IN SYNC LEARNING PROJECT

A new reality in collaborative patient safety

Simulation-based interprofessional education for the identification, escalation, and management of the deteriorating patient

Deb Newman

Program Lead - Identification, Escalation and Management of the Deteriorating Patient

Northern NSW Local Health District, 89 Tamar St Ballina NSW

NSW GOVERNMENT | **Health** Northern NSW Local Health District

Acknowledgements

Abbreviations

BTF   Between the Flags

HCP   Healthcare professional

IPE   Interprofessional education

RRS   Rapid response system

Definitions

Interprofessional education (IPE) is defined as when two or more professions come together to learn together, from, about, and with each other to improve health outcomes through effective collaboration (World Health Organisation, 2010).

Interprofessional practice is defined as when multiple healthcare workers from different disciplines work collaboratively to provide high quality, comprehensive, person-centred care (World Health Organisation, 2010, p.13).

Contents

Abstract

All healthcare professionals involved in the patient's care have a responsibility to actively identify, escalate and manage clinical deterioration within the acute healthcare setting. Interprofessional practice has been shown to improve outcomes for acutely deteriorating patients through timely and appropriate identification, escalation, and management of patient care. However, traditional methods of education for healthcare professionals within acute healthcare settings have not provided opportunities for disciplines to collaboratively learn together. Interprofessional education offers a means for all healthcare professionals to learn together, from, and with each other. A transformation from discipline-specific education to more collaborative healthcare training to build collaborative teams and relationships is required for effective interprofessional practice to occur in the acute healthcare setting. Innovative approaches are required to future-proof the delivery of interprofessional education across all disciplines within acute healthcare settings. Modern technology such as mixed reality avails the opportunity for healthcare professionals to join interprofessional education simulations (sometimes remotely) and interact in the same holographic scenario.

The aim of this study was to evaluate the effectiveness of interprofessional education using immersive mixed reality technology to influence healthcare professionals' collaboration in the identification, escalation, and management of the deteriorating patient within the regional acute healthcare setting. A pre- post- experimental study consisting of surveys at three timepoints was designed. The theoretical framework of social constructivism underpins this research.

Perceptions of interprofessional practice were assessed pre-post program using the Students Perceptions of Interprofessional Clinical Education - Revision, Version 2 (SPICE-R2). A Wilcoxon Signed Rank Test demonstrated significant improvement in total SPICE-R2 scores for nurses (p=.025) and allied health (p=.010). Engagement in interprofessional practice within work teams was assessed using the Jefferson Teamwork Observation Guide (JTOG). The Wilcoxon Signed Rank Test revealed a statistically significant increase in the overall JTOG score at follow-up (p = <.001), and four of the five JTOG subscales; roles and responsibilities (p=.005), communication (p=<.001); values and ethics (p=<.001); and teamwork (p=<.001). The findings of this study support the ongoing use of a simulation-based interprofessional education to enhance healthcare professionals interprofessional practice in the identification, escalation, and management of the deteriorating patient.

Executive Summary

Introduction

Locally, nationally, and internationally various assessment tools and support systems have been implemented to categorise hospital patients at risk of deteriorating. Within Northern NSW assessment tools and support systems such as Between the Flags (BTF) and Rapid Response Systems (RRS) have been implemented with varying degree of success. There remains concern regarding the lack of continued improvement in managing the deteriorating patient both nationally and internationally (Ede et al., 2019; Lee et al., 2020; Petersen et al., 2017). Evidence remains unclear as to why healthcare professionals (HCPs) do not escalate concerns for the deteriorating patient as per protocols (Ede et al., 2019; van Galen et al., 2016).

The Northern NSW Local Health District identified the management of deteriorating patients as one of the biggest risks to the organisation and convened the *Improving the Management of the Deteriorating Patient Taskforce*. The taskforce commissioned a body of research to investigate the factors that influence healthcare professionals' (HCPs) decisions during times of patient deterioration. Taskforce members felt that identifying HCPs' barriers and facilitators in the identification, escalation, and management of the deteriorating patient would assist in the development and implementation of interventions to support HCPs.

Background

The aim of this previous research was to explore HCPs' attitudes towards the identification, escalation, and management of the deteriorating patient. A mixed method approach was used. The psychometrically tested Clinicians' Attitudes towards Responding and Escalating care of Deteriorating patients (CARED) scale, developed by Chua et al. (2021), was used to explore HCPs' attitudes to the identification, escalation, and management of the deteriorating patient. Survey responses were received from 911 HCPs across the LHD, representing 20.7% of all HCPs (medical officers, nurses, and allied health) employed across the LHD at the time. Thirty-eight focus groups (consisting of 243 HCPs) were also held to further explore the barriers and facilitators to the identification, escalation, and management of the deteriorating patient, and the potential improvements that could be made. Survey results supported focus group findings that while the BTF system facilitated HCPs identification, escalation, and management of the deteriorating patient, while barriers included a lack of interprofessional communication and teamwork, often resulting in low HCP confidence and low ward culture. There was a strong recommendation for simulated deteriorating patient scenarios to enable ward teams to form professional relationships and learn together, to develop ward team-based skills and interprofessional practice and for the improved identification, escalation, and management of the

deteriorating patient. This previous work led to the development of the *In Sync Learning Project,* to trial these recommended interventions in a single site in the district.

The In Sync Learning Project

The *In Sync Learning Project*, a simulation-based interprofessional education (IPE) program, employed immersive technology to promote interprofessional practice during the identification, escalation, and management of the deteriorating patient. The project ran from March to May 2022 within four wards at The Tweed Hospital. The aim of the project was to improve the way that deteriorating patients are identified, escalated, and managed. The project also offered an opportunity for HCPs from all disciplines to learn together, improving interprofessional relationships, collaboration, and person-centred interprofessional practice. Improving interprofessional practice is important because it has been demonstrated to improve patient outcomes and reduce adverse effects (Dillon et al., 2018), enhance the attitudes, self-confidence, and job satisfaction of healthcare professionals (Baik & Zierler, 2019; Kangas et al., 2021), and improve team collaboration and conflict resolution (Bogossian & Craven, 2020). Interprofessional practice also promotes collaborative strategies to prevent deterioration and as a result reduces unnecessary use of inappropriate health services (Brooks et al., 2020).

Results

While 124 HCPs participated in the study, 71 completed the program and 52 completed the follow-up survey. The findings of the study demonstrated that simulation-based IPE can improve HCPs' perceptions of interprofessional practice using the Students Perceptions of Interprofessional Clinical Education Revised 2 ([SPICE-R2] Zorek et al., 2016). A Wilcoxon Signed Rank Test demonstrated significant improvement in total SPICE-R2 scores for nurses (p=.025) and allied health (p=.010). Additional findings for the study demonstrated that simulation-based IPE can also improve HCPs' perceptions of their engagement in interprofessional practice using the Jefferson Teamwork Observation Guide ([JTOG] Lyons et al., 2016). The Wilcoxon Signed Rank Test revealed a statistically significant increase in the overall JTOG score at follow-up (p = <.001). Participants in this study valued interprofessional practice and teamwork as a determinant for effective collaborative management of the deteriorating patient.

