Implementing and Validating a Provider Down Emergency Response Procedure in a National High-Level Isolation Unit: A Simulation-Based Quality Improvement Study

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Introduction

- Collapse of a healthcare worker wearing high-level personal protective equipment (PPE) in a High-Level Isolation Unit (HLIU) represents a rare but high-consequence emergency requiring rapid extraction while preserving infection prevention and control (IPC) measures.
- Such events pose operational challenges including contamination risk, communication barriers while in PPE, and complex team coordination.
- Although provider down procedures are described in international bio-containment units, structured validation within national HLIU settings remains limited(1,2).
- This project aimed to implement and evaluate a Provider Down emergency response procedure in the National High-Level Isolation Unit using simulation-based quality improvement methodology.

Methods

- A draft Provider Down standard operating procedure (SOP) was developed using international bio-containment guidance and adapted to the NHLIU Red–Yellow–Green zoning model (1).
- Validation was conducted using Zone 3 of the SimZones simulation framework, focusing on team and system performance within the authentic clinical environment (3).
- Cycle 1 baseline testing was performed in February 2026 using a full in-situ simulation involving collapse of a healthcare worker wearing high-level PPE in the Red Zone.
- Data sources included observer assessment tools, timing metrics, breach logs, participant feedback, video review, and structured hot and cold debrief sessions.
- Findings were analysed using a Plan–Do–Study–Act quality improvement approach to identify latent safety threats and inform protocol refinement (4).

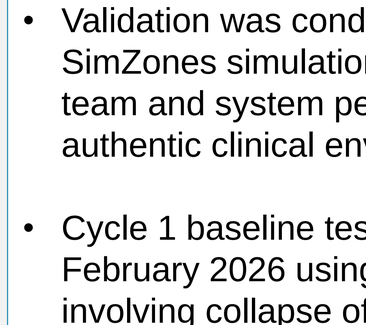

Figure 1. Plan Do Study Act (PDSA) Approach

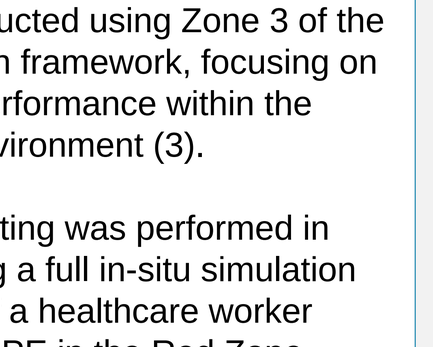

Figure 2. SimZone Framework

Results

- Cycle 1 simulation established baseline response metrics and identified several system-level vulnerabilities:
  - Recognition and declaration of a Provider Down event occurred at **1 minute 20 seconds,** with responder donning requiring **5 minutes** for the first responder and up to **9 minutes** for the full team.
  - Transfer from the Red Zone to the Transition Zone occurred in **1 minute 03 seconds**, followed by PPE decontamination **(3 minutes 55 seconds) and** PPE cut-down **(5 minutes 02 seconds).**
  - Log-roll transfer to the clean area required **49 seconds**, with final transfer completed in **1 minute 51 seconds**.
- Key vulnerabilities included: **communication barriers** caused by powered air-purifying respirator noise, **uncertainty in PPE cut-down sequencing**, **delays associated with responder donning**, **manual handling risks during transfer**, and **environmental factors such as equipment location and door access between zones.**
- Positive findings **included clear recognition of the event, effective leadership by the NHLIU coordinator**, and **controlled movement between contamination zones**.

Table 1. Cycle 1 Provider Down Timing Milestone

Milestone	Time
Collapse & PD Call	1.20 mins
Donning	5 mins (1 responder) / 9 mins (for all)
Responder Entry	2 mins
Transfer from Red to Yellow Zone	1.03 mins
Decontamination of Suits	3.55 mins
PPE Cut-down Sequence	5.02 mins
Mopping & Draping	5.22 mins
Clean Log Roll Technique	0.49 mins
Transfer to Yellow Clean Area	1.51 mins
Handover	Not tested
Ennvironmental Cleaning	3 mins
Doffing	Not tested


Recognition of Provider Down (PD) event


Transfer to Yellow Zone


Transfer to Yellow Zone


PD Decontamination & Cut-down of suit


Clean Team preparing the drape to move PD


Positioning & Transfer to Yellow Clean side


Transferred to clean side – immediate interventions


Environmental cleaning by Clean Team


Provider Down Cycle 1 Participants & NHLIU Simulation Facilitators

Figure 3. Photos of Provider Down Cycle 1 Simulation & NHLIU Team

Conclusions

- Simulation-based testing enabled system-level evaluation of a newly implemented Provider Down procedure within a national HLIU.
- The exercise identified operational, human factor, and IPC risks not evident during protocol development and informed targeted refinements including staged responder entry, revision of PPE cut-down sequencing, improved communication processes, and development of a dedicated Provider Down equipment kit.
- Further simulation cycles are planned to evaluate these refinements and strengthen operational reliability for high-risk, low-occurrence emergencies.

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