**Appendix 2. Prioritized Failure Modes, Contributing Factors and Risk Mitigation Strategies**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Step** | **Failure Mode** | **S** | **P** | **D** | **RPN**  | **Contributing Factors** | **Consequences** | **Risk Mitigation Strategies** |
| **Person** | **Tools/Tech** | **Organization** | **Environment** | **Task** |  |  |
| 1.0 Prepare to Doff PPE |  |  |  |  |  |  |  |  |  |  |  |  |
| 1.1 [HCW] Inspect PPE | 1. HCW pushes shroud down to see below it | 3 | 8 | 6 | 144 | * Physical and mental fatigue
* Anxiety/ concern for physical contamination
 | * Very limited vision in PAPR, obstructing HCW view
* No mirror to see/ help with inspection
 |  | * Not enough space to maneuver
 | * Rigorous patient activity (e.g., reaching over bed to roll patient)
* Difficult patient (e.g., combative, anxious, or inadvertent movement)
 | * HCW contamination
 | * Have mirror available
* Ensure communication channel between TO/ HCW in pt. room
* Pull HCW from room immediately if they are trying to fix shroud themselves
 |
|  | 3. HCW does not complete full self-inspection [fails to inspect all components] | 7 | 6 | 8 | 366 | * Inherent field of view limitations (i.e., unable to see entire body without assistance)
* Physical and mental fatigue
* Anxious reaction to potential breach
* HCW did not communicate to TO that they are ready to leave the room and have completed self-inspection
 | * Folds in PPE
 |  | * No mirror to see/ help with inspection
 | * Ambiguity on what exactly to assess/ inspect
* Combative patient
* Only one HCW in room
 | * HCW leaves pt. room before they should
* HCW unaware of contamination
* HCW unaware of breach
* HCW contaminated environment
* HCW contaminates team member
 | * Engage the TO earlier that HCW has completed pt. care and prepared to doff
* If other HCW is in the room, have them assist
* Provide HCWs with multiple body length mirrors in pt. room
* TO should utilize poly com if possible to always be able to communicate with and see (if possible) HCW
 |
| Visible contamination? |  |  |  |  |  |  |  |  |  |  |  |  |
| Yes: 1.1.1 [HCW] Disinfect surface of PPE with EPA-registered disinfectant (then proceed to 1.3) | 5. HCW smears around contamination with EPA-registered wipe | 7 | 7 | 3 | 147 | * HCW does not know how to correctly manage contamination
* Physical and mental fatigue
 | * EPA wipes are dry
* EPA wipes are not available
 |  |  | * There is no actual guidance on how to deal with contamination; instructional ambiguity on what to do if there is contamination
* Instructional ambiguity on how to effectively use EPA-registered wipe (e.g., motion of wiping
* Previous HCW does not close EPA wipe container
 | * PPE not thoroughly disinfected
* Increased surface area of contamination
 | * Create specific guidance for managing contamination (one wipe one swipe)
* TO should utilize poly com if possible to always be able to communicate with and see (if possible) HCW
* Ensure integrity and availability of supplies ahead of time
 |
| No: 1.2.1 [HCW] disinfect outer gloves | [see step 3.2-3.4] |  |  |  |  |  |  |  |  |  |  |  |
| 2.0 **[HCW] Engage trained observer** |  |  |  |  |  |  |  |  |  |  |  |  |
| 2.1 [TO] Review goals & hazards | 13. Instructions not clearly verbalized/ stated\*Applies to all instances steps involving verbal instruction | 6 | 6 | 6 | 216 | * Lack of TO knowledge and familiarity with doffing protocol
 | * Clarity of checklist structure and instructions
 | * Not having updated and clear protocols
* Culture of fear when working with clinicians with certain roles
 | * Physical environment precludes TO from watching HCW
 | * TO does not reading directly from checklist
* Working with HCW with difficult personality
 | * Missed Breaches
* Missed Contamination
* TO/ Doffing Assistant (DA) not empowered to speak up when they see something bad about to happen later on
 | * Utilize assertiveness techniques to speak up if unsure of step
* Ensure/ validate competency of TO
* Ensure HCW knows the roles and responsibilities of TO and DA
* Practice communication between HCW and TO (not just knowing the steps: assertive, active listening,
* Ensure closed-loop communication between each step
 |
| 2.2 [TO] Instruct HCW to examine PPE | 14. HCW touches equipment during inspection (e.g., purell machine) | 4 | 7 | 3 | 84 | * Team members not aware of where they/ others are in the room in relation their surroundings (e.g., other team members, equipment)
* Complacency when interacting with purell machine
* Attentional narrowing (HCW and TO; e.g., TO looks at steps vs. HCW, HCW focusing on other aspect of task)
 |  | * PPE training does not incorporate spatial awareness/ situational awareness
 | * Doffing room is small
* Doffing room is cluttered
* Too many people in doffing room
 | * No guidance on how many people should be in doffing room
* No guidance on what equipment is absolutely needed
* No guidance for TO for when to read step then observe
 | * Contamination of equipment that HCW/ team is unaware of
* Contamination of HCW at a later step
 | * HCW could benefit from instruction from Asst. or TO to move away from purell dispenser/any other piece of equipment that can be touched.
