Virtual Delivery of Medical Education: A Physician Assistant Program Literature Review

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ABSTRACT

Introduction: In the past few years of the Corona virus (COVID-19) we have seen a significant shift in the delivery of education that incorporates more online components. A virtual model of teaching has been adopted in many institutions worldwide. In the context of training physician assistants (PAs), the question remains if virtual medical teaching is effective enough to be continued as an educational strategy. **Purpose:** The purpose of this study was to analyze the evidence regarding the application and efficacy of virtual teaching (VT), with the aim of program improvement for PA students. This was done by reviewing emerging literature for evidence to determine if a virtual approach to PA education is effective. **Methods:** A comprehensive literature review of peer reviewed articles within North America from the year 2000-2023 was conducted. Electronic databases such as PubMed and the Journal of Physician Assistant Education (JPAE) were searched using key terms *"physician assistant"* AND *"virtual"* AND *"education"*. Inclusionary and exclusionary criteria were determined and applied to a total of 108 articles, which were screened by title and abstract. Full-text screening was completed on an eligible 27 articles. Data extraction was done on the final 12 articles, which were utilized in this literature review. **Results:** The outcomes of the 12 studies reviewed were organized utilizing the Kirkpatrick model of program evaluation. This model was used to compare advantages, disadvantages, student responses, effects of learning, behavioural changes, and organizational benefits. Overall, most pilot virtual programming was well-received and reviewed in the above comparative categories. **Conclusion:** Virtual education increases access to programs and can be an effective and cost-efficient method to teach PA students. Virtual education should be considered in current program curricula and further studied to determine long-term outcomes.

INTRODUCTION

Over the past several years, technological advances have continued to change the lives of students. Communication technology and infrastructure have developed to the point where interactive educational content can be delivered effectively in real-time across broad geographical terrain (1).

Throughout the Corona virus (COVID-19) pandemic, we have seen a substantial shift in the delivery of education. Many programs had to make abrupt transitions to an online curriculum (2). This included clinical year students participating in virtual rotations that had been developed in almost every specialty in the United States (3). Although there is documented advantages and disadvantages to this change in curriculum, pedagogical experts recommend a more hybrid approach to virtual learning that is comprised of a combination of synchronous and asynchronous activities (2).

A virtual model of teaching has been adopted in many institutions worldwide, this being defined as an approach to online instruction which does not require an in-person physical environment (4). It can be delivered through an internet-based learning management system in real-time with an instructor teaching students in a virtual conference room. It can also be arranged to be self-paced, which involves an instructor and student interaction. Virtual teaching (VT) has been shown to improve learner autonomy, foster the development of life-long learning skills, and allow learners to adapt to their own pace and learning style (4). In the context of training physician assistants (PAs), the question remains if virtual medical teaching is effective enough to continue to be implemented as an educational strategy.

Research Problem

The research problem was to investigate by reviewing the emerging literature for evidence to determine if a virtual approach to physician assistant education is effective.

Purpose

The purpose of this study was to analyze the evidence regarding the application and effectiveness of VT, with the aim of program improvement for PA students.

Objectives

The specific objectives of this study were to:

1) Describe the strength and weaknesses of virtual medical teaching for PA students.
2) Determine if PA students were satisfied with virtual teaching.
3) Evaluate if virtual teaching contributed to improvement in PA students' knowledge, skills, clinical reasoning, professionalism, and interprofessional roles.
4) Identify the gaps in knowledge and limitations of virtual teaching of PA students.
5) Make recommendations for changes to virtual teaching that can improve program delivery for PA students.

METHODS

A literature review of peer-reviewed articles on virtual education of PA students was conducted from August 2022 to November 2022. This review was not a "systematic review", nevertheless, it was conducted according to modifications of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocols (5). Electronic databases including PubMed, and supplemented by the Journal of Physician Assistant Education (JPAE), were searched using the key terms *"physician assistant"* AND *"virtual"* AND *"education"*, including additional search terms as shown below:

"PA student virtual teaching, virtual PA medical education, and virtual medical education of PA students".

The articles selected for further review were chosen based on specific inclusion guidelines (Figure 1). Importantly, the study had to be published in a peer-reviewed scientific journal, the article had to present original data assessing virtual teaching for PA students and had to speak to the objectives addressed related to the application and effectiveness of VT. Additionally, articles were to report on studies published from 2000 to 2023. This review considered any eligible study design, incorporating commentaries, case reports, case studies, cohort studies, and randomized control trials. The studies must have met the virtual education definition, which was inclusive of online discussion forums, case simulation software, patient simulators, videoconferencing, online modules, virtual patient cases, virtual rotations, virtual objective structured clinical examinations (vOSCEs), virtual reality, or a combination of virtual course components to compliment traditional in-person delivery. Exclusion criteria featured articles that were unrelated to PA education, lacked relevance to the purpose of the study, lacked generalizability, lacked documented results or outcomes of the intervention, and/or lacked a comparison of virtual and in-person programming. The search algorithm yielded 84 articles from the PubMed database and 34 articles from the JPAE. After successful removal of duplicated articles, 108 articles were processed on analysis of their title and abstract. A total of 27 articles were found to be eligible for full-text screening. Following the full-text screening, 12 articles were included for data extraction.

