

How Can Personal Protective Equipment Be Best Used and Reused: A Human Factors based Look at Donning and Doffing Procedures

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Abstract : Over 115,000 Health Care Workers (HCWs) have died from COVID-19, and millions have been infected while caring for patients. HCWs have filed thousands of safety complaints surrounding safety concerns due to Personal Protective Equipment (PPE) shortages, which included concerns around inadequate and PPE reuse. Protocols for donning and doffing PPE remain ambiguous, lacking an evidence-base, and often result in wide deviations in practice. PPE donning and doffing protocol deviations commonly result in self-contamination but have not been thoroughly addressed. No evidence-driven protocols provide guidance on protecting HCW during periods of PPE reuse. Objective: The aim of this study was to examine safety-related threats and risks to Health Care Workers (HCWs) due to the reuse of PPE among Emergency Department personnel. Method: We conducted a prospective observational study to examine the risks of reusing PPE. First, ED personnel were asked to don and doff PPE in a simulation lab. Each participant was asked to don and doff PPE five times, according to the maximum reuse recommendation set by the Centers for Disease Control and Prevention (CDC). Each participant was videorecorded; video recordings were reviewed and coded independently by at least 2 of the 3 trained coders for safety behaviors and riskiness of actions. A third coder was brought in when the agreement between the 2 coders could not be reached. Agreement between coders was high (81.9%), and all disagreements (100%) were resolved via consensus. A bowtie risk assessment chart was constructed analyzing the factors that contribute to increased risks HCW are faced with due to PPE use and reuse. Agreement amongst content experts in the field of Emergency Medicine, Human Factors, and Anesthesiology was used to select aspects of health care that both contribute and mitigate risks associated with PPE reuse. Findings: Twenty-eight clinician participants completed five rounds of donning/doffing PPE, yielding 140 PPE donning/doffing sequences. Two emerging threats were associated with behaviors in donning, doffing, and re-using PPE: (i) direct exposure to contaminant, and (ii) transmission/spread of contaminant. Protective behaviors included: hand hygiene, not touching the patient-facing surface of PPE, and ensuring a proper fit and closure of all PPE materials. 100% of participants (n= 28) deviated from the CDC recommended order, and most participants (92.85%, n=26) self-contaminated at least once during reuse. Other frequent errors included failure to tie all ties on the PPE (92.85%, n=26) and failure to wash hands after a contamination event occurred (39.28%, n=11). Conclusions: There is wide variation and regular errors in how HCW don and doff PPE while including in reusing PPE that led to self-contamination. Some errors were deemed "recoverable", such as hand washing after touching a patient-facing surface to remove the contaminant. Other errors, such as using a contaminated mask and accidentally spreading to the neck and face, can lead to compound risks that are unique to repeated PPE use. A more comprehensive understanding of the contributing threats to HCW safety and complete approach to mitigating underlying risks, including visualizing with risk management tools may, aid future PPE design and workflow and space solutions.

Keywords : bowtie analysis, health care, PPE reuse, risk management

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