* Need assistant and/or TO to cross-check HCW performance
* Training should involve spatial orientation between team members and environment
* Purposefully contaminate equipment/HCW to see what becomes contaminated and provide feedback
 |
|  | 15. Team does not identify all visible contamination | 8 | 3 | 5 | 120 | * HCW overreliance on TO/ DA
* DA/ TO overreliance on HCW
* TO/DA distracted
* Team is complacent because they have successfully doffed so many ties
* Larger HCWs have greater surface area to inspect
 | * PAPR hood makes it difficult to see all areas of potential contamination
* Fold in PPE
 |  | * Harder to do in a small room. E.g., DA and TO trying to watch while simultaneously avoiding bumping into people/ equipment
* Asst./ TO not close enough to HCW to aid in inspection
 | * Ambiguity on what ‘contamination’ mean
* HCW encourages TO/ DA to speed through step
 | * Higher likelihood of contamination at later steps
 | * Proximity of TO/DA affects how well they can aid in inspection. If there is no mirror, the DA or TO needs to be close enough to see to help the HCW. Even with a mirror, you can only see so much.
* HCW should be turning around to help TO/DA with assessment.
* Need to avoid overreliance on the expectation that the HCW is able to identify contamination and DA/TO don’t need to pay as close of attention.
* HCW should be treated as contaminated as a baseline. If there is visual contamination, then even more attention is needed.
 |
|  | 16. Team does not identify active breach | 9 | 4 | 5 | 180 | * HCW overreliance on TO/ DA
* DA/ TO overreliance on HCW
* TO/DA distracted
* Team is complacent because they have successfully doffed so many ties
* Larger HCWs have greater surface area to inspect
 | * PAPR hood makes it difficult to see all areas of potential contamination
* Fold in PPE
 |  | * Harder to do in a small room. E.g., DA and TO trying to watch while simultaneously avoiding bumping people/ equipment
* Asst./ TO not close enough to HCW to aid in inspection
 | * HCW encourages TO/ DA to speed through step
 | * Major injury
* Slower reaction time to breach, needs to be addressed immediately
 | * Proximity of TO/DA affects how well they can aid in inspection. If there is no mirror, the DA or TO needs to be close enough to see to help the HCW. Even with a mirror, you can only see so much.
* HCW should be turning around to help TO/DA with assessment.
* Need to avoid overreliance on the expectation that the HCW is able to identify contamination and DA/TO don’t need to pay as close of attention.
* Ensure there is a sink in doffing room (shower if possible or close by)
* Ensure organizational protocol for managing breach is in place.
 |
| Rip, Tear, or Contamination?  |  |  |  |  |  |  |  |  |  |  |  |  |
| Yes: 2.2.1 [TO] Instruct HCW to follow breach protocol | 17. Breach protocol not followed | 9 | 2 | 4 | 216 | * Stress/fear/anxiety of situation
* Familiarity with breach protocol
* TO/ DA not comfortable trying to calm HCW down
 |  | * No resources dedicated to manage breach
 | * Small space
 | * Instructional ambiguity [contamination and breach is bundled together in instructions
* Instructional ambiguity (there are various scenarios for a breach i.e. what to do if first pair of gloves are ripped, versus the second pair of gloves being ripped etc.)
* No access to physical copy of breach protocol
 | * Increased risk of injury to TO/ DA and HCW
* Slower reaction time to breach, needs to be addressed immediately
 | * Facility should be specific in their protocols on what should happen for each specific breach (i.e., a tiered breach protocol)
* Error-based, stress exposure training
* Universal guidance is needed for breach protocol that can be easily adaptable to local institutions
* TO/ DA need to be empowered to calm HCW down
 |
| No: Proceed to step 3 |  |  |  |  |  |  |  |  |  |  |  |  |
|  **3.0 Disinfect outer gloves** |  |  |  |  |  |  |  |  |  |  |  |  |
| 3.1 Examine for contamination | 19. Cuff of the outer glove is exposed | 4 | 10 | 5 | 200 | * HCW has small wrists
 | * Gown cuffs are not fluid impermeable
* Outer glove cuff roles down
 | * Protocol does not include securing cuff to gown
 |  | * Physical tasks requiring vigorous movement
* Tasks involving a wet patient
 | * Contamination of gown or person
* Contamination can seep under outer glove into inner glove
 | * Use duct tape to secure in place or other means of securing the gloves to the gown
* Ensure gown cuffs are fluid impermeable
 |
|  | 20. HCW does not identify all contamination | 6 | 6 | 7 | 252 | * Hands are too close to body and can’t see potential contamination as easily.