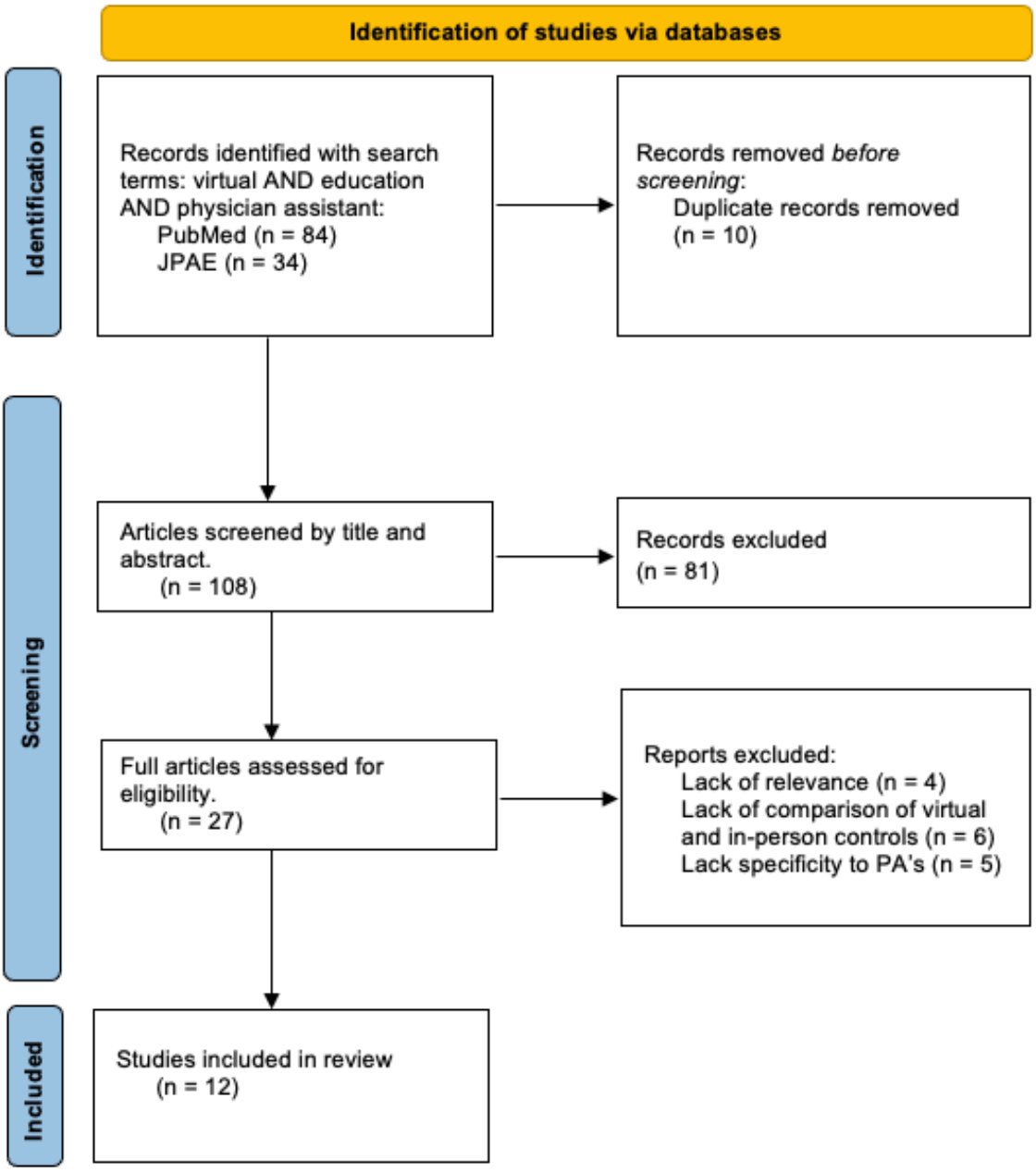

Figure 1: PRISMA diagram outlining search criteria and results (5).

RESULTS

Strength and Weaknesses of Virtual Teaching of Physician Assistant Students

The findings from the articles were summarized as follows:

Table 1: Summary of virtual teaching offered, strengths of virtual teaching, and weaknesses of virtual teaching.

Article	Type of Virtual Teaching offered	Strengths of Virtual Teaching	Weaknesses of Virtual Teaching
Anderson, D. L. (2021).	This article presents the utility, feasibility, and applicability of hybrid learning in PA education. For the purposes of this article, hybrid learning refers to delivering didactic educational content through a combination of online teaching and face-to-face, hands-on immersion experiences.	Key evidence-based rationales for considering hybrid PA education include the ready availability of teaching platforms to deliver educational content online, learner preference for engaging in virtual learning environments, opportunities to increase PA student enrolment and the instructor/faculty pool, interprofessional education experiences, and the ability for learners/faculty to remain in the rural and underserved communities in which they live and work. Research demonstrates that online discussion forums increase levels of student participation as compared to participation in traditional classroom-based lectures.	Concerns over inattentiveness, distractibility, and poor student participation in traditional educational settings. Primary barriers to total online programming include difficulties in evaluating student performance of proper physical exam technique and clinical skills, as well as difficulties in providing clinical oversight. O'Doherty et al., noted that some students may perceive a loss of value in student-teacher encounters when they occur online as opposed to in-person (6). Potential downside to moving medical education online, is that the autonomy afforded to students planning their own schedule might only benefit those who are especially self-sufficient, which could potentially hinder other students with-out such ability.
DelNero, T., & Vyas, D. (2021).	In 2019, an interprofessional education (IPE) activity was offered in person with 213 pharmacy and 45 physician assistant (PA) students participating in one-on-one team huddles focusing on managing an acutely ill patient. In 2020, the same IPE activity, including 194 pharmacy and 45 PA students, was offered virtually. Peer evaluations, an attitudes survey, and confidence surveys were administered to evaluate the impact of the IPE activity.	As to be expected, the virtual IPE activity required fewer human and space resources, which is encouraging for programs that do not have adequate resources for IPE delivery. Overall attitudes regarding the impact of the IPE activity on their learning were also more positive in the virtual group versus the in-person group.	On the item, "what is your confidence level in using the Situation, Background, Assessment, Recommendation (SBAR) method to communicate with a provider" the average on the 2019 in-person group was 3.94/5 versus 3.79/5, $p<0.01$. Despite higher peer evaluations, pharmacy students reported lower confidence in the 2020 (virtual) group versus the in-person group.

