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: resistent 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
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, Dickison & 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 what the effects of actions in the environment are)
They found that Boeing pilots were more flexible and the skill was more robust after learning with a focus on these environmental cues

We applied this approach to training preparing and executing epidural anesthesia

Method

37 medical students participated in simulation study
Skill: preparation of epidural anesthesia
34 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-sterile 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
Procedure
1. Place sterile gloves
2. Sterile gown, sterile mask
3. Sterile gown, sterile mask with head cover (non-obstructive nurse)
4. Disinfect the area
5. Open sterile pack
6. Draw up the medication
7. Dress the sterile nurse
8. Place the epidural
9. Place the epidural set in other corner
10. Grote bakje, voor roze Chloorhexidine
11. Kleine bakje boven epiduraal-naaldenset
12. Grote bakje, voor roze Chloorhexidine, in andere bovenhoek
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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 syringe 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 unfamilair 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