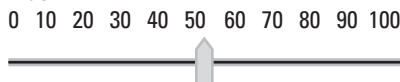   _____
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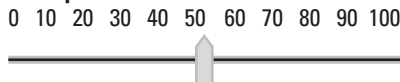   _____
   _____

Survey Completion

Thank you for your interest in the study. Your feedback is critical to understanding the impact of the COVID-19 pandemic on nursing education. Thank you for your tireless efforts on behalf of nursing students and the public.