Donkers, K., DeLong, D., & Brown, N. (2019).	Pilot study assessing impact of virtual patients (VPs) and online modules on first-year physician assistant students' confidence in documentation performance. Five VP cases (head, eyes, ears, nose, and throat; musculoskeletal; abdominal; neurological; and comprehensive history and physical examination) and one module (cardiac sounds) were implemented to complement the core PA curriculum.	Benefits of online techniques include logistical flexibility, opportunity for practice, and self-directed learning. Perceived benefits of VPs also included enhanced scheduling flexibility, a low-stress learning environment, realistic case progression, and immediate feedback.	Instructors should consider including role play or live patient interactions to address verbal communication training goals. Further exploration of the ability of VPs to accurately assess student empathy is necessary.
Dyer, E., Swartzlander, B. J., & Gugliucci, M. R. (2018).	The project adopted technology that teaches medical and other health professions students to be empathetic with older adults, through virtual reality (VR) software that allows them to simulate being a patient with age-related diseases, and to familiarize medical students with information resources related to the health of older adults.	Research indicates that empathy leads to better patient care and outcomes and that educational interventions work, so it is worthwhile to address this subject area in the curriculum. VR immersion training is an effective teaching method to help develop empathy and is a budding area for library partnerships.	A valid assessment tool needs to show that the intervention successfully improved student learning and empathy. Implementation became a time-management challenge for library staff who juggled multiple programs and time frames. The stations require secure space in the libraries to protect the equipment when not in use but that is accessible to students when needed.
Francis, E. R., Bernard, S., Nowak, M. L., Daniel, S., & Bernard, J. A. (2020).	To assess the impact on self-efficacy for pre-clinical physician assistant students through immersive VR operating room simulation.	The introduction of VR simulation improved pre-clinical PA student self-efficacy in the operating room setting. Benefits from using VR as an educational tool in healthcare are well documented with significant improvements seen in operating room performance.	
Goldsmith, C.-A. W., Miller, K. E., Lee, L., Moreau, T., White, S., & Lee Massey, S. (2009).	This pilot study examined differences in academic achievement between two cohorts of physician assistant students; one cohort received the majority (>80%) of class content via synchronous distance education (SDE), while the other received the majority (>80%) of class content onsite via traditional delivery (TD).	Despite the one cohort having most of its didactic lessons taught via SDE, this group was able to achieve grades and scores statistically equivalent to those of their TD classmates.	The mean scores were lower for the SDE cohort in 7/9 classes measured. There were no statistically significant differences overall, but lower mean scores in the SDE cohort in all six courses.
Kanofsky, S., & Tzakas, P. (2022).	This article presents the design and perceived impact of an end-of-program virtual objective structured clinical examination (vOSCE) within the PA Consortium Program at the University of Toronto in Canada.	With physical space no longer a consideration, they were able to increase the total number of testing stations with the vOSCE, which provided more opportunity for students to demonstrate their skill and for faculty to evaluate student performance.	They did learn from the survey analysis that faculty rater comfort for failing a student on the performance assessment differed between an OSCE and a vOSCE, specifically, with faculty raters feeling more comfortable providing a failing grade in the virtual platform.

Maldonado, R. (2011).	Multimedia clinical case scenario software in lieu of text-based problem-based learning (PBL) cases were compared to determine efficacy and learning outcomes.	An increase in their clinical confidence due to the hands-on nature of practicing patient care via case simulation and were superior methods of learning. Virtual problem-based learning case modalities were superior and encouraged critical thinking in students. The resultant savings per facilitator, per PBL case, is 5.87 hours or $251.	
Mccallister, E., & Weidman-Evans, E. (2021).	The purpose of this study was to examine the effects an asynchronous IPE activity had on graduate healthcare students' beliefs regarding IPE, as measured by the Readiness for Interprofessional Learning Scale (RIPLS).	Physical space and time within the program are often cited as barriers to carrying out IPE, the virtual platform eliminated this barrier. The asynchronous IPE activity did not negatively impact the participants' readiness for and attitudes towards IPE as indicated by pre-and post-test responses on the RIPLS.	
McDaniel, M. J., Russell, G. B., & Crandall, S. J. (2018).	The purpose of the study was to compare virtual microscopy with light microscopy to determine differences in learning outcomes and learner attitudes in teaching clinical microscopy to PA students.	Comparison of the last 5 cohorts with the class of 2016 cohort in this study revealed that the class of 2016 cohort scored significantly higher on the practical examination than any of the previous cohorts. This result is a strong indicator that incorporation of the virtual microscopy methods into the laboratory portion of the Clinical and Diagnostic Skill (CDS) course resulted in improved learning outcomes.	Access to technology for providing video streamed virtual microscopy capabilities is expensive and acquiring the technology may be hampered by budgetary restraints.
Neary, S., van Rhee, J., & Roman, C. (2020).	The COVID-19 pandemic has presented PA educators with unprecedented challenges in delivering content remotely with minimal time to develop new pedagogical strategies. We surveyed faculty about their experience during the early weeks of adapting to these new instructional techniques.	When asked "How, if at all, do you believe the quality of didactic education in your program has been altered since COVID-19 adaptations?" the most common response across all roles was that it had no effect on quality.	Over 40% of respondents felt that the quality of education had decreased. When referencing the personal perception of decreased quality of didactic education, logistics was also the most cited theme with 25 mentions. The logistics sub-code of hands-on skills and assessments was cited most frequently as contributing to the decline in quality of didactic education. Cultivating relationships is an entirely different affair when working remotely, and there are a variety of challenges to training and assessing students through virtual media.

Satnarine, T., & Lee Kin, C. M. (2022).	The COVID-19 pandemic resulted in the pause of medical clinical rotations. As a result, virtual rotations were implemented. This article seeks to review the published literature to explore which specialties adapted this format, what are the advantages and disadvantages observed, determine what were the responsibilities and involvements of students participating in these rotations, how well these rotations substituted for in-person rotations, and to evaluate if there is a continued role for them outside of COVID-19	Advantages included monetary savings, less time consuming, increased number of participants, flexibility, and diversity. Virtual rotation participants have obtained interviews and matched to residency programs. Beneficial aspects of virtual rotations include enhanced ease of interaction with faculty, a well-structured program and curriculum, student-focused case discussions, improved ability to identify critical patients, and improved familiarity and ability to work in a virtual healthcare setting.	Disadvantages included lack of assessment of practical skills, lack of school credit, inability to obtain letters of recommendation, decreased direct patient contact, and technical problems. Issues that were not unique to the field of medical education, including common technical problems such as poor internet connectivity, distractions, feelings of isolation, limited peer engagement, and difficulty fostering participation in an online learning environment.