* False sense of security due to previous hand hygiene
* False sense of security due to PPE being outer layer
* Vigilance decrement
 | * Bulky PPE (e.g., shroud in the way)
* Incorrect glove size
 | * Inadequate training for HCW and TO/DA on identifying contamination
 | * No mirror or other means to help identify contamination
 |  | * Further contamination by not identifying
* Risk contaminating otherwise uncontaminated people or equipment
 | * Training for contamination identification
* Education on contamination and assessing risks (why it is important and why it varies)
 |
|  | 21. DA /TO do not identify all contamination | 7 | 6 | 9 | 378 | * False sense of security due to previous hand hygiene
* False sense of security due to PPE being outer layer
* Vigilance decrement
* TO/ DA not comfortable to speak up
* DA uncomfortable being too close to HCW
 |  | * Inadequate training for HCW and TO/DA on identifying contamination
 | * Physical distance between DA/ TO and HCW
 |  | * Further contamination by not identifying
* Risk contaminating otherwise uncontaminated people or equipment
 | * Training for contamination identification
* Education on contamination and assessing risks (why it is important and why it varies)
* Utilize appropriate assertiveness techniques to speak up when concerned for contamination
 |
| Visible contamination? |  |  |  |  |  |  |  |  |  |  |  |  |
| Yes: 3.1.1 [HCW]Apply EPA-registered wipe to contaminated area | 22. EPA-registered wipe not utilized correctly | 7 | 6 | 3 | 126 | * HCW does not know how to correctly manage contamination
* Mental and physical fatigue
* Concerned about ‘wastefulness’ of using too many wipes; belief of fiduciary responsibility to organization
 | * EPA wipes are dry
* Not enough wipes available so HCW tries to conserve wipes
 | * No training for one wipe one swipe
* Organizational culture of conservation
 | * Wipes not placed in convenient location
 | * No recommendations/ instructions for how to remove contamination with EPA registered wipe
* There is no actual guidance on how to deal with contamination; instructional ambiguity on what to do if there is contamination
* Instructional ambiguity on how to effectively use EPA-registered wipe (e.g., motion of wiping
* Previous HCW does not close EPA wipe container
* Ambiguity on how practice is done on the unit vs. BCU
 | * HCW smears around contamination; just moving contamination around and not off
* PPE not thoroughly disinfected
* Increase surface area of contamination
 | * Use recommended motion for removing contamination; i.e., one wipe one swipe down and away
* Create guidance for how to deal with contamination (one wipe one swipe)
* Ensure integrity and availability of supplies ahead of time
* Voice message that it is ok to use more than one wipe.
* Ensure training/ validation requires recommended motion
* Optimize placement of EPA-registered wipe
 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| No: 3.2 [HCW] Apply ABHR to palm or EPA-registered disinfectant wipe | 23. Appropriate amount of ABHR not utilized. | 7 | 5 | 8 | 280 | * Anthropometric differences in hand size will influence how much ABHR is needed.
* Think more is better to the amount of excess
* No haptic feedback because there are so many layers
* HCW concerned that gloves will be compromised by using too much ABHR
 | * Foam dissipates faster than gel.
* Depends on color of gloves if it’s hard to see
* Automatic machine not functioning properly
* Machine runs out of ABHR
 |  | * Location of ABHR dispenser not practical
 | * Hand not aligned properly with automatic sensor in ABHR machine
 | * Gloves not thoroughly disinfected
* HCW shakes off ABHR if too much is used
* Takes too long to dry
 | * Edu on too little or too much
* Ensure integrity/ availability of equipment before doffing
 |
| 3.3 [HCW] Rub top/bottom of both hands and in between fingers and thumbs | 25. HCW does not thoroughly disinfect all surfaces | 8 | 6 | 7 | 336 | * Complacency of doffing team to ensure this is done effectively at all doffing stages
* TO/ DA not empowered to speak up
* Slip/ lapse
 | * Color of gloves can make it difficult to see
* Not enough ABHR
 | * Incomplete education and training on performing hand hygiene with gloves
 | * Location of ABHR dispenser not practical
 | * Difficult HCW
* Ambiguity on performing hand hygiene on gloves vs. hands
 | * Incomplete disinfection
 | * Both visual and verbal cues should be provided.
* Recommend fully extending arms during this step.
* Empowerment and assertiveness training for TO/DA to speak up if actions deviate from safe practice/ verbalized instructions
* Training on appropriate application of ABHR for gloves
 |
|  | 26. HCW touches a clean area | 4 | 4 | 6 | 96 | * Team members not aware of where they/ others are in the room in relation their surroundings (e.g., other team members, equipment)
* Complacency when interacting with purell machine
* Attentional narrowing (HCW and TO; e.g., TO looks at steps vs. HCW, HCW focusing on other aspect of task)
 |  | * PPE training does not incorporate spatial awareness/ situational awareness
 | * Doffing room is small
* Doffing room is cluttered
* Too many people in doffing room
 | * No guidance on how many people should be in doffing room
* No guidance on what equipment is absolutely needed
* No guidance for TO for when to read step then observe
 | * Contamination of equipment that HCW/ team is unaware of

Contamination of HCW at a later step | * HCW could benefit from instruction from Asst. or TO to move away from purell dispenser/any other piece of equipment that can be touched.
* Need assistant and/or TO to cross-check HCW performance
* Training should involve spatial orientation between team members and environment
* Purposefully contaminate equipment/HCW to see what becomes contaminated and provide feedback
 |
| 3.4 [HCW] Wait for gloves to dry | 27. HCW Does not wait for hands to dry | 7 | 6 | 3 | 126 | * Lack of knowledge regarding how ABHR disinfects
* Lack of knowledge regarding how the method of applying AHBR disinfects (i.e., friction-based)
 | * Gloves too big (purell builds up in grooves)
 |  |  |  | * If gloves are wet during removal, it is easier to snap.
* Virus/bacteria not killed
* Other items can become contaminated
 | * Every time TO instructs HCW to disinfect, they need to say ‘wait for your hands to dry’ and also not to shake, etc.
