**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, Dickson & Anderson (2005) showed that 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-obscurative 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

**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 (e.g. 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**