Impact of Virtual Teaching on Physician Assistant Students

To assess the impact of VT on PA students, the findings were further analyzed according to the Kirkpatrick Model of Program Evaluation, as presented in Table 2, where the program evaluation is analogous to VT.

This model focuses on program outcomes at four different levels of impact on learning from learner satisfaction and beyond (6). The various levels are as follows:

1. The first “level” (How satisfied are learners with VT?) is used to assess learner reactions to VT. Learners might be asked, for example, if they felt the program was useful for learning and if individual components were valuable.
2. The second ‘‘level’’ (What have learners gained from VT?) requires the evaluator to assess what participants learned during the VT program. Tests of knowledge and skills are often used, preferably with an appropriate control group, to investigate this aspect.
3. The third ‘‘level’’ (What have learners applied that they gained from VT?) evaluation focuses on learner behavior in the context for which they were trained (e.g., application of knowledge previously gained to a new standardized patient encounter, diagnoses, treatment and management of patients, and self-guided learning).

4. The fourth "level'' (What organizational benefits resulted from VT?) evaluation focuses on learner outcomes observed after a suitable period in the VT programs' larger context. The VT programs' impact, for example, on patient outcomes, cost savings, and improved healthcare team performance.

Table 2: Summary of the impacts of virtual teaching offered on PA programs, according to the Kirkpatrick Model (6).

Article	**Reactions: How did participants feel about the training**	**Learning: Improvement in knowledge and skills**	**Behavior: Application of the learning to practice**	**Organizational benefits: How did the organization change its curriculum and training**
Anderson, D. L. (2021).	Students prefer virtual education for didactic components.	Online instruction improves learner autonomy, advances technology skills, and increases accessibility. Virtual education is equally as effective as in-person delivery. Curricular content delivered through an online format provides opportunities to address the various learning styles of a student body. A study by Forbes et al., showed that PA programs using distance education had a 96.9% five-year first-time pass rate on the Physician Assistant National Certifying Exam, outperforming the national average of all PA programs by 0.9% (7).	Research demonstrates that online discussion forums increases levels of student participation as compared to participation in traditional classroom-based lectures.	Development of hybrid programs would increase the number of seats available to prospective students and expand the opportunity for students who would otherwise face barriers to traditional education, such as the inability to relocate. Keeping students in the communities in which they live would foster the PA mission of better serving rural and underserved communities while also allowing students to fully understand the social and health disparities that are prevalent in the area they plan to serve. Transitioning educational content to an online format would help to open the instructor pool, allowing subject matter experts to train the health professionals of tomorrow in their respective disciplines.

DelNero, T., & Vyas, D. (2021).	PA students provided higher peer ratings for the virtual IPE activity versus the in-person activity. Pharmacy students reported lower confidence in the 2020 group (virtual) versus the in-person group. Overall attitudes regarding the impact of the IPE activity on their learning were more positive in the virtual group versus the in-person group.			A one-on-one model utilizing videoconferencing tools is a model that other programs could adapt for delivering IPE.
Donkers, K., DeLong, D., & Brown, N. (2019).		A VP-based protocol significantly improved student confidence for taking a history, performing a physical examination, and undertaking clinical reasoning as well as providing overall documentation confidence.	Results indicate significantly improved post training confidence on all measures: history, physical exam, clinical reasoning, and overall confidence.	Cook and Triola (2009) advocate for curricula that complement VP modules (such as lectures, simulation, and real patient interactions) because a foundation upon which VPs can build is essential if students are to fully reap the desired benefits (8). Instructors should consider including role play or live patient interactions to address verbal communication training goals. Ultimately, this study indicates vast potential for VPs to deliver useful, practical, enjoyable, and cost-effective benefits to PA students as they develop confidence and readiness for clinical practice.
Dyer, E., Swartzlander, B. J., & Gugliucci, M. R. (2018).		Assessment results indicate that students demonstrate increased understanding of and empathy with older adults who have age-related conditions such as macular degeneration and hearing loss.		

Francis, E. R., Bernard, S., Nowak, M. L., Daniel, S., & Bernard, J. A. (2020).	VR applications have revealed that students receive benefits in the form of increased team cohesiveness and self-efficacy.	Exposure to VR training after the traditional lecture improves self-efficacy amongst PA students ($p<0.05$). Exposure to VR improved self-efficacy compared to traditional methods ($p<0.05$). Students who received VR training demonstrated a significant improvement in their self-efficacy compared to the students that did not receive VR.	Benefits from using VR as an educational tool in healthcare are well documented with significant improvements seen in operating room performance, laparoscopic skills, and bronchoscopy.	Future implications of this research include the potential to expand this project to additional PA programs and healthcare professions.
Goldsmith, C.-A. W., Miller, K. E., Lee, L., Moreau, T., White, S., & Lee Massey, S. (2009).		Academic achievement was not statistically significant between the SDE and traditional cohorts on any of the 13 course grades or 8 practical/lab grades measured.	It is of interest that since these data were gathered that statistical analysis of the SDE and traditional cohorts during the clinical year revealed no statistical difference in preceptor evaluations and end-of-rotation exam performance during the clinical year of the inaugural class.	Comparison of academic performance between the distant cohort (Worcester) and TD cohort (Manchester) will continue in future years to measure and validate equivalent academic accomplishment. In future years, the study will be expanded to compare clinical-year performance. Clinical preceptor evaluations and PANCE scores will be compared between students educated in SDE and traditional formats. This pilot study suggests that SDE can be an effective model for didactic education in PA programs.