* Understanding and competency of germ theory and disinfection
 |
|  | 29. HCW touches contaminated PPE (e.g., on gown) following disinfection | 6 | 5 | 4 | 120 | * Hands are too close to body and HCW touches themselves as they are disinfecting
* Lack of self awareness; not being able visualize area
* Some HCWs are trained to wait (e.g., surgery)
 |  |  | * Doffing area too small
 |  | * HCW re-contaminates self during disinfection
 | * Need adequate cross checking/ monitoring to ensure contamination doesn’t take place
* Train people what they are doing with their body/motions during each step
* Part of TO/Asst. training should be to look for high risk points for contamination
 |
| **4.0 Remove outer apron** |  |  |  |  |  |  |  |  |  |  |  |  |
| 4.1 [HCW/Asst.] Untie strap | 30. Assistant touches contaminated area of PPE | 6 | 7 | 2 | 84 | * TO is paying too much attention to the HCW at the expense of DA
* HCW and DA don’t have adequate spatial and self awareness
* TO not watching closely enough (or role not there)
 | * Type of apron (one that isn’t a tear away), means you have to take it over your head or may need help taking it off
 |  | * More likely to bump into HCW when the space is small
 | * Asst. helps with task that is not necessary
* No guidance on how to remove a grossly contaminated apron
 | * Risk of Asst. contamination
 | * HCW should be removing apron by themselves before entering the doffing area (if you can’t because of space, need to add a disinfectant step); second most contaminated PPE.
* Only use aprons where the HCW worker is able to pull off outer apron individually
* If those are not available, should cut off apron rather than pulling over head
 |
|  | 31. Assistant does not perform hand hygiene after untying strap | 8 | 5 | 8 | 320 | * TO is paying too much attention to the HCW at the expense of DA (needs to pay attention to both people)
* Without TO, DA might ‘slip’ due to multitasking
* HCW doesn’t speak up when they identify someone not doing a step
* Step 3 applies to DA too
 |  | * Not all organizations have a DA and/or TO protocol
 | * Location proximity of purell machine may be good for HCW, but not necessarily DA
 |  | * Contaminate oneself, HCW, and environment
 | * Instructions should also prompt DA to use hand hygiene
* Empower team members to speak up if they notice deviation from protocol/ unsafe practices
* HCW also needs to look out for other team member (HCW treated as ‘primary’ all the time, but also needs to watch out for other team members)
 |
| 4.2 [HCW] Remove apron | 33. HCW touches surgical gown with contaminated portion of PPE | 6 | 6 | 4 | 144 | * Hands are too close to body and HCW touches themselves as they are disinfecting
* Lack of self awareness; not being able visualize area
* TO/HCW rush through step
 |  |  | * Doffing area too small
 |  | * HCW re-contaminates self during disinfection
* HCW contaminates surgical gown
 | * Need adequate cross checking of team members and actions
* Provide feedback on what team members are doing with their body/motions during each step (muscle memory)
* Train team that everything has the potential to be contaminated, even if it’s not visible
* Need organization protocol for remediation if contamination of next level of PPE occurs
 |
|  | 34. HCW touches outside of apron during removal  | 5 | 9 | 5 | 225 | * TO/assistant not paying close enough attention
* Lack of awareness and training
* Completing step to fast
 | * Difficult to tell which side of apron is outside versus inside
 |  |  |  | * HCW contaminates gloves
 | * Color code inside of apron to differentiate outside and inside
* Perform hand hygiene immediately
 |
| Can apron be pulled away at neck? |  |  |  |  |  |  |  |  |  |  |  |  |
| No 4.2.2 [HCW] Lift strap over head (then step 4.2.3) | 36. HCW touches other PPE with contaminated portion of apron | 8 | 8 | 3 | 192 | * Hands are too close to body and HCW touches themselves as they are disinfecting
* Lack of self awareness; not being able visualize area
* TO/HCW rush through step
 | * Type of apron utilized does not tear
 |  |  | * High likelihood of contamination when lifting strap over head
 | * HCW contaminates PAPR hood/gown while pulling over head
* Extremely high likelihood of contamination
 | * HCW should be removing apron by themselves before entering the doffing area (if you can’t because of space, need to add a disinfectant step); second most contaminated PPE.
* Only use aprons where the HCW worker is able to pull off outer apron individually
* If those are not available, should cut off apron rather than pulling over head
* Need adequate cross checking of team members and actions
* Provide feedback on people what they are doing with their body/motions during each step (muscle memory)
* Train team members that everything has the potential to be contaminated
 |
| 4.2.3 [HCW] Pull apron away from body | 37. HCW touches surgical gown with apron | 6 | 6 | 4 | 144 | * Hands are too close to body and HCW touches themselves as they are disinfecting
* Lack of self awareness; not being able visualize area
* TO/HCW rush through step
 |  |  | Doffing area too small |  | * HCW decontaminates self during disinfection
* HCW contaminates surgical gown
 | * Need adequate cross checking of team members and actions
* Provide feedback on what team members are doing with their body/motions during each step (muscle memory)
* Train team that everything has the potential to be contaminated, even if it’s not visible
* Need organization protocol for remediation if contamination of next level of PPE occurs
 |
|  | 38. CW touches outside of apron | 5 | 9 | 5 | 225 | * TO/assistant not paying close enough attention
* Lack of awareness and training
* Completing step to fast
 | * Difficult to tell which side of apron is outside versus inside
 |  |  |  | * HCW contaminates gloves
 | * Color code inside of apron to differentiate outside and inside
* Perform hand hygiene immediately
 |
| 4.3 [HCW] Roll apron inside to outside | 39. HCW touches outside of apron and contaminated gloved hands | 6 | 6 | 4 | 144 | * Hands are too close to body and HCW touches themselves as they are disinfecting
* Lack of self awareness; not being able visualize area
