Teaching sterile skills in anesthesia
Is providing context helpful for robust skill acquisition?

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Epidural anesthesia
• Pan relief method during childbirth and during and after operations
• As it is an invasive technique, it carries the risk of contamination
• Residents basically learn the procedure in the clinic
• Even after 4 years of training, residents still make sterility errors (Friedman et al, 2008)
• sterility is a complex concept
• sterility is not visible

Present training is not optimal
• Medical skills should be flexible and robust (Cnossen, 2015)
• Flexible: applicable outside context in which it was learned
• Robust: resistant to stress and workload
• Present training of complex procedures often focuses on the order of the steps of the procedure
• This makes learning vulnerable
  • steps may be forgotten and skipped
  • steps may be performed in the wrong order
• In practice there is no fixed order of steps
  • different procedures have different steps, equipment, medication
  • not all steps have to be performed in a strict order
  • in practice, every supervisor has their own preferred order and method
• Focus on the steps in the procedure during learning
  • does not lead to flexibility in the skill
  • what if a step cannot be performed
  • does not lead to robustness of the skill
  • in stress situation memory errors can happen

Different approach: focus on the context
• Taatgen, Huss, Dickinson & Anderson (2005) showed that in teaching flexible cognitive skills teaching materials should draw attention to
  • the pre-conditions of actions (knowing when)
  • the post-conditions of actions (knowing the effects of actions in the environment)
• They found that Boeing pilots were more flexible and the skill was more robust after learning with a focus on these environmental cues
• learners can then rely on environmental cues rather than keeping track of all the executed steps in their mind
• We applied this approach to training preparing and executing epidural anesthesia

Method
• 37 medical students participated in simulation study
• Skill: preparation of epidural anesthesia
  • 14 steps
  • 10-15 minutes
Procedure
• Video instruction of procedure
• Studying description of steps on paper
  • non-sterile actions were written in red
  • sterile actions were written in green
• 15 minutes practice with materials and instruction sheets
• Test: perform the procedure with an “non-obstructive nurse”

Instructions
• List condition
  • 34 steps in chronological, strict order
• Context condition
  • steps arranged in sets
  • order within set was not important
  • photographs
  • pre-conditions of a set of actions (“before”)
  • post-condition (“after”)
  • description of the actions to be performed within the set

List condition
1. Push button on black box
2. Draw the sterile sheet
3. Push the switch
4. Draw the sterile tray
5. Sterile gauze
6. Sterile needle
7. Sterile syringe
8. Sterile scissors
9. Sterile forceps
10. Sterile needle
11. Sterile bottle
12. Sterile container
13. Sterile bottle
14. Sterile tray
15. Sterile scalpel
16. Sterile plastic
17. Sterile paper
18. Sterile package
19. Sterile instrument
20. Sterile equipment
21. Sterile glass
22. Sterile brush
23. Sterile sponge
24. Sterile towel
25. Sterile bandage
26. Sterile gauze
27. Sterile tourniquet
28. Sterile syringe
29. Sterile needle
30. Sterile instruments
31. Sterile instrument
32. Sterile tool
33. Sterile equipment
34. Sterile apparatus

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Main results

Discussion
• Contrary to expectation the context condition did not result in robust skill
  • This stands in contrast to Taatgen et al’s study
  • Context condition even resulted in more sterility errors than the list condition
Why?
• Environmental cues
  • In epidural anesthesia procedure, there are also many environmental cues in list condition (eg syringes filled or empty?)
  • Boeing pilots used complicated system with low usability, so possibly profited more from context
• Memory load
  • Context condition possibly imposed larger memory load on participants
  • The known advantages of the context method were at least partly offset by the disadvantages of this high memory load
Sterility
• Apparently, sterility errors are difficult to prevent, even though we explicitly noted which steps of the procedures were sterile or not
• The participants in the experiment were probably unfamiliar with the concept of sterility
• Sterility is a complex concept
  • it is not obvious for example that crossing a sterile workspace with (unsterile) bare underarms is not sterile

Conclusions & recommendations
• Complex medical skills involve many steps and induce a high memory load to learn them
• Providing context when teaching a procedure may therefore not necessarily lead to better skill acquisition than learning the steps
• but the resulting skill may be more flexible and robust after context-learning
• Further research is needed to test whether it may be advantageous to first study the steps in a procedure until all steps are remembered before performing the skill
• separating studying the declarative knowledge from training the procedural skill
• we can then also test the flexibility and robustness of the skill
• Further research is needed to test whether teaching sterility concepts separately from the procedure itself is needed

References