Teaching Procedural Skills: an overview of the literature

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How did we get here?

- CU Residents
- Academy of Medical Educators
- Literature review
- Workgroup formed to create new model to teach procedures
Schedule

- **3 levels of learners**
  - Beginner
    - Skill automation
  - **Small group activity**
  - Intermediate
    - Cue recognition
  - Advanced
    - Hypothetical situations

- **Practice teaching procedural skills in small groups**
  - Master
    - Deliberate practice
  - **Group Competition**
3 STAGE LEARNING OF PROCEDURAL SKILLS
Teaching is procedural skills is hard

- Watch the video
- Evaluate what is done well or … not so well
Teaching is procedural skills is hard

- Feedback?
Categorization of Learners

- **Beginner Learners**
  - Steps
- **Intermediate Learners**
  - Cues
- **Advanced Learners**
  - Troubleshooting
Categorization of Learners

- Teaching in a systematic way can improve learning
- Assessing and categorizing a learner allows for directed teaching
- Focus on ALL three levels

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*** Small group activity

*** Group Competition
BEGINNER LEARNERS
Beginners Learners

How do I do it?

- Entry level learners for a specific procedural skill
- Have little past experience with procedure
- Often are still trying to figure out how the procedure should progress
Dance, Dance, Revolution: motor skills in the “real world”
SKILL AUTOMATION
How the brain learns skills

- Initially multiple brain areas activated
- Becomes streamlined
- Require repetition
- Learning curves are different but everyone can become competent with practice

*Simulation-based mastery learning reduces complications during central venous catheter insertion in a medical intensive care unit.* Barsuk, J.H., et al., Crit Care Med, 2009
Automated Knowledge

- “Second nature”
- Un-accessible to the teacher
- Multi-faceted
  - Motor
  - Assessment
  - Cognitive
Brain changes with practice

- Increased practice => reduction in un-necessary brain activation

Motor skill acquisition

- 37 Surgical residents
- 12 tasks that required mastery to move forward

Motor skill acquisition

TABLE 1. Task Descriptions and Expert Proficiency Levels

<table>
<thead>
<tr>
<th>Task</th>
<th>Cutoff Time (seconds)</th>
<th>Proficiency Score*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Palm needle driver</td>
<td>7 seconds, no errors</td>
<td></td>
</tr>
<tr>
<td>2. 2-Handed knot tying without tension</td>
<td>10 seconds, no errors</td>
<td></td>
</tr>
<tr>
<td>3. 1-Handed knot tying without tension</td>
<td>10 seconds, no errors</td>
<td></td>
</tr>
<tr>
<td>4. 2-Handed knot tying with tension, surgeon’s knot</td>
<td>13 seconds, no errors</td>
<td></td>
</tr>
<tr>
<td>5. 2-Handed knot tying with tension, slip knot</td>
<td>15 seconds, no errors</td>
<td></td>
</tr>
<tr>
<td>6. 1-Handed knot tying with tension, slip knot</td>
<td>15 seconds, no errors</td>
<td></td>
</tr>
<tr>
<td>7. Simple interrupted suturing</td>
<td>18 seconds, no errors</td>
<td></td>
</tr>
<tr>
<td>8. Interrupted horizontal mattress suturing</td>
<td>31 seconds, no errors</td>
<td></td>
</tr>
<tr>
<td>9. Interrupted vertical mattress suturing</td>
<td>31 seconds, no errors</td>
<td></td>
</tr>
<tr>
<td>10. Simple running suturing</td>
<td>165 seconds, no errors</td>
<td></td>
</tr>
<tr>
<td>11. Subcuticular running suturing</td>
<td>204 seconds, no errors</td>
<td></td>
</tr>
<tr>
<td>12. Subcuticular interrupted suturing</td>
<td>33 seconds, no errors</td>
<td></td>
</tr>
</tbody>
</table>

*Score = cutoff time - completion time - 10 x sum of errors.

Motor skill acquisition

Beginner Learners

Teaching Tips

◦ Describe movements with simple terms and from the perspective of the learner
◦ Demonstrate with movements
◦ Be patient

*** Remember the steps are often highly automated
Tips from the Literature

- **Interference leads to less learning**
  - Limit distractions during learning
  - Minimize talking the first time someone sees a procedure

- **Build motor skills in non-clinical settings**


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    - Deliberate practice

- *** Small group activity

- *** Group Practice

- Practice teaching procedural skills in small groups
Automation of Knowledge

In small groups:

1. Designate a teacher
2. Pick up the banana and suture kit
3. **Without talking**, teach the group how to close a laceration
4. Group members should try to document each step in the procedure (physical and mental)
5. Compare procedural steps when finished
Automation: Discussion

- Was suturing easy to teach without talking?
- How many steps did your group identify?
- Were there steps that were noticed by the group but not the teacher?
- As a learner, was it helpful or difficult to watch a procedure without narration?
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INTERMEDIATE LEARNERS
What is a Cue?