* TO/HCW rush through step
 | * Hard for team members to tell the difference between inside and outside
 |  |  |  | * HCW self contaminates when rolling
 | * There should be clear demonstration of folding the apron from inside to outside
* Immediately perform hand hygiene
* Aprons should have visual cues for what is inside versus outside
* Provide video-based training for feedback
 |
|  | 40. HCW does not roll apron inside to outside | 5 | 9 | 5 | 225 | * Hands are too close to body and HCW touches themselves as they are disinfecting
* Lack of self awareness; not being able visualize area
* TO/HCW rush through step
 |  |  | * Not enough space to raise arms in front to roll gown
 |  | * Risk for contamination
 | * There should be clear demonstration of folding the apron from inside to outside
* Color code inside of apron to differentiate outside and inside
* Ensure the physical size of doffing room is adequate to doff safely
 |
| 4.5 [HCW] Inspect PPE | 42. Team misses a breach in PPE  | 10 | 5 | 5 | 250 | * Team members do not thoroughly inspect
* Team members do not understand the gravity of highly infectious organisms
* Complacency with PPE due to comfort with usage
 | * Equipment sizing plays a role (e.g., folding) can make it more difficult to find a breach
 |  |  | * Size of breach is small and not visible
 | * HCW potentially infected
 | * Knowledge germ theory and viruses/bacteria they will encounter (not just doffing steps) [applies to all steps]
 |
|  | 43. Team misses gross contamination | 7 | 6 | 4 | 168 | * Team members do not thoroughly inspect
* Team members do not understand the gravity of highly infectious organisms
* Complacency with PPE due to comfort with usage
 | Equipment sizing plays a role (e.g., folding) can make it more difficult to find a breach |  |  | * Size of contamination is small and not visible
 | * HCW potentially infected
 | * Knowledge germ theory and viruses/bacteria they will encounter (not just doffing steps) [applies to all steps]
 |
|  | 44. HCW touches oneself while inspecting | 4 | 6 | 4 | 96 | * Team members not aware of where they/ others are in the room in relation their surroundings (e.g., other team members, equipment)
* Attentional narrowing (HCW and TO; e.g., TO looks at steps vs. HCW, HCW focusing on other aspect of task)
 |  | * PPE training does not incorporate spatial awareness/ situational awareness
 | * Doffing room is small
* Doffing room is cluttered
* Too many people in doffing room
 | * No guidance on how many people should be in doffing room
* No guidance on what equipment is absolutely needed
* No guidance for TO for when to read step then observe
 | * HCW re-contaminates oneself
 | * Need assistant and/or TO to cross-check HCW performance
* Training should involve spatial orientation between team members and environment
* Purposefully contaminate equipment/HCW to see what becomes contaminated and provide feedback
* Hand hygiene should be performed immediately after doffing apron
* Ensure there are mirrors to aid in inspection
* If there is no space for mirrors, ensure you have a TO/ DA to help
 |
| Rip, tear, or contamination? |  |  |  |  |  |  |  |  |  |  |  |  |
| Yes: 4.5.1 Apply EPA registered wipe (contamination); Follow breach protocol (rip/tear) |  [See 3.1.1] |  |  |  |  |  |  |  |  |  |  |  |
| **5.0 Disinfect outer gloves** |  |  |  |  |  |  |  |  |  |  |  |  |
| 5.1 Do step 3 in order | [See step 3] |  |  |  |  |  |  |  |  |  |  |  |
| **6.0 [HCW] Remove boot covers** |  |  |  |  |  |  |  |  |  |  |  |  |
| 6.2 [HCW] Take off first boot cover | 45 Assistant touches bottom of HCW boot cover  | 8 | 8 | 5 | 320 | * Asst. not competent in technique
* Asst. distracted
* Physical build of HCW and Asst. Could be more challenging when the HCW has longer legs or larger calves; could be more challenging if asst. has flexibility limitations/ trouble bending over
* Lack of spatial awareness (positioning, line of sight)
 | * Elastic portion of boot cover can get caught on shoe
* Boot cover not fluid impermeable
* Boot covers made for ORs, not for pathogen transmission
 | * Access to/availability of particular type of boot covers is limited
* Variability of boot covers within organization
 | * Size of doffing space not adequate
 | * No explicit direction to avoid touching bottom of boot cover
 | * Strikethrough (fluid penetrates PPE)
 | * TO should provide clear direction for the assistant not to touch the bottom of the boot cover anticipating this occurrence
* Boot covers (and all equipment) should be fluid impermeable
* TO needs to visually orient themselves to see that the task is being completed safely
* Optimize the placement of equipment within the doffing room to promote safe behaviors and efficiency
* Ensure the physical size of the doffing room is adequate to doff safely
 |
|  | 46. Edge of gown is contaminated and touches scrub pants | 6 | 4 | 6 | 144 | * HCW does not follow directions
* Poor verbalization of instructions
* Lack of spatial awareness
* Distraction/attentional narrowing
 | * Gown size too short
* Boot covers too short
 | * Inadequate training on safely removing PPE
 | * Size of doffing space not adequate
 |  | * Contamination of scrub pants and potentially taking contamination outside of room to other areas
* Strikethrough because scrubs are not fluid impermeable
* Ineffective response to stress/anxiety
 | * Boot covers should not be removed first, they should be removed during the last step (consistent with current CDC guidelines)
* Ensure the physical size of the doffing room is adequate to doff safely
* Ensure there is a protocol in place to ensure contamination of scrubs is managed effectively (e.g., disinfectant wipe on scrub area, shower immediately)
* Error-based/ perturbation training
* Train and evaluate the competency of the TO in providing verbal instructions
 |
| **7.0 Disinfect outer gloves** | [see step 3] |  |  |  |  |  |  |  |  |  |  |  |
| **8.0 Remove outer gloves** |  |  |  |  |  |  |  |  |  |  |  |  |
| 8.1 [HCW] Take off first glove slowly | 53. Glove is not dry | 7 | 6 | 3 | 126 | * HCW attempts to complete step too quickly
 | * Gloves become slippery when ABHR is not dry.