Recommendations
1. Implement IPE framework for the provision of continuing clinical education across the Northern NSW Local Health District.
2. Implement interprofessional simulation-based training to improve teamwork and collaborative relationships for the improved management of the deteriorating patient.

3. Promote engagement within all professions to ensure multidisciplinary attendance at simulation-based IPE.
4. Chief Executive endorsement of simulation-based IPE to be mandatory or CE-directed training for all Northern NSW Local Health District clinical staff.

Background

In 2010, NSW Health introduced a state-wide patient safety initiative, the Between the Flags (BTF) program. This program is underpinned by NSW Health Policy Directive *Recognition and management of patients who are deteriorating,* most recently updated in 2020 (NSW Health, 2020) and is aimed to improve the identification, escalation, and management of patient deterioration within all NSW acute healthcare settings (Clinical Excellence Commission, 2023). The BTF program comprises a colour-coded two-tiered approach to patient deterioration: a yellow-zoned Clinical Review in which a patient review is undertaken by the HCPs responsible for the patient's care within 30 minutes, and a red-zoned Rapid Response in which an urgent patient review is undertaken by a rapid response team or designated emergency responder (NSW Health, 2020). The BTF program remains in place and continues to provide a clinical safety net for all patients in all NSW Health acute healthcare settings. Despite this, barriers in how HCPs work collaboratively within this system to provide care have been identified (Ede et al., 2020).

The most comprehensive and effective response to patient deterioration occurs when the healthcare team collaborate and practice interprofessionally (World Health Organisation [WHO], 2010). Therefore, all HCPs involved in the patient's healthcare journey have a responsibility to actively identify, escalate and manage clinical deterioration. There is compelling evidence that IPE supports interprofessional practice (Janes et al., 2022; D'Costa et al, 2022; Ojelabi et al., 2022; Shakhman et al., 2020; WHO, 2010), however, education within the acute healthcare setting continue to be conducted in isolation and discipline specific (Bogossian & Craven, 2020).

Interprofessional practice occurs when multiple HCPs from different disciplines work collaboratively with patients and families to deliver high quality care (WHO, 2010). Interprofessional practice can "decrease total patient complications, length of hospital stay, tension and conflict among caregivers, staff turnover, hospital admissions, clinical error rates, and mortality rates" (WHO, 2010, p.18). Interprofessional education has been shown to improve interprofessional practice by enhancing interprofessional team communication, information sharing, and awareness and recognition of team member roles (Mahajan et al., 2018; Raurell-Torreda et al., 2021).

A recent Australian study reported that HCPs' confidence and attitude towards the identification, escalation, and management of the deteriorating patient can be significantly influenced by both discipline and years of experience (Newman et al., 2023b). A qualitative study by the same authors recommended IPE opportunities be provided across all acute healthcare settings to promote collaborative interprofessional relationships for improved identification, escalation, and management of deteriorating patients (Newman et al., 2023a). An interprofessional approach to delivering high

quality person-centred care and interprofessional practice, must begin with IPE within acute healthcare settings.

While working towards high quality interprofessional practice, consideration must be given to innovative ways to future-proof the delivery of IPE. Incorporating innovative technology into healthcare education has been found to advance teaching and learning within the dynamic and ever-changing nature of healthcare (Moro et al., 2019). Virtual and mixed reality technologies are relatively new to healthcare simulation education, however, there is early evidence that undergraduate students have found the technology to be useful to their education (Moro et al., 2020).

The identification, escalation, and management of the deteriorating patient can be effective when the responding interprofessional team works collaboratively (Dillon et al., 2018), yet healthcare organisations do not routinely provide IPE opportunities for HCPs within the acute healthcare setting. This issue has created the impetus for this body of work to be undertaken within Northern NSW Local Health District to evaluate the impact of simulation-based IPE using immersive mixed reality technology to influence interprofessional practice in the identification, escalation, and management of the deteriorating patient.

Literature Review

A critical review of the literature has been undertaken to explore and identify current gaps in the evidence relating to identification, escalation, and management of the deteriorating patient.

The Deteriorating Patient

Internationally, various clinical safety nets or rapid response systems (RRSs) for early detection of patient deterioration have been implemented within acute healthcare settings. Despite this, research has shown varying degrees of success and a lack of improvement also noted in the identification, escalation, and management of the deteriorating patient across acute healthcare settings (Burke et al., 2020; Ede et al., 2019; Petersen et al., 2017). The successful identification, escalation, and management of the deteriorating patient is required to avoid adverse outcome for patients (Ede et al., 2020). Adverse patient outcomes continue to occur due to failed or delayed responses to patient deterioration (Walker et al., 2021). Adverse patient outcomes and complications can impact patients, HCPs, and the healthcare organisations in which they occur (Burke et al., 2020). Previous studies have identified that reasons HCPs do not identify, escalate, and manage early warning signs of patient deterioration are multi-faceted and complex (Al-Moteri et al., 2019; Treacy & Stayt, 2019).

Rapid Response Systems

Research has highlighted the value and benefit of RRSs as HCPs report strong beliefs and confidence in their organisation to provide a safety net for deteriorating patients (Newman et al., 2023b). However, the failure by HCPs to identify and escalate signs of patient deterioration can lead to delays in the activation of these well-regarded RRSs. Reported reasons for delays include low confidence and experience levels (Wood et al., 2019), issues entrenched in local ward culture, traditional hierarchies between disciplines, and human behaviours (Newman et al., 2023a).

Rapid response systems are predominantly activated and utilised by nurses who escalate concerns to the medical team. As nurses are the largest discipline group within the acute healthcare setting, most literature reports on nurses' use of RRSs for the identification, escalation, and management of the deteriorating patient. During activation of the RRS, nurses often refer to using their clinical judgement (also referred to as intuition or gut feeling) in conjunction with the clinical safety net (Jensen et al., 2019). The observation of subtle, non-specific clinical cues and changes, and escalation of clinical judgement forms a necessary element of the identification, escalation, and management of the deteriorating patient (Jensen et al., 2019). Rapid response systems allow for 'clinical judgement' within the activation triggers (ACSQHC, 2019; Haegdorens et al., 2023; Lyons et al., 2018), however increasing the ability and confidence of HCPs to use their clinical judgement is difficult to achieve without previous experience and training in doing so (Newman et al., 2022a).

The utilisation of the RRSs can provide HCPs with experience in the identification, escalation, and management of the deteriorating patient. Healthcare professionals with less experience in the identification, escalation, and management of the deteriorating patient report fears of repercussions and being viewed negatively by their others for failing to provide adequate care (Al-Moteri et al., 2019; Della Ratta et al., 2016; Newman et al., 2022b; Walker et al., 2021). Conversely, ever cautious HCPs can overreact to RRSs without using their clinical judgement resulting in what some would consider 'unnecessary' escalations of care causing frustration, alarm fatigue, and the creation of excessive workloads for others (Flenady et al., 2020; Haegdorens et al., 2023). Anton et al. (2021) identified that through experience HCPs can develop and learn to rely on their intuition to expedite clinical decisions. However, experience-derived intuition is difficult to measure with some studies only recently developing tools to measure the predictive value of nurse intuition (Haegdorens et al., 2023). Experience using RRSs could provide HCPs with confidence in their clinical judgement, and stronger beliefs towards the use of RRS for patient deterioration. Simulation-based education could provide HCPs with an opportunity to practice these skills, and experience RRS activation in a safe learning environment (Kinsman et al., 2021).

