Virtual protective equipment: paediatric resuscitation in the COVID-19 era

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INTRODUCTION

Critically ill patients in the paediatric emergency department (PED) often require resuscitation by large multidisciplinary teams with aerosol-generating procedures, including compressions or endotracheal intubation. There is concern that healthcare workers could contract severe acute respiratory syndrome coronavirus 2 during aerosol-generating procedures or resuscitations.[1 2] When COVID-19 status is unknown, personal protective equipment (PPE) is essential to reducing exposure risk. Historic variable infection control guideline adherence, combined with recent PPE shortages, challenges healthcare organisations' ability to adequately protect team members.[1 3]

Telemedicine is a risk-reduction strategy to minimise staff exposure and to conserve PPE by decreasing bedside team size and enabling remote assistance in neonatal resuscitation.[4] No previous studies have described on-site telemedicine, as 'virtual personal protective equipment' (VPE), to limit bedside staff exposures and to preserve PPE during paediatric resuscitations.

When new processes, roles and equipment are introduced, system-focused simulations are conducted prior to training.[5] Due to the COVID-19 pandemic urgency, we used system-focused, iterative simulation to rapidly test telemedicine equipment, revise team structure, evaluate PPE usage and initiate interprofessional training for VPE implementation.

METHODS

This study was conducted in the PED (51 000 patient visits per year) and the special isolation unit (SIU) of an academic tertiary-care, free-standing children's hospital.

Participants were recruited from the inpatient emergency response (Code Blue) team and PED. Prescenario briefs included an introduction to VPE: telemedicine equipment, proposed team structure and PPE requirements. Responders were restructured into *inside* and *outside* teams. Inside teams, located bedside, included an inpatient/emergency physician, anaesthesiologist, respiratory therapist and two nurses who donned PPE. Outside teams, located outside the patient room, communicated via telemedicine and included the physician team leader, documenter, PPE coach, medication prep nurse, pharmacist, consultants and additional staff (online supplementary figure 1 and table 1).

Eight simulations with VPE were conducted of a paediatric patient with respiratory failure requiring resuscitation with aerosol-generating procedures. A Laerdal SimBaby was used for two inpatient and two PED simulations. A Laerdal Baby Anne was used for the remainder. Three telemedicine devices were tested: a Microsoft Surface Pro tablet with InTouch Viewpoint software and two InTouch telemedicine carts (Vici and Lite). Devices were accessed using InTouch Provider Access Software on laptops outside patient rooms. Surface Pro Viewpoint software provided limited panning/zooming capability, with otherwise similar functionality to Vici and Lite carts. InTouch devices were cleaned per protocol between resuscitations.

Debriefing, conducted by simulation facilitators, included telemedicine equipment, team structure, communication, new processes, roles and equipment. Issues were discussed between Code Blue and emergency department resuscitation committees. Iterative modifications occurred between simulations. Asynchronous clinical debriefing contributed additional feedback.

PED clinical and simulated resuscitations are routinely reviewed for quality assurance. No identifying patient information nor clinical details were obtained for this study. The total number of staff entering each room was recorded. PPE compliance was defined as all staff donning recommended gear for a patient's isolation status. PPE consumption was calculated based on recommended gear.

Review by the Seattle Children's institutional review board determined this study was not research.

RESULTS

Eight system-focused simulations using VPE (two SIUs and six PEDs) and four clinical events (PED) occurred between 9 March and 3 April 2020. Debriefing themes were collated across events.

Standard paediatric resuscitation elements occurred in all scenarios. Equipment and team structure were iteratively modified based on debriefing. Inpatient units where outside teams were unable to directly visualise patients had greater team satisfaction when telemedicine equipment incorporated better cameras, controlled by outside teams. In the PED, glass walls allowed better visibility. Audibility challenges (insufficient volume and echoes) resulted in optimisation of external speakers, microphones and their locations, particularly when inside team members wore controlled air-purifying respirators.

Table 1 Resuscitation team structure and PPE compliance

	Pre-COVID (2019)	COVID era
Resuscitations reviewed	40 clinical PED resuscitations	12 (8 simulations (2 special isolation units and 6 PEDs) and 4 clinical PED resuscitations)
Number of staff in resuscitation room	Goal: 13–18 Team leader, airway physician, survey physician, order entry physician, history/family physician, medication administration nurse, medication preparation nurse, documenter, circulating nurse (one to two), cardiopulmonary resuscitation coach, circulating technician (one to two), respiratory therapy (one to two), social work and consultants (one to three) Actual total team : 14–19 (range)	Goal: 4–5 Airway physician, bedside physician (combining role of survey physician and assistant for procedures), bedside nurses (one to two) and respiratory therapy Actual total team size: 4–6 (range)
Compliance with recommended PPE*	22.5% (9/40)	83.3% (10/12)

*PPE for PED pre-COVID resuscitations was gowns, simple face masks and gloves; in the COVID era, PPE standards were updated regularly per availability and guidelines.
PED, paediatric emergency department; PPE, personal protective equipment.

Inpatient teams implemented nurse documenter headsets. PED teams did not, due to loss of situational awareness and outside team communication difficulties. Decontaminating telemedicine equipment between patients was feasible.

VPE benefits included decreasing staff exposure and PPE consumption while increasing appropriate use. Team member VPE satisfaction varied. PPE consumption was reduced 57%–79% compared with pre-COVID19 teams, if donning appropriate PPE. Debriefing revealed these PPE barriers: forgetting appropriate PPE, inaccurate donning/doffing and prioritising patient distress over personal safety.

Early challenges included telemedicine equipment (login delays, control and positioning difficulties), communication (audibility, alerting the other team and confirming requests) and diminished situational awareness (patient reassessments and procedural readiness). Two audio equipment failures led to team leaders donning PPE and joining inside teams. To address these issues, iterative changes were made to team preparation (eg, telemedicine equipment job aid), communication standards (eg, 'inside' or 'outside' phrase to alert the other team) and expectations (eg, if necessary, additional member could don PPE and join the inside team).

DISCUSSION

In-hospital telemedicine-facilitated paediatric resuscitation was feasible in PED and inpatient settings. Telemedicine acted as VPE, decreasing total staff exposure during simulated and clinical resuscitations by 57%–79% and conserving PPE.

The introduction of telemedicine equipment as VPE via system-focused simulation required iterative refinement. Physical environment differences informed local modifications optimising audibility and visibility. Given the rapidly evolving pandemic, telemedicine equipment was available for clinical use between PED simulations. Over time, equipment refinement and experience decreased technology-related frustration, team organisational delays and failure to maintain new team structures.

PPE compliance improved with the addition of VPE technology. Debriefing revealed that prior low infection control guideline adherence may have been due to organisational or individual barriers. These findings are similar to other published reports.[3] COVID-19 era teams achieved excellent PPE compliance. This may be due to smaller bedside teams (VPE effect) or adding a PPE coach. Excellent compliance is critically important to staff safety during a pandemic.

This single-centre study had some limitations. Specific telemedicine equipment or team structures may not be generalisable. No specific quality of care metrics were collected. Future studies could evaluate whether changes in equipment, team structure, communication and PPE impact key clinical resuscitation metrics.

CONCLUSION

In-hospital telemedicine as VPE is feasible and may support paediatric resuscitation teams in an academic setting. Implementation of split inside/outside teams has led to decreased staff exposure and PPE conservation and may have contributed to increased PPE guideline compliance. Iterative system-focused simulation established VPE for on-site resuscitation through rapidly refining the new team structure, equipment, processes and standards.

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