 |  |  |  | * HCW contaminates inner layer and gown
* Gloves not sufficiently disinfected
* Gloves snap an flies across room
* Glove rips
 | * See step 3
* Empowerment and assertiveness training for TO/DA to speak up if actions deviate from safe practice/ verbalized instructions
 |
|  | 54. HCW reaches under wrist | 7 | 7 | 3 | 147 | * HCW attempts to complete step too quickly
 |  |  |  | * Common way HCWs remove glove
 | * Contaminate inner gloves and gown
 | * Need standardized way for glove removal that emphasizes glove to glove contact
 |
|  | 56. HCW snaps glove [all glove steps] | 7 | 6 | 3 | 126 | * HCW attempts to complete step too quickly
 |  |  |  |  | * Contaminates oneself
 | * Empowerment and assertiveness training for TO/DA to speak up if actions deviate from safe practice/ verbalized instructions
 |
| 8.1.2 [HCW] Pinch glove and lift at wrist | 58. HCW reaches under glove | 7 | 7 | 3 | 147 | * Many HCWs do not routinely use this technique (i.e., pinch glove at wrist) so are not used to doing it this way
* Complacency with PPE
 |  |  |  |  | * Contaminates glove and/or gown
 | * Need standardization for glove removal that emphasizes glove to glove contact
 |
| 8.1.4 [HCW] Hold balled glove in palm of other gloved hand | 59. Fingers of first glove hang down and touch inner glove | 6 | 6 | 6 | 216 | * Harder to hold in ball for HCWs with smaller hands
* Difficult for DA/TO to see what is going on with gloves while paying attention to everything else
 |  |  |  | * It is not necessary to keep glove in hand
 | * Contaminates oneself
* Increased difficulty for removing second glove
 | * Can throw glove away because it is not necessary to keep it in hand
* Need verbal and visual confirmation that entire glove is balled in hand before proceeding if step is followed
 |
|  | 60. HCW touches outside of glove 2 with inner glove of hand 1 | 6 | 6 | 4 | 144 | * Distraction/ attentional focus (focused on removing glove, not other hand)
* Complacency with PPE
* Many HCWs do not routinely use this technique (i.e., pinch glove at wrist) so are not used to doing it this way
 |  |  |  | * Sequence of removal for gloves is different for each hand
* Removing second glove more difficult than removing first
 | * Contaminates oneself
 | * Apply EPA-registered wipe or ABHR if contamination of inner glove takes place
 |
| **9.0 [HCW] Inspect both inner gloves** |  |  |  |  |  |  |  |  |  |  |  |  |
| 9.1 [HCW] Inspect palms, backs of hands, and fingers | 65. HCW does not identify all contamination | 5 | 7 | 6 | 210 | * Team members do not thoroughly inspect
* Team members do not understand the gravity of highly infectious organisms
* Complacency with PPE due to comfort with usage
 | Equipment sizing plays a role (e.g., folding) can make it more difficult to find a breach |  |  | * Size of contamination is small and not visible
 | * HCW potentially infected
 | * Knowledge of germ theory and viruses/bacteria they will encounter (not just doffing steps) [applies to all steps]
 |
|  | 66. Team does not identify breach | 9 | 5 | 4 | 180 | * Team members do not thoroughly inspect
* Team members do not understand the gravity of highly infectious organisms
* Complacency with PPE due to comfort with usage
 | * Equipment sizing plays a role (e.g., folding) can make it more difficult to find a breach
* Can be difficult to identify breach if gloves are flesh colored
 |  |  | * Size of breach is small and not visible
 | HCW potentially infected | * Knowledge of germ theory and viruses/bacteria they will encounter (not just doffing steps) [applies to all steps]
* Ensure gloves are not flesh colored
 |
| Rip, tear or contamination? |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 68. HCW proceeds to next step after feeling sting | 9 | 2 | 7 | 126 | * Not comfortable/ confident speaking up
 |  |  |  |  | * Infected with bacteria/ virus
* Breach protocol not followed
 | * TO should inform HCW at this step that if they feel a sting from applying ABHR, that there could potentially be a small hole not visible to the eye.