Kanofsky, S., & Tzakas, P. (2022).	Communication: general agreement that communication skills could be fairly assessed. Mixed opinions on if virtual formats negatively impacted assessment of non-verbal communication. Fairness: agreement that vOSCE was fair for assessment of history and verbal communication but less fair in physical exam skills. Student participants expressed a belief that virtual care will be an inevitable part of their future clinical role and reported an appreciation for the opportunity to practice their virtual care skills through the vOSCE testing experience.	Physical exam: most frequently cited barrier. Survey responses stated that some aspects could be partially assessed. Fidelity: mixed perceptions. Depended on the comparison (virtual patient or in-person). Format and process: overall considered to be smooth, easy to navigate and well organized. Technology: was stable and easy to navigate with no major issues that delayed or altered outcomes for candidates. The overall pass rate for the vOSCE was 98%, the same rate we have experienced with the traditional OSCE in previous years.	Able to increase total testing stations due to lack of space limitations.	Taking into consideration the post testing faculty/student perceptions of the vOSCE experience, the logistics of preparing, running, and evaluating the vOSCE, as well as the overall success of implementation of this initial vOSCE testing experience, our PA program has decided to continue conducting the end-of-program vOSCE.
Maldonado, R. (2011).	Students perceived an increase in their clinical competence due to the hands-on nature of practicing patient care via case simulation and indicated that the simulations were a superior method of learning.	The use of multimedia clinical case scenario software (MMCCSS) offers an exciting opportunity to encourage clinical reasoning skills using an updated format for problem-based learning (PBL). The clinical reasoning score between cohorts increased 12% with the increased use of MMCCSS.		The savings in faculty facilitator time was 41% using the blended curriculum of text-based cases and multimedia cases. This time savings could potentially rise to 92% using multimedia cases exclusively. The results of this study suggest an exciting opportunity to further the clinical reasoning of PA students in PBL courses in a way that students find both valuable and worthwhile. Additionally, MMCCSS cases provide an opportunity for PBL courses in smaller programs, or those programs concerned about increasing the faculty workload.

Mccallister, E., & Weidman-Evans, E. (2021).	The participants felt the activity met its objectives, which indicates that asynchronous IPE delivery may be a viable technique in this population.	A significant change (p<0.05) in score was found only in the Roles and Responsibilities. sub-scale. A positive effect on the participants' beliefs about professional Roles and Responsibilities was also noted; however, this must be confirmed by further study with larger sample sizes.	When applied to IPE in practicing healthcare professionals, reviews showed that "e-learning" (asynchronous) was an effective way to improve knowledge and attitudes, although not necessarily skills or behaviors.	
McDaniel, M. J., Russell, G. B., & Crandall, S. J. (2018).	Students overwhelmingly preferred (92%) the virtual microscopy and noted in their comments that *"video streaming made it easier to be sure that the professor and I were talking about the same thing at the same time".*	Analysis of the first post-test demonstrated that students in the video-streamed group had significantly better learning outcomes than those in the light microscopy group. Between the 2 post-tests students first assigned to the light microscopy group scored a 6.6 mean point increase. Analysis of practical examination data revealed higher scores for the study group compared with 5 previous cohorts of first-year students. Comparison of the last 5 cohorts with the class of 2016 cohort in this study revealed they scored significantly higher on the practical examination than any of the previous cohorts. This result is a strong indicator that incorporation of the virtual microscopy methods into the laboratory portion of the Clinical and Diagnostic Skills (CDS) course resulted in improved learning outcomes.		As a result of this study, instructional strategies for the CDS course in the Wake Forest School of Medicine physician assistant (WFSMPA) program have been modified to reflect a more blended learning methodology.

Neary, S., van Rhee, J., & Roman, C. (2020).	Prior experience with technology was associated with significantly lower levels of faculty stress during the pivot to online instruction. Most PA program directors and faculty reported greater levels of stress both overall and with respect to their teaching since the COVID-19 pandemic and the associated adaptations.	Most of the respondents felt educational quality had remained consistent despite the transition to online teaching, and a majority of both faculty and program directors anticipate only minor changes to program structure once they are able to return to traditional classroom learning.		The results of this study suggest that greater experience with online teaching methods and technology will reduce faculty stress related to online instruction.
Satnarine, T., & Lee Kin, C. M. (2022).	Advantages included saving money and time, more flexibility, increased diversity, and participation of international medical graduates. Disadvantages included lack of assessment of practical skills, inability to receive credit, and inability to obtain a letter of recommendation. Medical students agreed that virtual rotations should be continued. Other problems were experienced that were not unique to the field of medical education, including common technical problems such as poor internet connectivity, distractions, feelings of isolation, limited peer engagement, and difficulty fostering participation in an online learning environment.	In rotations that did not allow direct patient contact, there were decreased opportunities to practice history-taking, formulation of differential diagnoses, case presentations, and development of management plans. Virtual rotation participants have been invited for interviews at the participating institution's residency programs and have matched there. Students cited beneficial aspects of virtual rotations to include enhanced ease of interaction with faculty, a well-structured program and curriculum, student-focused case discussions, improved ability to identify critical patients, and improved familiarity and ability to work in a virtual healthcare setting.		Virtual rotations have proven to be a good substitute for in-person rotations, with most medical students seeing a need for the rotations in the future. Due to widespread development and acceptance of these rotations, it is likely that these rotations will continue.

DISCUSSION

Advantages of Virtual Teaching

The findings in the literature highlighted a wide variety of advantages to virtual education of PA students. Articles used in this study allowed for a literature review of VT of PA students, which explored diverse aspects such as resource allocation and cost savings, student engagement and preference, learning outcomes and styles, skill development, and logistical benefits.

A benefit of VT is the reduction in resource utilization inclusive of both physical space as well as labor. In some circumstances, the implementation of virtual programming was determined due to cited barriers of traditional content delivery (7). For example, in the study of IPE delivery by DelNero and Vyas (2021), compared to in-person instruction which required three large classrooms and eight staff, when transitioned to virtual, only two staff facilitators were needed. With this reduction in resource needs, cost savings can also be appreciated (8). As discussed by Maldonado (2011), the use of Multimedia Clinical Case Scenario Software (MMCCSS) substantially helped to reduce faculty workload by 41% in a blended model, with a potential to increase to 92% with a complete virtual transition (9). The use of VT components in addition or in replacement of in-person instruction appear to allow for a significant reduction in required resources.