Interprofessional Relationships

The relationship between healthcare team members is an important component of interprofessional practice. Interprofessional practice is described as when multiple HCPs from different disciplines work together with patients, families, carers, and communities to deliver the highest quality of care (WHO, 2010). In contrast, dysfunctional interprofessional teams and relationships have been found to jeopardise patient care (Price et al., 2021). Strong interprofessional team factors can influence and foster HCPs compliance with the use of RRSs in the identification, escalation, and management of the deteriorating patient (Flenady et al., 2020). Effective interprofessional relationships have been found to enhance interprofessional trust, respect and communication, and result in interprofessional practice with shared patient goals (Mikhail et al., 2023). The repetitive practice of teamwork and team-based skills within simulation-based IPE has resulted in students feeling better prepared to engage in interprofessional practice (Powers et al., 2022), yet little evidence exists surrounding the perceptions and experience of IPE for HCPs within the acute healthcare setting.

Communication

Effective interprofessional communication between interprofessional team members during the identification, escalation, and management of the deteriorating patient is crucial for patient safety (Jin et al., 2022). Ineffective team communication has been identified as a major contributor to adverse outcomes for patients (Ede et al., 2020; Green et al., 2017). Variations in communication tools used to escalate concerns to the interprofessional team can be a point of contention. The Introduction, Situation, Background, Assessment, Recommendations (ISBAR) tool can improve the quality of communication and handover of clinical information leading to improved patient safety (Treacy & Stayt, 2019). Education and experience using communication tools such as ISBAR increases HCPs' responsibility to succinctly communicate concerns to the interprofessional team and provides security and predictability surrounding communications with others (Haddeland et al., 2022). While studies have found benefits for students in improving communication through IPE (Liaw et al., 2020; Nieuwoudt et al., 2021), little evidence exists exploring the impact that IPE can have on qualified HCPs' communication skills for the identification, escalation, and management of the deteriorating patient.

Traditional Hierarchy

A transformation from hierarchical to more collaborative healthcare teams and relationships is required for effective interprofessional practice to occur in the acute healthcare setting. Sociocultural influences can impact on HCPs' interprofessional relationships, which can affect the decision to activate the RRS and escalate concerns to the responding team (Chua et al., 2020). Perceived hierarchy between disciplines can hinder the escalation of patient care resulting in a risk to patient safety (Chua et al., 2019; Chua et al., 2020). Long-standing traditional hierarchies between

healthcare disciplines seem unlikely to change overnight; however, regular interprofessional engagements and meetings could improve interprofessional communication (Jin et al., 2022). Interprofessional activities that promote mutual trust and respect can reduce these entrenched hierarchical perceptions and promote a horizontal vision of disciplines (Jin et al., 2022; Okpala, 2021). Specifically, IPE can facilitate the breakdown of disciplines that work and train in isolation within the acute healthcare setting (Petersen et al., 2017), and promote a greater understanding of HCP roles in the identification, escalation, and management of the deteriorating patient (Lee et al., 2020). Undergraduate IPE has been found to influence graduating students' professional identity and future social position within the interprofessional team, despite their previous discipline stereotypes (Price et al., 2021).

Interprofessional Practice

Interprofessional practice is a clear expectation across the Australian health care system (ACSQHC, 2022). There is a multitude of reported benefits of IPE and interprofessional practice, with patients experiencing improved patient outcomes, decreased hospital bed days, and reduced adverse events (de Gans et al., 2022; WHO, 2010). Health care professionals have reported improved self-confidence, competence, and attitude towards participating within the interprofessional team (Donesky et al., 2020; Kangas et al., 2021; Mahajan et al., 2018), in addition to increased job satisfaction (Baik & Zierler, 2019). From a collaborative perspective, improved conflict resolution and enhanced team functioning can be achieved through collaborative leadership (Bogossian & Craven, 2020). Despite this evidence, concern remains that qualified HCPs are not prepared to effectively collaborate in interprofessional teams. To continue to strengthen the delivery of healthcare and patient outcomes, HCPs must engage in interprofessional practice, enabled though IPE (WHO, 2010).

Effective interprofessional practice is vital in the delivery of high-quality person-centred healthcare. The Interprofessional Education Collaborative (IPEC) has identified four core competencies for interprofessional collaborative practice, which were developed in 2011, updated in 2016, and are currently for public comments (IPEC, 2011; IPEC 2016; IPEC 2023). Throughout these versions, these four core competencies have essentially remained the same: values and ethics, roles and responsibilities, communication, and teamwork (IPEC, 2023). These competencies must be included in organisation-wide education to promote and support interprofessional practice (Allen et al., 2017).

Interprofessional Education

The WHO (2010) defined IPE as when "two or more professions learn about, from and with each other to enable effective collaboration and improve health outcomes" (p.13). Research has reported that simulation-based IPE can influence teamwork and workplace culture and facilitate

effective identification, escalation, and management of the deteriorating patient (Klemenc-Ketis et al., 2020). Interprofessional education promotes a shared understanding of each disciplines' roles and responsibilities, assisting to reduce stereotypes and prejudice (Walker et al., 2021). Education within the acute healthcare setting remains siloed, and while this supports a discipline specific depth of knowledge, it does not allow HCPs to develop skills that support interprofessional practice (van Diggele et al., 2020).

Methods of education within the healthcare system are well-established. However, it has become evident that traditional didactic methods of education offered within the acute healthcare system no longer meet modern clinical demands (Walker et al., 2021). Educational opportunities for nurses to participate in clinical deterioration simulations have been reported to increase preparedness to identify, escalate and manage deteriorating patients (Mikhail et al., 2023). Simulation-based IPE has previously been introduced at an undergraduate level, where healthcare students from different disciplines reported positive improvements in interprofessional practice (Ivey et al., 2018; Lunde et al., 2021; Nichols et al., 2019; Nieuwoudt et al., 2021; Powers et al., 2022; Price et al., 2021).

Simulation-based Education

Simulation-based education as a method of IPE is considered an engaging form of learning. Simulation-based education within the healthcare setting has been shown to enhance communication, teamwork, and behavioural skills (D'Cunha et al., 2021; Shi et al., 2021). Simulation-based education offers realism within scenarios, prompting learners to provide realistic responses (Rice et al., 2016). Social learning theories support education in which behaviours are learnt socially through reinforcement and mimicking others (Flenady et al., 2020). The combination of IPE and simulation offers learners the opportunity to interact with each other while caring for a patient in a safe learning environment (Patten & Fieler, 2019; Rice et al., 2016). Learners' safety in simulation has been identified as a key benefit in the development of clinical skills, knowledge, and practice (Bliss & Aitken, 2018). Simulation-based education within the nursing field has previously been found to enhance nurses' ability to identify the deteriorating patient and improved patient care (Bliss & Aitken, 2018; D'Cunha et al., 2021; Kinsman et al., 2021; Orique & Phillips, 2018). There is evidence that just two hours of simulation-based IPE can result in enhanced interactions between disciplines, and improved perceptions of interprofessional practice (Mahramus et al., 2016). Additional benefits include increased job satisfaction (Baik & Zierler, 2019), and improved self-confidence, competence, and attitudes towards interprofessional practice (Donesky et al., 2020; Kangas et al., 2021; Mahajan et al., 2018).