* Empowerment and assertiveness training
 |
| 9.1.4. [HCW] Perform hand hygiene with ABHR (see step 17) | 69. Ineffective hand hygiene | 8 | 6 | 3 | 144 | * HCW rushes through steps due to increased anxiety and panic
 |  |  |  | * Unclear whether ABHR is enough or should HCW be doing hand washing at this point especially if there is blood.
 | * Contamination/ possible infection
 | * Need to practice what to do in case of breach/ contamination
* TO needs to remind HCW to stay calm and focus on completing task safely; TO needs to be comfortable to tell the HCW to slow down and do task correctly (empowerment assertiveness)
 |
| **10.0 Remove PAPR** |  |  |  |  |  |  |  |  |  |  |  |  |
| 10.1 [Asst.] Detach hose at the hood |  |  |  |  |  |  |  |  |  |  |  |  |
| 10.2 [Asst.]Turn off system | 70. Asst. touches contaminated portion of HCWs PPE while assisting battery back removal | 5 | 7 | 3 | 105 | * Lack of awareness/ behavioral synchronization between HCW and assistant
* TO focuses too much on HCW
* Team Rushing through step
 |  |  | * Small doffing area
 |  | * Asst. contaminates oneself
 | * Asst. should perform hand hygiene afterward
* Incorporate step to check for and remediate any potential contamination prior to starting step
* DA/HCW should verbalize where equipment is and where they are in relation to other team members and equipment
* Receipt of communication should be acknowledged to ensure shared understanding
 |
| **11.0 Remove hood** |  |  |  |  |  |  |  |  |  |  |  |  |
| 11.1 [Asst.] Grab outside of HCWs hood |  |  |  |  |  |  |  |  |  |  |  |  |
| 11.2 [Asst.] Roll hood up towards top of shoulders | 75. HCW/Asst. touches underneath inner shroud | 8 | 3 | 5 | 120 | * Lack of self/team awareness of actions in relation to potentially contaminated PPE
 | * Easier to contaminate longer hood
 |  |  | * It is difficult to roll up both layers of PAPR hood. This requires practice
* Instructions do not indicate for Assistant to lift the inner shroud of the hood and roll up only the outside. However in demonstration both shrouds are rolled up to form a cuff.
 | * HCW/ asst. contamination
 | * Ensure remediation steps are in case of contamination
* Consider alternate PAPR shroud
* Encourage verbalization between team members of where they are in relation to other people
* Provide extra practice for rolling up shroud
 |
|  | 82. HCW touches face with gloves | 9 | 7 | 2 | 126 | * Natural tendency, especially for people with corrective lenses or long hair
* Increased likelihood for HCWs with corrective lenses and/or long hair
 |  |  |  | * No explicit instructions to not touch face
 | * Risk of contamination
 | * TO needs to verbalize at this step not to touch face/hair (provide reinforcement)
* Ensure adequate hair coverage and straps for corrective lenses
 |
| **12.0 Remove gown** |  |  |  |  |  |  |  |  |  |  |  |  |
| 12.1 [HCW] Release tie | 83. HCW touches uncontaminated portion of PPE | 6 | 5 | 4 | 120 | * HCWs more vigilant with gowns than other portions of PPE
* Team members need to have self/team awareness
* More difficult to manage for HCWs with shorter arms
 |  |  | * Doffing area is too small
 | * Assistant helped the HCW untie the apron (second most contaminated PPE) but does not assist HCW with gown which is even more difficult to remove without contaminating oneself
* No guidance for releasing Velcro
 | * Contaminates scrubs (final layer of protection)
 | * Recommend that Assistant untie gown and start fold on either side of the gown in the back to avoid outside of the gown from touching HCW’s scrubs
* Provide instructional guidance for HCW to release Velcro
 |
| 12.2 [HCW] Pull gown slowly away from body until off shoulders | 85. HCW touches uncontaminated portion of PPE | 6 | 5 | 4 | 120 | * HCWs more vigilant with gowns than other portions of PPE
* Team members need to have self/team awareness
* More difficult to manage for HCWs with shorter arms
 |  |  |  | * Instructions are not specific enough.
 |  | * HCW should be instructed to only touch the outside of the gown. Start with one hand touching opposite shoulder on the outside of the gown; repeat instructions for opposite shoulder.
* Recommend that Assistant untie gown and start fold (6 inches) on either side of the gown in the back to avoid outside of the gown from touching HCW’s scrubs
* Include instructions for assistant not to shake gown if they are providing assistance with gown removal
 |
| **13.0 Disinfect inner gloves** |  |  |  |  |  |  |  |  |  |  |  |  |
| 13.1 [HCW] Apply ABHR to palm or EPA-registered disinfectant wipe | [see step 3] |  |  |  |  |  |  |  |  |  |  |  |
| **14.0 Disinfect shoes** |  |  |  |  |  |  |  |  |  |  |  |  |
| **15.0 Disinfect inner gloves**  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15.1 see step 13 |  |  |  |  |  |  |  |  |  |  |  |  |
| **16.0 Remove inner gloves**  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16.1 Do 8.1-8.3 |  |  |  |  |  |  |  |  |  |  |  |  |
| **17.0 Perform hand hygiene** |  |  |  |  |  |  |  |  |  |  |  |  |
| **18.0 Inspect body for contamination** |  |  |  |  |  |  |  |  |  |  |  |  |
| 18.1 [HCW] Hold out both arms to side | 91. Team misses contamination | 10 | 4 | 5 | 200 | * Team members do not thoroughly inspect
* Team members do not understand the gravity of highly infectious organisms
* Complacency with PPE due to comfort with usage
 | * Equipment sizing plays a role (e.g., folding) can make it more difficult to find a breach
 |  |  | * Size of contamination is small and not visible
 | * Potential contaminate others outside of doffing area
* HCW potentially infected
 | * HCW should shower immediately after patient care (not just after patient shift)
* Ensure there are proper/structured decontamination protocol/practices (i.e., sequential steps for cleaning different areas)
* Knowledge germ theory and viruses/bacteria they will encounter (not just doffing steps) [applies to all steps]
 |
| 18.2 [HCW] Slowly turn around | 93. Team misses contamination | 10 | 4 | 5 | 200 | * Team members do not thoroughly inspect
* Team members do not understand the gravity of highly infectious organisms
* Complacency with PPE due to comfort with usage
 | * Equipment sizing plays a role (e.g., folding) can make it more difficult to find a breach
 |  |  | * Size of contamination is small and not visible
 | * Potential contaminate others outside of doffing area
* HCW potentially infected
 | * HCW should shower immediately after patient care (not just after patient shift)
* Ensure there are proper/structured decontamination protocol/practices (i.e., sequential steps for cleaning different areas)
* Knowledge germ theory and viruses/bacteria they will encounter (not just doffing steps) [applies to all steps]
 |
| Rip, tear, or contamination? |  |  |  |  |  |  |  |  |  |  |  |  |
| Yes: 18.3.1 Apply EPA registered wipe (contamination); Follow breach protocol (rip/tear) | 95. Protocol for contamination/ breach not followed | 10 | 6 | 3 | 180 | * Complacency/ fatigue with being at end of protocol (for both the TO and HCW… the TO might be doffing several people)
 |  | * Breach/contamination protocol not in place at organization
 |  | * Instructional ambiguity for how to manage contaminated scrubs
* Instructional ambiguity for how to manage breach
 |  | * Should give more specific instructions at this point if there is a contamination because now the scrubs are contaminated and now HCW’s skin could potentially be contaminated. Inspect HCW’s visible skin? Where are scrubs contaminated? Should HCW leave the doffing area without supervision? etc.