In consideration of resources while also evaluating learning outcomes and program delivery, Kanofsky and Tzakas (2022) outlined a dual benefit with their virtual OSCE's, allowing for more testing stations because of the reduction in resources and space (10). This promoted further evaluation of students and opportunity for faculty feedback. Other studies echoed the importance and value in the ability of virtual rotations and simulations to provide immediate feedback to students (11). Further, virtual learning has the advantage of increasing clinical competence and critical thinking by practicing care via case simulation in a non-threatening, and safe environment (9).

Logistically, the incorporation of virtual learning into PA programs was shown to create opportunities to increase PA student enrollment and seats, increase the instructor and faculty pool, as well as provide an opportunity for students to remain in underserved rural areas where they live and work (4). This is also applicable in clinical practice with the use of virtual rotations which increases the number of participants and improves flexibility and diversity (3). Virtual platforms also allow for increased student autonomy and the ability for each individual learner to move at their own pace and in their own learning style (4).

Disadvantages of Virtual Teaching for PA Students

Disadvantages of virtual learning have been described in the articles reviewed with a main theme of the inability to teach and evaluate physical skills (4). This is cited as a barrier to total online programming, where it was discussed that a virtual platform would result in challenging and ineffective means to teach/evaluate proper physical exam techniques, skills, and clinical oversight (4). This concept led to a perception of a decrease in didactic educational quality in Neary et al. (2020), as faculty cited concerns over assessing students through virtual media (2). Limited physical skills and patient interaction with virtual clinical rotations were also of concern. In a virtual setting, there is a lack of assessment of practical skills, and direct patient care is diminished (3). It can also be said that the "soft skills" of patient communication could be difficult to develop in virtual and simulated environments (11). Although the goal was to assess empathy through virtual simulation, proper exploration is needed to determine if this is a sufficient and effective teaching modality (11).

Another consideration that was observed in several of the studies is the concept of community and collaboration, where O'Doherty et al. (2018), noted that *"some students may perceive a loss of value in student-teacher encounters when they occur online as opposed to in-person"*(12). Further studies suggest that virtual programming can lead to distractions, feelings of isolation, limited peer engagement and difficulty fostering participation (3).

For the individual learner, although most measures of success noted no statistically significant decline in various testing methods, there were a few worth noting. In Goldsmith et al. (2009), the mean scores were lower for the synchronized distance education cohort in 7/9 classes measured (1). Similarly, in evaluating confidence, there was a noted statistically significant decline in communication when compared to in-person cohorts (8). Aside from simply measuring scores and grades, the impact on individual learning styles is notable. The autonomy afforded to students who can then work at their own pace may only benefit those who are self-sufficient, and may hinder students without such ability (4).

Satisfaction with Virtual Teaching

Majority of the studies cited positive responses from both learners and educators with virtual education. It seems that students feel that learning objectives were being met and, in some instances, more through virtual modalities compared to in-person (7,8). For example *"overall attitudes regarding the impact of the IPE activity on their learning were also more positive in the virtual group versus the in-person group"* (8), as well as "*students overwhelmingly (92%) preferred the virtual microscopy*" and noted in their comments that "*video streaming made it easier to be sure that the professor and I were talking about the same thing at the same time*" (13). It should be noted that the transition to online instruction was easily adopted by students and was further described as an overall preference in the majority (4). This could be in part attributed to the generational shift of virtual based care. Students feel that virtual care and education will be inevitable in future, as such, learning in this manner allows for the opportunity to develop virtual care skills (10).

Responses from faculty were positive in the majority, and resulted in continued use of the virtual programs used in the respective studies. Despite the changes to the PA programs associated with COVID-19, roughly half of the respondents found VT to be manageable. Although greater stress levels were cited overall with respect to teaching through the pandemic, prior experience with online

teaching was associated with significantly reduced stress levels with the adjustment in pedagogy (2). As such, it would be difficult to discern if increased stress was strictly associated with virtual learning or was skewed by the ongoing pandemic. Further studies would be required to determine significance.

Effects on Learning: Knowledge and Skills

The second level of the Kirkpatrick model discusses the effect on learning. This literature review presented learning outcomes in several different areas such as clinical reasoning, interprofessional roles, general knowledge, and skills. Various tools were used as measures of efficacy, such as surveys, scoring modules, and exam grades.

Two studies demonstrated improvement in clinical reasoning with the use of virtual instruction. In Donkers et al. (2019), virtual patient encounters and online modules inclusive of comprehensive history and physical exams were used with the goal of improving documentation performance. This pilot study complimented the core PA curriculum and resulted in significantly improved confidence on all measures of history taking, physical exam, clinical reasoning, and overall confidence (11). Similarly, in Maldonado (2011), the use of MMCCSS were shown to improve clinical reasoning with scores between virtual and in-person cohorts improving by 12% (9).

Two studies evaluated the effect of virtual pedagogy on interprofessional education. The outcomes of the studies suggested that the mode of delivery did not impact student outcomes (8,14), nor did it impact the participant's readiness for, and attitudes towards interprofessional education (7).

Improvement in Knowledge

The development of the students' knowledge with VT demonstrated no statistically significant decrease in academic performance, and in some instances an increase was observed. In Goldsmith et al. (2009), the authors were able to review 13 different course grades and 8

practical/lab grades and make a direct comparison of a synchronized distant education and traditional in-person cohort of students. Their findings showed no statistical difference in grades measured (1). These findings were similar with the use of virtual OSCE's compared to traditional testing methods (10).

Studies also noted improvement in student knowledge and performance as demonstrated by exam passing rates. A study by Forbes et al. (2021), showed that PA programs using distance education had a 96.9% five-year first-time pass rate on the Physician Assistant National Certifying Exam, outperforming the national average of all PA programs by 0.9% (4). Similarly, in a comparative study with a nursing course, researchers discovered that those who completed the course online had an exam passing rate of 32% higher than those who took the same course on campus (4).