The delivery of simulation-based education to manage patient deterioration remains contentious. One study identified that web-based simulation compared to face-to-face learning was

more effective for nurses' knowledge, skill acquisition, competence, and confidence (Chung et al., 2018). Kinsman et al. (2021) provided evidence of the comparable impact between face-to-face and web-based modes of simulation, identifying that both modes provided nurses with clinical benefits during patient deterioration. It was reported that simulation-based education was able to be translated into enhanced clinical practice for patient deterioration, with the authors recommending blending face-to-face and web-based simulation for a more engaging educational experience (Kinsman et al., 2021). Interprofessional education using high-fidelity team-based simulations has been effective for students in the development of interprofessional practice, particulary collaborative skills such as communication (Lee et al., 2020).

Incorporation of regular in-house simulation-based education of interprofessional teams to manage emergency responses is recommended and is applicable across all acute clinical areas (Theilen et al., 2017). However, the implementation of IPE within the clinical environment can pose additional challenges. Mahajan et al. (2018) identified barriers to implementing IPE within the acute hospital setting, including a lack of IPE curriculum availability, poor support between disciplines, and lack of standardisation of clinical competencies to support interprofessional practice. Challenges to the introduction of IPE in undergraduate curriculum are well documented and include minimal faculty and student buy-in, inadequate room space, lack of organisational support, and conflicting discipline specific schedules (Patten & Fieler, 2019; Hawick et al., 2021).

The impact of growing clinical loads with increasingly complex patients adds to the requirement for the development of alternate learning environments and platforms within the acute healthcare setting (Hussain et al., 2021). Educational interventions that are short, easily accessible, interactive, and memorable, as well as those that are both theory-based and practical, have been found to be effective in healthcare education (Gasteiger et al., 2021). Recent pandemic-related infection prevention and control risks have also prioritised necessity for technologies to support ongoing education for HCPs outside of the clinical environment (Gasteiger et al., 2021; Martin et al., 2020). Immersive technology is a recent initiative and is suitable for use during and following the pandemic to provide IPE to HCPs at the coal face (Gasteiger et al., 2021).

Immersive Technology

Immersive technology consists of applications and equipment that create and extend reality. These technologies consist of; virtual reality, a total immersion into a synthetic environment; augmented reality, created by superimposing digital images onto a real-world view; and mixed reality, which encompasses both virtual and augmented reality and uses interactive holographic images laid over real-world environments (Intel, 2021). The use of immersive technology in simulation-based IPE is emerging as an effective strategy to support interprofessional practice (Hussain et al., 2021;

Kaplonyi et al., 2017; Rodriguez-Abad et al., 2021; Taubert et al., 2019). Over the last five years the field of medicine (and less predominately within other professions) have utilised virtual reality and augmented reality for clinical training (Gasteiger et al., 2021; Hong et al., 2019; Hussain et al., 2021; Kumar et al., 2021; Taubert et al., 2019). However, the impact of broader healthcare IPE using immersive technology has not been widely studied (Hong et al., 2019; Moro et al., 2019).

Other industries have provided positive reviews of the use of immersive technology. Comprehensive literature reviews within the construction industry identified that immersive technologies such as VR and AR had potential to increase student motivation, participation and interactions when utilised in educational training (Wang et al., 2018). Virtual reality has much to offer healthcare education, with some studies specifying the importance of HCPs and consumers being actively involved in the development of this innovative technology (Dean et al., 2020). Current studies are exploring a gap in research regarding the factors that influence VR and AR interventional success, to what extent, for whom and in which context the technology is effective (Gasteiger et al., 2021). Liaw et al. (2020) recommended further investigation into whether healthcare settings can leverage the use of immersive technology to substitute current education programs to have increased scalability and sustainability for IPE. This important knowledge gap forms the premise for the current study.

An integral relationship has been identified between the use and compliance of the clinical safety nets and RRSs for the identification, escalation, and management of the deteriorating patient, interprofessional practice and IPE (Flenady et al., 2020). Studies have demonstrated that improving elements of interprofessional practice such as collaborative relationships, workplace culture, communication, and teamwork were found to have a positive effect on HCPs' decision-making surrounding the identification, escalation, and management of the deteriorating patient (Chua et al., 2021; Mikhail et al., 2023; Smith et al., 2021).

In summary, studies have identified the facilitators to improving the success of RRSs include interprofessional practice, collaborative teamwork, interprofessional trust, and continuing IPE (Flenady et al., 2020; Olsen et al., 2019). Simulation based IPE using immersive technology offers a potentially unique opportunity for HCPs to collaborate in the identification, escalation, and management of the deteriorating patient, remotely if necessary. There is an opportunity to study the effectiveness of IPE using immersive mixed reality technology to influence HCPs' interprofessional practice to identify, escalate and manage the deteriorating patient within the acute healthcare setting.

Theoretical Framework

This study was underpinned by social constructivism. Social constructivism is a social learning theory that postulates that individuals are active participants in the formation of their own knowledge and that learning occurs mostly in social and cultural settings (Schreiber & Valle, 2013). While constructivism pertains to how people learn and the thinking process, social constructivism asserts that knowledge is not gained through observation alone, but socially constructed through interactions with others (Amineh & Asl, 2015; Liu & Chen, 2010). Social constructivism advocates that successful teaching and learning is contingent on interpersonal interactions and discussion, with the focus on understanding the discussion (Amineh & Asl, 2015).

Lev Vygotsky, a major theorist of the 20th century, believed that learners construct meaning from reality, where culture and society plays a crucial role in knowledge development (Vygotsky & Cole, 1978). Vygotsky identified the Zone of Proximal Development in which the learner's knowledge can grow with the assistance of others with higher levels of knowledge. Social constructivism claims that learned occurs through the social interactions with others, often in groups (Amineh & Asl, 2015).