* This instruction is more detailed with regards to contamination versus rip/tear; it should be the same for all steps where contamination/rip/tear are addressed
* TO and Assistant should also be rotated
* TO and DA also need to be empowered to speak up if their tired
* Develop and ensure the integrity of breach/ contamination protocol that is appropriate for the size/level of the institution
* Rehearse/practice breach and contamination protocols
 |
|  | 98. HCW does not shuffle feet on disinfectant soaked pads | 6 | 6 | 3 | 108 | * TO/asst. not having eyes on HCW
 | * Pads not adequately soaked
* Bottom of shoes not smooth
 |  | * No wet/dry pads are on the floor when exiting doffing area especially since boot covers came off on the dirty side of the doffing room and shoe soles have been touching potentially contaminated floor.
 | * Ambiguity on shuffling versus contact time. Is a short contact time enough?
 | * Brings contamination in hallway
 | * Consider putting on a new pair of shoes (i.e., doff shoes)
* Ensure a minimum contact time during shuffling
* Empower team members to speak up and point out if they aren’t doing it
* TO should reinforce important of step
 |
| **Misc./ Globally Relevant Failure Modes to all steps** | 100. HCW does not follow steps as instructed by TO | 7 | 6 | 3 | 126 | * Inadvertent due to fatigue and audibility limitations
* Deliberate non compliance due to hierarchy status, complacency, normalization of deviant behavior
 |  |  |  |  |  | * Empowerment and assertiveness training
 |
|  | 101.PPE is too big for HCW | 7 | 4 | 3 | 84 |  |  | Sufficient PPE size not available |  |  | * Gets in way of completing doffing steps.
* Makes it more difficult to spot contamination
 | * HCW needs to know their size limit
* Ensure appropriate size (verbal confirmation) during donning
* TO needs to be empowered to say ‘no’ need to change before providing pt. care
* Ensure organization tracks supply levels and ensure appropriate supply levels based on personnel size needs

[preparation and readiness] |
| **Other Insights** | 102. Assistant keeps walking back and forth between dirty and clean area | 9 | 10 | 7 | 630 | * TO inexperience
* TO failure understand risk
* Lack of spatial awareness
* Distraction/ attentional narrowing
 |  | * Org does not provide training in the understanding of germ theory (and viruses/bacteria) and competency in disinfection/identifying and assessing risks
 | * No clear designation between clean and warm areas.
 | * TO is focusing on multiple things simultaneously
* Ambiguity of whether the TO should always stay on the clean side
 | * TO contaminates ‘clean’ area of doffing room
* Others who pass through clean area become contaminated and don’t know it (e.g., carry it out of hall)
 | * Provide visual indication of contamination vs. contamination free areas of doffing room
* Provide education/ training in the understanding of germ theory (and viruses/bacteria) and competency in disinfection/identifying and assessing risks
* Training should involve spatial orientation awareness between team members, environment, and equipment in relation to team member body movements
* Team members should utilize assertiveness techniques and speak up if they are unsure or uncomfortable
* Ensure there is both a TO and assistant to facilitate the doffing process for the HCW; One person providing assistance alone will consistently cross into both clean/contaminated zones
 |
|  | 103. PPE too small | 7 | 7 | 3 | 147 | * HCW discomfort/ embarrassment of in selecting bigger size PPE
* HCW too large
 |  | * Org. does not have sufficient size available
 |  |  | * Greater risk for contamination/breach (gaps, rips)
 | * Ensure HCW knowledge of equipment size and fit (including shoe size
* Ensure organization tracks supply levels and ensure appropriate supply levels based on personnel size needs
* Confirm size of PPE elements are appropriate during donning
* Consider the physical attributes of healthcare workers volunteering care for patients exposed to high consequence pathogens
 |

NOTE: S, severity; P, probability; D, detectability; RPN, risk priority score (calculated by multiplication of three values S\*P\*D).