It can be summarized that regarding learner performance metrics, online medical education delivery can result in comparable, if not enhanced, academic performance when compared to in-person methods (4). Majority of the evidence continues to demonstrate these outcomes which should be considered in Canadian PA programs.

Improvement in Skills

One of the more debated areas of virtual education in medicine is its efficacy in teaching physical skills. The literature has shown to have mixed outcomes with general recommendations to utilize virtual modalities in combination with in-person instruction for a more hybrid pedagogical approach. As demonstrated by Donkers et al. (2019), virtual components such as virtual patients and online modules were used to help improve learner's confidence in history taking, physical exams, clinical reasoning, and overall confidence (11). The significance of this finding is that *"according to efficacy theory, confidence inspires performance by motivating effort, persistence, and resilience to failure"* (15). Confidence might also be inspired by the

ability of the student to be placed in a simulated unfamiliar environment prior to clinical rotations. This allows for opportunities for exposure to areas such as an operating room (OR) without the risk of harm to patients (16). As such, if virtual models help to improve and develop student confidence, it should be considered an essential component of preparing for professional success.

However, when it comes to evaluation of clinical skills, appropriate planning and consideration needs to be implemented to allow for fair and reasonable assessment. The literature suggests that while there are some physical exam skills that can be done through a virtual platform, there are also components that cannot be. With emphasis on a more blended approach, Kanofsky and Tzakas (2022) suggest that educators should consider incorporating alternative assessment formations throughout the curriculum to ensure proper evaluation of physical exam skills (10).

Behavior: Application of Learning to Practice

Various articles had the opportunity to review how virtual learning impacted behavior in their studies. Generally, some of the changes noted were increased participation in online discussion forums, increased confidence, and improved OR skills (4,11,16).

The application of learning seems to have overall positive outcomes. For consideration, when applied to IPE in McCallister and Weidman-Evans (2021), they stated *"e-learning was an effective way to improve knowledge and attitudes although not necessarily skills or behaviors"* (7). This may lead one to conclude that a disadvantage of virtual education may be a lack of efficacy in behavioral or skill-based training. However, contrary to this finding certain types of virtual education can be used explicitly to teach physical skills such as laparoscopic and bronchoscopy techniques via virtual reality (16). One study was able to perform a statistical analysis of a SDE cohort in comparison to an in-person traditional cohort. In result, they noted

no difference in preceptor evaluations during the clinical year rotations (1). As such, there does not appear to be any documented evidence in this review which suggests that virtual education is inferior when compared to traditional education for instruction on skills or general clinical encounters.

Due to the newer utilization of virtual education of PAs, future studies should be expanded to compare clinical-year performance and review of certification exam scores to assess for statistical differences in outcomes (1).

Organizational Benefits

The final level of the Kirkpatrick model focuses on outcomes in respect to the program's larger context (6). This level of evaluation should be considered when PA programs are considering adapting virtual education components. All the literature in this review that adopted virtual education found more benefits than negatives in their outcomes, and opted to continue to use this pedagogy. Virtual or hybrid programs have the advantage of being able to increase seats in the program while additionally improving access to prospective students who would normally face geographical barriers. Consequently, this allows for rural applicants to learn in the communities they serve which creates opportunity for improvement in overall health disparities related to access to care seen in rural and northern areas (4).

With regards to faculty workload and recruitment, one study noted that the use of virtual adjuncts saw significant savings in faculty facilitator time related to the use of multimedia problem-based learning cases. Not only did the students find these worthwhile and useful, but time savings for faculty could have been up to 92% if used exclusively (9). Virtual education allows for the opportunity to expand instructor pools geographically which promotes opportunity for experts in their field to educate PA students (4). There is evidence of increased stress associated with a transition to virtual learning, however, as stated in Neary et al. (2020), *"greater*

experience with online teaching methods and technology will reduce faculty stress related to online instruction" (2).

STUDY LIMITATIONS AND FURTHER RESEARCH

Gaps in Knowledge and Limitations of the Review

This literature review does have limitations despite attempting to incorporate all available evidence specific to PA programs within North America. Limitations of this review consider the small sample sizes in the various PA programs. This makes generalization challenging as each program is both unique in curriculum, class sizes, and demographics. There is a relatively small amount of data available on the long-term outcomes of virtual education, specifically on clinical rotations and on patient care. It should also be considered that not all published data can be reflective of negative trial outcomes. It may be possible that with the abrupt transition to online education, more negative outcomes did occur but were not explicitly or formally studied.

Further Research

Further research is needed to demonstrate long-term outcomes with virtual education compared to traditional delivery. It is important to determine if there are any impacts on patient care or the greater healthcare system to ensure there is no lack of necessary skills or knowledge needed to provide optimal care. This could be assessed utilizing the Canadian PA entrustable professional activities as they relate to patient care, for example (17):

- *EPA 1: Practices patient-focused, safe, ethical, professional, and culturally competent medical care.*
- *EPA 2: Obtains histories and performs physical examinations, demonstrating the clinical judgement appropriate to the clinical situation.*
- *EPA 4: Formulates and prioritizes comprehensive differential diagnoses.*

- *EPA 8: Recognizes a patient requiring immediate care, providing the appropriate management, and seeking help as needed.*
- *EPA 9: Plans and performs procedures and therapies for the assessment and the medical management appropriate for general practice.*

Future studies can also include student's self-perceived readiness for clinical rotations and post-graduation job performance (11).