The practical experience of learning by doing, that is experiential learning, is considered a fundamental element of learning (Lewis & Williams, 1994). While experiential learning offers meaningful experiences for the learner, this must be coupled with debriefing and reflection to maximise benefits (Bauchat & Seropian, 2020). Kolb's' learning cycle (see Figure 2) is the most widely recognised experiential learning theory comprising of a four-stage cycle of experiencing, reflecting, thinking, and acting (Kolb & Kolb, 2018). While concrete learning experiences and reflective practices are important, the application of meaningful learnt experiences in the learner's real world is imperative (Kolb & Kolb, 2018). Previous use of Kolb's learning cycle has demonstrated students' development of self-efficacy and critical thinking to provide person-centred care (Long & Gummelt, 2020).
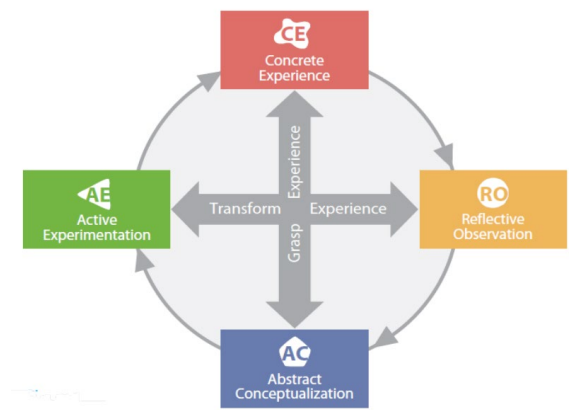
Figure 2. Kolb's experiential learning cycle (Kolb, 2007, p.8)

A social constructivism lens is well suited to pedagogies aimed at building interprofessional practice to identify, escalate, and manage the deteriorating patient. Previous nursing education with nurses has shown that teamwork competencies are best achieved with educational strategies rooted in social constructivism (Barton et al., 2018). Simulation using immersive mixed reality technology will support experiential learning in which HCPs will 'learn by doing' and by 'reflecting on the experience' (Kolb & Kolb, 2018). Simulation has been shown to provide an ideal environment to engage learners socially and promote the co-construction of collaborative, team-based problem-solving skills (Rogers, 2011).

Research Aim and Questions

Research Aim

To evaluate the effectiveness of interprofessional education using immersive mixed reality technology to influence healthcare professionals' interprofessional practice to identify, escalate and manage the deteriorating patient.

Research Questions

Does interprofessional education using immersive mixed reality technology influence healthcare professionals':

- perceptions of interprofessional practice during the identification, escalation, and management of the deteriorating patient?
- perceptions of engagement in interprofessional practice during the identification, escalation, and management of the deteriorating patient?

Methods

Study Design

A pre- post- experimental study consisting of surveys.

Study Measurements

1. ***Healthcare professionals' perceptions of interprofessional practice in the management of the deteriorating patient.***

Participants perceptions of interprofessional practice were measured at pre (T1) and post intervention (T2). The Students Perceptions of Interprofessional Clinical Education Revised 2 ([SPICE-R2] Zorek et al., 2016), a 10 item psychometrically tested tool was used to measure healthcare professionals' perceptions of interprofessional practice. The SPICE-R2 is comprised of three subscales: interprofessional teamwork and team-based practice (4 items), roles/responsibilities for collaborative practice (3 items), and patient outcomes from collaborative practice (3 items). Items are measured on a 5-point Likert scale from (1) strongly disagree to (5) strongly agree. Scores are calculated as means

for each factor and across the total tool. Higher scores indicate higher perceptions of interprofessional practice. This tool was chosen due to its previously reported strong internal reliability, with Cronbach's alpha between 0.86 to 0.89 (Lockeman et al., 2017). To the authors' knowledge, there has been no documented psychometric testing of the SPICE-R2 tool with qualified HCPs.

2. ***Healthcare professionals' perceptions of their engagement in interprofessional practice.***

Participant perceptions of their engagement in interprofessional practice was measured at pre-intervention (T1) and follow-up (T3), six to eight weeks after the completion of the intervention to allow HCPs time to translate their learnings into clinical practice. The Jefferson Teamwork Observation Guide ([JTOG] Lyons et al., 2016), a 14-item observational tool was used to assess the extent to which HCPs engaged in interprofessional practice. The JTOG measures five core competencies of interprofessional practice: values and ethics, roles and responsibilities, communication, teamwork, and leadership. Items are measured on a four-point Likert scale from one (strongly disagree) to four (strongly agree) and calculated as mean scores for each competency. "Not applicable" responses are treated as missing responses. The JTOG was adapted for this study to be completed by participants as a reflection on a time since their completion of the IPE program when they were involved in interprofessional practice in their workplace.

Study Setting

The study was conducted in the Northern NSW Local Health District across four clinical units (two medical and two surgical) at The Tweed Hospital.

Study Population

Medical officers, nurses, and allied health professionals working across four units (two medical and two surgical) at The Tweed Hospital.

Eligibility Criteria

Medical officers, nurses, and allied health professionals (physiotherapists, occupational therapists, pharmacists, social workers, and speech pathologists) employed at The Tweed Hospital and who work in one of the selected units were eligible to participate in this study. Healthcare professionals who did not work as medical officers, nurses, allied health professionals, or who did not work in the four medical and surgical units at The Tweed Hospital were not eligible to participate in this study.

The Intervention

A four-week IPE program was delivered via an online learning platform (Practera) with immersive simulations delivered using mixed reality technology.

Online Learning Modules

Participants were asked to complete four interactive online learning modules via the Practera platform. The learning modules were designed to be delivered weekly over a period of four weeks. These learning modules were used in conjunction with simulated scenarios delivered via immersive mixed reality technology. Course learning outcomes are presented in Table 1.

Table 1. Course learning outcomes

Learning Outcome 1	Review and integrate principles of accountability and interprofessional practice to complex health scenarios inclusive of health and safety guidelines and emergency response protocols.
Learning Outcome 2	Apply and demonstrate collaborative practice by sharing information, communicating ideas, listening attentively, providing and receiving feedback, resolving conflict of opinions and making decisions for effective interprofessional practice.
Learning Outcome 3	Apply collaborative and ethical reasoning to optimise person-centred care. Seek and value the opinions of others in decision-making.
Learning Outcome 4	Reflect critically on own and other team members' roles.

To achieve these learning outcomes, the following four modules were designed and developed to build capability in the identification, escalation, and management of the deteriorating patient, whilst working effectively within an interprofessional team. See Table 2 for Education Module Content.

Table 2. Education module content

Module 1	• Introduction to mixed reality technology and online learning platform • Escalation of care processes • Clinical care pathways • Participants introduce themselves via asynchronous chat • Prepare for first mixed reality simulation
Module 2	• Crisis resource management • Communication barriers and enablers within teams
Module 3	• Narrative and collaborative reasoning
Module 4	• Revise course content • Prepare for second mixed reality simulation

The modules included approximately one hour per week of experiential online learning via the Practera platform. The module content and learning activities, including asynchronous interprofessional practice group discussions prepared participants to engage in the interprofessional mixed reality simulation scenarios.

