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

Fokie Cnossen¹, Katja Paul¹, Roelof Lettinga² & Götz Wietschas²
¹ Cognitive Modeling group, Institute of Artificial Intelligence and Cognitive Engineering, University of Groningen
² Anesthesiology, University Medical Centre Groningen
¹.cnossen@rug.nl

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, 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 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

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 profitted 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

METHOD

Procedure
• Time 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

REFERENCES
Friedman, Z., Siddiqui, N., Katznelson, R., Devito, I., & Davies, S. (2008). Experience Is Not Enough: Repeated Breaches in Epidural Anesthesia Aseptic Technique by PanVascular Medicine, 15, 1-10.1007/978-3-319-29037-4

EPISTLE TABLE 1

<table>
<thead>
<tr>
<th></th>
<th>List</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterility errors</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Order errors</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Clinically relevant errors</td>
<td>Red</td>
<td>Red</td>
</tr>
</tbody>
</table>

EPISTLE TABLE 2

<table>
<thead>
<tr>
<th></th>
<th>List</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterility errors</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Order errors</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Clinically relevant errors</td>
<td>Red</td>
<td>Red</td>
</tr>
</tbody>
</table>

EPISTLE TABLE 3

<table>
<thead>
<tr>
<th></th>
<th>List</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterility errors</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Order errors</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Clinically relevant errors</td>
<td>Red</td>
<td>Red</td>
</tr>
</tbody>
</table>

EPISTLE TABLE 4

<table>
<thead>
<tr>
<th></th>
<th>List</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterility errors</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Order errors</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Clinically relevant errors</td>
<td>Red</td>
<td>Red</td>
</tr>
</tbody>
</table>

EPISTLE TABLE 5

<table>
<thead>
<tr>
<th></th>
<th>List</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterility errors</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Order errors</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Clinically relevant errors</td>
<td>Red</td>
<td>Red</td>
</tr>
</tbody>
</table>

METHOD

Procedure
• Time 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

REFERENCES
Friedman, Z., Siddiqui, N., Katznelson, R., Devito, I., & Davies, S. (2008). Experience Is Not Enough: Repeated Breaches in Epidural Anesthesia Aseptic Technique by PanVascular Medicine, 15, 1-10.1007/978-3-319-29037-4