CONCLUSION

The primary purpose of this study was to complete a literature review to determine if virtual education is effective, and if it should be considered for PA program quality improvement. There are several documented advantages to this pedagogical approach, such as cost savings and resource optimization, equal or improved learning outcomes, and improvements in flexibility, access, and exposure. Learners generally had positive responses, and programs who implemented VT models did continue to use them in their curriculum after evaluation of outcomes. With regards to professionalism, none of the articles specifically identified any effects of student professionalism with either VT or traditional in-person education. Interprofessional education was discussed and evaluated utilizing participant scoring. This demonstrated that there was no significant difference, negative impacts, or changes to learning outcomes, associated with virtual based IPE activities. Some of the cited disadvantages were the increased difficulty in instruction of physical skills, development of communication skills, loss of student-teacher encounters, as well as a lack of long-term studies that demonstrate clinical competence and impacts on patient care. Although the use of virtual education was not formally discussed in the context of diversity and inclusion, the concept of extending educational opportunities to students who reside rurally and in underserved communities is significant. It should be heavily

considered, as extending healthcare to these communities is a primary goal of service in this profession. In summary, virtual education can be an effective method to teach PA students and should be considered and further studied.

RECOMMENDATIONS

Based on a review of both the current evidence as described in this paper along with personal experiences of virtual education in a physician assistant program, the following recommendations could be considered in future:

1. In the event of another circumstance requiring a move to virtual teaching, an up-to-date archive of video-based lectures or other complimentary material should be maintained to help both students and staff facilitate a smooth transition.
2. In the appreciation of a more diverse and inclusive approach, a virtual based program should be considered in effort to expand program availability. In Manitoba for example, consideration of expansion to the University College of the North would allow for more training opportunities to northern applicants and those who may otherwise face barriers due to the inability to relocate.
3. Some of the articles discussed limitations with virtual education. The most significant being increased difficulty in instructing physical skills, and a lack of peer and educator connection. This was also a known disadvantage during the COVID-19 pandemic. In effort to reduce effects of this barrier, a hybrid approach would allow for blocks of in-person education to facilitate physical skill teaching, face-to-face connection, and in-person support.
4. Adoption of a virtual model would assist in program cost, at a minimum by a reduction in commuting, parking, and housing. Each term at the U of M currently costs $10,243.97,

this is substantially more expensive than most degrees at the same level (18). This high program cost, and lack of available professional loans, makes PA programs cost prohibitive to many applicants. Any opportunity to reduce this cost burden should be considered to improve access to programs.

5. Based on this review, national exam scores improved using virtual education (4). As the national exam is delivered through an online format, use of online exams throughout PA programs may help facilitate a sense of increased comfortability and subsequent success when writing the national exam. As such, consideration should be made to continue this practice as it may be beneficial and increase student achievement.

REFERENCES

1. Goldsmith CAW, Miller KE, Lee L, Moreau T, White S, Lee Massey S. The Effects of Synchronized Distance Education on Academic Achievement in a Physician Assistant Program. 2009.
2. Neary S, Van Rhee J, Roman C. The Effect of the Coronavirus Pandemic on Physician Assistant Educators. Journal of Physician Assistant Education. 2020 Sep 1;31(3):121–5.
3. Satnarine T, Lee Kin CM. A Review of Virtual Medical Student Rotations During the COVID-19 Pandemic: Their Role, Advantages, Disadvantages, and Future Prospects. Cureus. 2022 Apr 19;
4. Anderson DL. Why hybrid programs are the future of physician assistant education. Journal of Physician Assistant Education. 2021 Dec 1;32(4):282–5.
5. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021 Mar 29;n71.
6. Frye AW, Hemmer PA. Program evaluation models and related theories: AMEE Guide No. 67. Med Teach. 2012 May 19;34(5):e288–99.
7. Mccallister E, Weidman-Evans E. Article 12 Provide Interprofessional Education to Physician Assistant and Physical Therapy Students. The Internet Journal of Allied Health Sciences and Practice [Internet]. Vol. 19, Internet Journal of Allied Health Sciences Internet Journal of Allied Health Sciences and Practice and Practice. 2021. Available from: https://nsuworks.nova.edu/ijahsp/vol19/iss1/12
8. DelNero T, Vyas D. Comparison of an In-Person versus a Virtual Interprofessional Education Activity Focused on Professional Communication. Pharmacy. 2021 Jun 15;9(2):111.
9. Maldonado R. The Use of Multimedia Clinical Case Scenario Software in a Problem-Based Learning Course: Impact on Faculty Workload and Student Learning Outcomes [Internet]. Vol. 22, The Journal of Physician Assistant Education |. 2011. Available from: www.dxrgroup.com
10. Kanofsky S, Tzakas P. Virtual OSCEs for the Pandemic and Beyond. J Physician Assist Educ. 2022 Jun 1;33(2):152–5.
11. Donkers K, DeLong D, Brown N. Effect of online training modules and virtual patients on first-year physician assistant students' confidence levels. Journal of Physician Assistant Education. 2019 Sep 1;30(3):159–63.
12. O'Doherty D, Dromey M, Lougheed J, Hannigan A, Last J, McGrath D. Barriers and solutions to online learning in medical education - An integrative review. Vol. 18, BMC Medical Education. BioMed Central Ltd.; 2018.
13. McDaniel MJ, Russell GB, Crandall SJ. Innovative strategies for clinical microscopy instruction: Virtual versus light microscopy. Journal of Physician Assistant Education. 2018;29(2):109–14.
14. Sherman E, Berg K, Cooper D, Gustitus R, Tiernan C. Does mode matter? Perception of student competence following an IPE communication experience. J Interprof Educ Pract. 2020 Dec 1;21.
15. Locke EA, Frederick E, Lee C, Bobko P. Effect of self-efficacy, goals, and task strategies on task performance. Journal of Applied Psychology. 1984 May;69(2):241–51.

16. Francis ER, Bernard S, Nowak ML, Daniel S, Bernard JA. Operating Room Virtual Reality Immersion Improves Self-Efficacy Amongst Preclinical Physician Assistant Students. J Surg Educ. 2020 Jul 1;77(4):947–52.
17. Jones I, Burrows K, Nickell L, Millham A. CANADIAN PHYSICIAN ASSISTANT COMPETENCY FRAMEWORK 2021. CanMEDS-PA. 2021;5.
18. University of Manitoba. Graduate tuition and fees [Internet]. 2022 [cited 2023 Apr 1]. Available from: https://umanitoba.ca/registrar/tuition-fees/graduate