Mixed Reality Interprofessional Education

Interprofessional education sessions were delivered using immersive mixed reality technology through HoloLens2 devices (Microsoft, 2023) in modules one and four, where participants, as an interprofessional team, engaged in mixed reality scenarios. (Modules two and three consist of online

self-directed learning). The HoloPatient software (GigXR, 2023) enables participants to simultaneously access the same deteriorating patient scenario, allowing the development of communication and teamwork skills during the identification, escalation, and management of the holographic deteriorating patient. Participants, as an interprofessional team, progressed through the stages of the simulated patient's journey together, guided by an experienced facilitator, with the rate of progression based on the degree of collaboration and clinical reasoning discussed within their interprofessional team (see image 1 below).
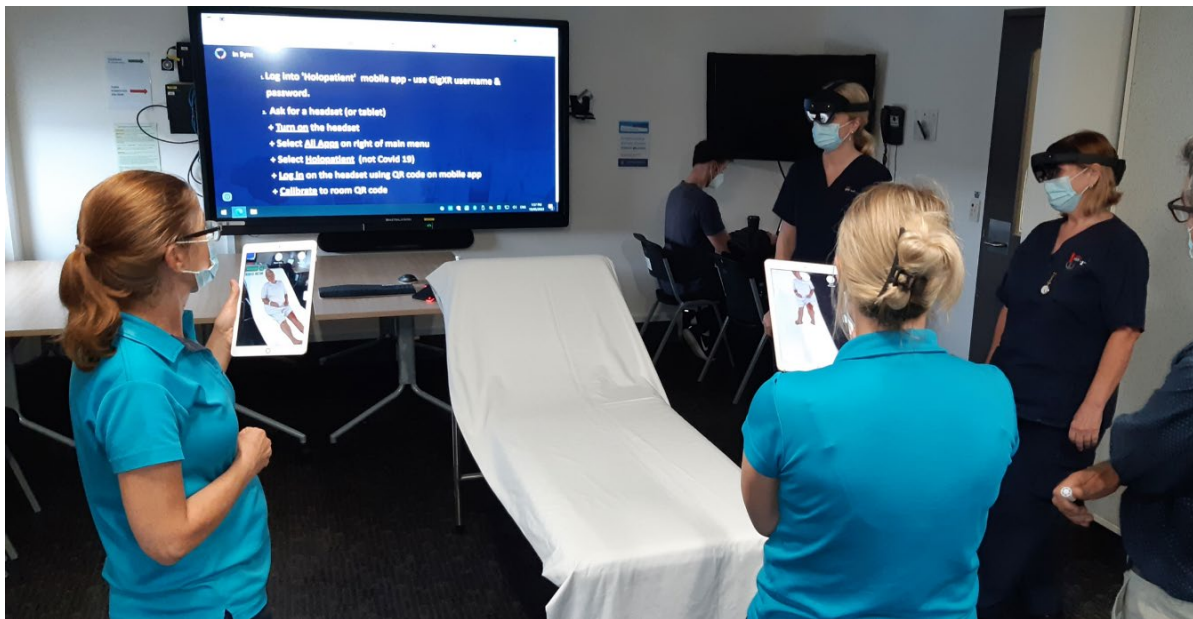
Image 1. A group of interprofessional HCPs managing a holographic deteriorating patient together using HoloLens2 headsets and tablets.

Study Procedure

Recruitment

Participants were invited to complete the online survey at pre and post intervention and six weeks follow-up. Online and paper-based surveys were available. A unique code was requested to anonymously match the HCPs data at pre- and post-intervention, and follow-up. Informed consent to participate in the evaluation was implied when participants returned the completed survey.

Sample Size

It was expected that 150 HCPs would be eligible to participate across the four units. An apriori power analysis was conducted using G*Power 3.1.9.7 to estimate an appropriate sample size for the main outcome variable measured by the SPICE-R2. It was estimated that a sample size of 29

participants would be required to detect a medium effect (d = .54; Brennan et al., 2021) with 80% power.

Data Analysis

Data was matched pre, post, and follow-up using a unique code. Univariate and multivariate analysis of variance was conducted to determine the change in HCPs' perception of interprofessional practice in the identification, escalation, and management of the deteriorating patient. The level of significance used was alpha $\leq$0.05. All statistical analyses were performed in IBM SPSS Version 27.0.

Ethical Considerations

The study was conducted in full conformance with principles of the National Statement on Ethical Conduct in Human Research 2007 (National Health and Medical Research Council, 2018). Ethical approval was granted by the North Coast NSW Human Research Ethics Committee, approval QA419, and Southern Cross University Human Research Ethics Committee, approval 2022/105.

Results

The four-week IPE program was delivered between March and May 2022. A total of 124 HCPs enrolled in the program. As the mean scores for both tools (SPICE-R2 and JTOG) were found to be not normally distributed, data were analysed using the Wilcoxon Signed Rank Test with medians and interquartile ranges (IQR) reported. Subgroup analysis was then conducted based on profession for nurses and allied health only to determine changes in perception of and engagement in interprofessional practice by discipline.

Perceptions of interprofessional practice (SPICE-R2)

Seventy-one (*n*=71) participants completed matched paired survey responses at post-intervention (T2). Most participants were female (83.1%) and 29.6% were aged between 25-34 years (see Table 3). Participants consisted of 54 nurses (76.1%), three medical officers (4.2%), and 14 allied health (19.7%). New graduates were the majority (32.4%) at post-intervention.

Table 3. Demographics of HCPs at post-intervention (*n*=71)

Characteristics	(*n*=71)
Age	
18-24	15 (21.1%)
25-34	21 (29.6%)
35-44	16 (22.5%)
45-54	11 (15.5%)
55 -64	8 (11.3%)
Gender	
Male	12 (16.9%)
Female	59 (83.1%)
Workplace discipline	
Nursing	54 (76.1%)
Medicine	3 (4.2%)

Allied health	14 (19.7%)		
Discipline experience			
New graduates (≤ 1 year)	23 (32.4%)		
Early career (2-5 years)	17 (24.0%)		
Mid-career (6-10 years)	15 (21.1.%)		
Experienced (>10 years)	16 (22.5%)		

The internal reliability was calculated with Cronbach's alpha scores of .89–.93 across both timepoints (T1 .89-.90, T2 .929-.935) indicating strong internal reliability of this tool for use with qualified HCPs (nursing, medical, and allied health).

Changes in HCPs' perceptions of interprofessional practice from pre- to post-intervention are presented in Table 4. Scores at T2 indicate HCPs' perceptions of interprofessional practice significantly increased including across all subscales.

Table 4. Changes in HCPs' perceptions of interprofessional practice

Subscales	T1 (*n*=71)	T2 (*n*=71)		
	Median (IQR)	**Median (IQR)**	***p* Value:**	**Effect size**
Teamwork (4 items)	4.50 (4.0, 5.0)	4.75 (4.25, 5.0)	***p* = .016**	.20
Roles and Responsibilities (3 items)	4.00 (3.66, 4.33)	4.00 (3.66, 4.33)	***p* = .014**	.21
Patient Outcomes (2 items)	4.33 (4.0, 5.0)	4.67 (4.0, 5.0)	***p* = .002**	.26
Total overall score	43.0 (39.0, 46.0)	45.0 (41.0, 48.0)	***p* = <.001**	.28

Changes in perceptions' of interprofessional practice by discipline are presented in Table 5. Allied health (*n*=14) demonstrated a statistically significant improvement in perceptions of interprofessional practice (*p*=.01) including, teamwork (*p*=.036) and patient outcomes (*p*=.042). Nurses (*n*=54) also demonstrated statistically significant improvement in perceptions of interprofessional practice (*p*=.025) including patient outcomes (*p*=.016). Less than 5 paired samples were available from medical officers, whilst analysis was performed, the results were not discussed (Dwivedi et al., 2017).

Table 5. Changes in HCPs' perceptions of interprofessional practice by discipline

Subscales	T1 (*n*=71)	T2 (*n*=71)	
	Median (IQR)	**Median (IQR)**	**Two-tailed *p* Value**
Teamwork			
Nursing (*n*=54)	4.50 (4.0, 5.0)	4.50 (4.18, 5.0)	*p* = .149
Medicine (*n*=3)	4.25 (4.0, 4.75)	4.75 (4.0, 5.0)	*p* = .180*
Allied health (*n*=14)	4.75 (4.0, 5.0)	5.00 (4.75, 5.0)	***p* = .036**
Roles and Responsibilities			
Nursing (*n*=54)	4.00 (3.66, 4.33)	4.00 (3.66, 4.41)	*p* = .085
Medicine (*n*=3)	3.66 (2.66, 3.66)	4.00 (3.66, 4.0)	*p* = .180*

Allied health (*n*=14)	3.83 (3.66, 4.08)	4.17 (3.91, 4.33)	*p* = .065
Patient Outcomes			
Nursing (*n*=54)	4.33 (3.91, 4.66)	4.67 (4.0, 5.0)	***p* = .016**
Medicine (*n*=3)	4.33 (3.0, 5.0)	4.33 (3.66, 5.0)	*p* = .564*
Allied health (*n*=14)	4.67 (3.91, 5.0)	5.00 (4.58, 5.0)	***p* = .042**
Total score of subscales			
Nursing (*n*=54)	42.5 (38.75, 46.25)	44.0 (40.0, 48.0)	***p* = .025**
Medicine (*n*=3)	43.0 33.0, 43.0)	44.00 (39.0, 46.0)	*p* = .109*
Allied health (*n*=14)	44.5 (40.25, 46.0)	47.0 (45.0, 48.0)	***p* = .010**

*Less than 5 paired samples

Perceptions of engagement in interprofessional practice (JTOG)

Fifty-two (*n*=52) participants completed matched paired survey responses at follow-up (T3). Most participants were female (78.8%) and 26.9% were aged between 25-34 years (see Table 6). Participants consisted of 35 nurses (67.3%), two medical officers (3.8%), and 15 allied health (28.8%). While participant demographics did not change significantly over the three timepoints, fewer nurses participated at follow-up.

Table 6. Demographics of HCPs at follow-up

Characteristics	**(*n*=52)**
Age group (years)	
18-24	11 (21.2%)
25-34	14 (26.9%)
35-44	13 (25.0%)
45-54	9 (17.3%)
55 -64	5 (9.6%)
Gender	
Male	11 (21.2%)
Female	41 (78.8%)
Workplace discipline	
Nursing	35 (67.3%)
Medicine	2 (3.8%)
Allied health	15 (28.8%)
Discipline experience	
New graduates (≤ 1 year)	12 (23.1%)
Early career (2-5 years)	12 (23.1%)
Mid-career (6-10 years)	12 (23.1%)
Experienced (>10 years)	16 (30.8%)

Table 7 presents the changes in HCPs' perception of their engagement in interprofessional practice in their workplace as medians and IQRs. The Wilcoxon Signed Rank Test revealed a statistically significant increase in the overall JTOG score at follow-up (*p* = <.001), with a moderate effect size (d = .37). Pre-intervention to follow-up medians showed significant increases for four JTOG subscales: roles and responsibilities (*p* = .005), communication (*p* = <.001); values and ethics (*p* = <.001); and teamwork (*p* = <.001). The median score for the leadership sub-scale remained the same at follow-up.

Table 7. Changes in HCPs' perception of their engagement in interprofessional practice in their workplace.

Subscales	T1 (n=52) Median (IQR)	T3 (n=52) Median (IQR)	p Value	Effect size
Leadership (2 items)	3.00 (3.0, 3.87)	3.00 (3.0, 4.0)	p = .149	.14
Roles and responsibilities (3 items)	3.00 (3.0, 3.33)	3.33 (3.0, 3.66)	**p =.005**	.27
Communication (4 items)	3.00 (2.81, 3.25)	3.25 (3.0, 3.93)	**p = <.001**	.39
Values and ethics (3 items)	3.00 (3.0, 3.33)	3.33 (3.0, 4.0)	**p = <.001**	.39
Teamwork (2 items)	3.00 (3.0, 3.0)	3.50 (3.0, 4.0)	**p = <.001**	.34
Total overall score	42.00 (40.0, 46.0)	46.00 (42.0, 52.0)	**p = <.001**	.37

The comparisons in JTOG scores across disciplines are presented in Table 8. The medians showed an increase from pre-intervention to follow-up for all disciplines, with a statistically significant increase in the overall JTOG score (p = .001) for the discipline of nursing. Statistically significant increases were also found for the nursing discipline across the four subscales: roles and responsibilities (p = .013), communication (p = <.001), values and ethics (p = <.001), and teamwork (p = .004), all with moderate effect sizes. Less than five paired samples were available from medical officers.

Table 8. Changes in HCPs' perceptions of their engagement in interprofessional practice in their workplace by discipline.

Subscales	T1 (n=52) Median (IQR)	T3 (n=52) Median (IQR)	p Value
Leadership			
Nursing (n=35)	3.00 (3.0, 4.0)	3.00 (3.0, 4.0)	p =.468
Medicine (n=2)	2.50 (1.50, 2.25)	3.50 (2.25, 3.0)	p =.317*
Allied health (n=15)	3.00 (3.0, 3.5)	3.00 (3.0, 3.5)	p =.380
Roles and Responsibilities			
Nursing (n=35)	3.00 (3.0, 3.33)	3.33 (3.0, 3.66)	**p =.013**
Medicine (n=2)	3.00 (2.25, 2.25)	3.33 (2.25, 2.75)	p =.317*
Allied health (n=15)	3.00 (3.0, 3.66)	3.33 (3.0, 3.66)	p =.302
Communication			
Nursing (n=35)	3.00 (2.75, 3.50)	3.25 (3.0, 4.0)	**p = <.001**
Medicine (n=2)	2.87 (2.06, 2.25)	3.25 (2.25, 2.62)	p =.317*
Allied health (n=15)	3.00 (3.0, 3.25)	3.25 (3.0, 3.75)	p =.070
Values and ethics			
Nursing (n=35)	3.00 (3.0, 3.33)	3.66 (3.0, 4.0)	**p = <.001**
Medicine (n=2)	2.83 (2.0, 2.25)	3.17 (2.25, 2.50)	p =.317*
Allied health (n=15)	3.00 (3.0, 3.0)	3.33 (3.0, 3.66)	p =.117
Teamwork			
Nursing (n=35)	3.00 (3.0, 3.0)	3.00 (3.0, 4.0)	**p =.004**
Medicine (n=2)	3.00 (2.25, 2.25)	3.25 (2.25, 2.62)	p =.317*
Allied health (n=15)	3.00 (3.0, 3.5)	3.50 (3.0, 4.0)	p =.074
Total score of subscales			
Nursing (n=35)	42.0 (40.0, 48.0)	48.0 (42.0, 54.0)	**p =.001**
Medicine (n=2)	40.00 (28.5, 31.5)	46.00 (31.5, 37.5)	p =.317*
Allied health (n=15)	42.0 (42.0, 46.0)	46.00 (43.0, 51.0)	p =.089

*Less than five paired samples

Discussion

This study evaluated the impact of a simulation-based IPE program on HCPs' perceptions of and their engagement in interprofessional practice. This IPE program was designed to enhance interprofessional practice within the continuing education space and improve HCPs' collaborative management of the deteriorating patient. The study was conducted in a regional acute healthcare setting with nurses, allied health, and medical officers, where interprofessional teams routinely work together to deliver care to patients. While qualified HCPs do not regularly have the opportunity to partake in collaborative education, this study has provided evidence that HCPs can benefit from simulation-based IPE in their workplace. There were two major findings from this study. The first indicate allied health and nurses' perceptions of interprofessional practice significantly improved as a result of their participation in the IPE program. Secondly, nurses' perceptions of their engagement in interprofessional practice and team-based activities in their workplace significantly improved following completion of the IPE program.

Perceptions of interprofessional practice

Nurses and allied health showed significant improvement in their overall perceptions of interprofessional practice as a result of their participation in the IPE program. In particular, when breaking down the elements of interprofessional practice, allied health and nurses' perceptions of interprofessional practice and its impact on *patient outcomes* significantly improved following participation in the IPE program. In addition, allied health perceptions of interprofessional practice for the benefit of *teamwork* also significantly improved. To the authors knowledge this is the first study to evaluate the impact of a simulation-based IPE program designed to improve the management of the deteriorating patient in an acute healthcare setting, and psychometrically test the SPICE-R2 scale with qualified HCPs.

The use of a simulated environment enabled allied health and nurses to reflect and better understand the benefits of collaborating and providing a coordinated approach to patient care (Lavelle et al., 2017). Previous studies have shown that an opportunity to participate in IPE provides a strong belief that cross-discipline collaboration can have a positive impact on patient outcomes (Kangas et al., 2021; Pence et al., 2022). Patient-centredness and holistic care have been identified as outcomes of interprofessional collaboration (Ojelabi et al., 2022), and are evidenced to improve patient outcomes within the acute healthcare setting (Reed et al., 2021).

Allied health participants reported significant improvement in their perceptions of interprofessional practice and its impact on *teamwork* as a result of this simulation-based IPE program. Teamwork experience can lead to confidence in teamwork and team-based skills and participation in

interprofessional practice within the healthcare system (Dirks, 2019). While not widely documented marginalised HCPs such as allied health are underutilised during the management of the deteriorating patient in the acute healthcare setting, and consequently in such education (Gupta et al., 2020). However, interprofessional programs for allied health professionals have previously been shown to foster collaborative staff with an increased understanding of other disciplines' roles, leading to improved teamwork and interprofessional practice in the acute healthcare setting (Sooful et al., 2020). In the same way, IPE can lead others to develop a deeper understanding of allied health roles, with acknowledgement of the valuable contribution that can be made by allied health within the interprofessional team (Shakhman et al., 2020). This IPE program included facilitation of interprofessional teamwork and debriefing within each practical session followed by reflective activities. These activities may have led to the acknowledgement and recognition of the valuable role allied health play in the interprofessional team, which may have contributed to this positive result.

Perceptions of engagement in interprofessional practice

At follow-up, nurses reported a significant improvement in the perception of their engagement in interprofessional practice in their workplace. Furthermore, nurses displayed a significant improvement in four team characteristics of *roles and responsibilities*, *communication*, *values and ethics*, and collaborative *teamwork*. Time to follow-up allowed participants to translate their IPE program learnings into clinical practice, with nurses demonstrating that through reflection, perceptions of their engagement in interprofessional practice in their workplace had significantly improved. Overall, allied health perceptions of their engagement in interprofessional practice improved however no statistical significance was found for this group.

The results of this study are comparable to others which have reported the value of simulation-based IPE, particularly for the development of effective teamwork and team-based skills (Herge & Hass, 2023; Wai et al., 2020). Improved teamwork communication has been shown to be positively influenced by previous IPE experience (Herge & Hass, 2023; O'Neill-Pirozzi et al., 2019). An improvement in role recognition and understanding the value of each other's roles within the interprofessional team has been recognised in previous simulation-based IPE programs (Kayyali et al., 2019; Reed et al., 2021), and is known to be a major contributing factor to strong interprofessional practice (Schilling et al., 2022). Healthcare professionals have previously reported that strong collegial relationships and task experience increases their confidence to contribute to teamwork and interprofessional practice during the identification, escalation and management of the deteriorating patient (Newman et al., 2023a). For this reason, IPE, as a contributing factor for interprofessional practice and improved patient outcomes (Spaulding et al., 2021), should be prioritised within

healthcare organisations as the recommended form of ongoing education and training for qualified HCPs.

The simulation-based IPE program in this study provided an innovative opportunity for HCPs to learn about and then practice the identification, escalation, and management of the deteriorating patient within their interprofessional teams. The results from this study provide evidence that an IPE program using immersive mixed reality technology can positively influence HCPs' perceptions of and engagement in interprofessional practice during the identification, escalation, and management of the deteriorating patient. The study also highlighted the importance of ongoing continuing education to provide qualified HCPs with opportunities to train together, learning from, with and about each other.

Strengths and limitations

While originally developed for students, this study provides evidence for further use of the SPICE-R2 tool with qualified HCPs. While this study displayed strength in the diversity of allied health disciplines, there was limited medical representation. Based on this, generalisability for medicine was not possible. The use of mixed reality technology for simulation-based training is relatively new and despite pre-program orientation to the technology, further training and support may be required to promote continued engagement in the program. This study reports specifically in the context of the identification, escalation, and management of the deteriorating patient however other clinical focus areas could be considered. A larger randomised control trial would be required to confirm these results. As social constructivism posits learning together and from others and in groups, further exploration of how this occurred will be investigated using focus groups.

Conclusion

Participants in this study valued IPE as a determinant for effective interprofessional practice in the identification, escalation, and management of the deteriorating patient. The findings of this study demonstrate that simulation-based IPE can improve allied health and nurses' perceptions of and engagement in interprofessional practice during the identification, escalation, and management of the deteriorating patient. As interprofessional practice is essential for the safe and quality identification, escalation and management of the deteriorating patient, healthcare organisations should introduce and promote IPE opportunities for all HCPs to engage and experience the benefits of collaborative practice.

Recommendations

5. Implement IPE framework for the provision of continuing clinical education across the Northern NSW Local Health District.

6. Implement interprofessional simulation-based training to improve teamwork and collaborative relationships for the improved management of the deteriorating patient.

7. Promote engagement within all professions to ensure multidisciplinary attendance at simulation-based IPE.

8. Chief Executive endorsement of simulation-based IPE to be mandatory or CE-directed training for all Northern NSW Local Health District clinical staff.

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