- Sounds, sights, smells, auras, gut feelings that let you know things are RIGHT or WRONG

- Barely noticeable to advanced learners, not known by beginners
Examples of Missed Cues

- Why didn’t you stop? You could see the area was bleeding.
- Why did you keep cutting? You could obviously see you were in the wrong tissue plane.
- Why did you tie that knot? You were clearly in the wrong spot.
Intermediate Learners

HOW DO I KNOW I’M DOING IT RIGHT?

- Well acquainted with how procedure should progress
- Capable of performing procedure with close supervision
- Often are competent in a normal uncomplicated procedure but may not be confident that their assessment and decisions are correct
Teaching procedural skills is hard

- Feedback?
Intermediate Learners

Teaching Tips

◦ Identification of landmarks
  • How do you know its not an artery
  • How do you know you are pulling on a structure too hard
  • How do you know the bleeding is really stopped
Surgical Suture Errors

- **Use of the wrong suture.** Some materials are not recommended for patients with anemia, malnutrition, or other conditions. A surgeon who overlooks these health warnings can injure their patient.

- **Poor stitching technique.** A suture that is not inserted correctly may allow the wound to remain partially open. This makes it very difficult for the wound to heal, while also allowing bacteria to get inside the patient’s body.
Surgical Suture Errors

- **Incorrect removal.** If a medical worker removes a suture prematurely or incorrectly, the wound’s healing process will be interrupted.

- **Health Consequences to Suture Errors:** Victims of improper suturing may suffer from *serious medical complications*, including infection and excessive blood loss. These complications can be very expensive to treat, as well as painful and potentially traumatic for the patient. *Fortunately, there are legal options for anyone who has been injured by surgical suturing errors.*

http://www.tsrinjurylaw.com/minnesota-surgical-error-attorneys
Intermediate Learners

Teaching Tips

◦ Teach checkpoints to ensure things are going correctly
  • Ex: Stopping to make sure the patient is correctly positioned at certain points

◦ Think of transitions between steps and how you know the last step is complete and correct
Intermediate Learners

Teaching Tips

- Teach cues for when things are going wrong
  - How do you know the patient is becoming unstable
  - How do you know when something “just doesn’t look right”
  - How do you know when you cut/punctured something wrong
Tips from the Literature

- Observation is a good surrogate for experience and picking up on cues
  - Much better outcomes with feedback
  - Learners should observe from behind the person doing procedure


Why is teaching intermediate learners so difficult?

- Knowledge is half-automated
- Learner already can do steps
- Learners often don’t show knowledge gaps until a complication occurs
Schedule

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• Practice teaching procedural skills in small groups
  ◦ Master
    • Deliberate practice
  *** Group Competition
ADVANCED LEARNERS
Dance, Dance, Revolution: Advanced
What makes this child advanced?

- Do you think he memorized it?
- How good would he be at a different version of DDR?
- Where is he now?
Advanced Learners

HOW DO I TROUBLESHOOT IT?

- Confident in their ability to perform procedures in a correct and efficient manner
- Can identify abnormalities or complications within a procedure
- Often have seen only a few complications or rare abnormalities within a procedure and are not comfortable managing all situations
Advanced Learners

“How do you troubleshoot it?”

Teaching Tips:

◦ Common pitfalls
◦ Uncommon complications
◦ Management of unusual circumstances

*** Minimally automated, use hypothetical situations
Tips from the Literature

- Realistic situations are best for advanced skills
- Learning without feedback is poor
- Not all learners of the same year are of the same level

Review of Learner Categories

• **Beginner Learners**
  ◦ What do I do?

• **Intermediate Learners**
  ◦ How do I know it's correct?

• **Advanced Learners**
  ◦ How do I get myself out of trouble?
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• Practice teaching procedural skills in small groups
  ◦ Mastery
    • Deliberate practice
  *** Group Competition
Small Group Practice
Role Play Directions

1. Return to small groups
2. Give case scenario to one group member
   * This person should read the case to themselves, they will be the learner
3. Chose another group member to be the teacher
4. Role play the scenario
   1. Determine level of learner
   2. Structure teaching to the appropriate level
   3. Give Feedback
5. Discuss as a group
Specific Teaching Tips

• Beginner
• Intermediate
• Advanced
Schedule

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Defining an Master/Expert

Pick the MASTER NFL quarterback?

A) Peyton Manning

B) Kyle Orton

C) Tim Tebow
Defining Expertise

• Experience ≠ Expertise

• Expertise is validated via expert performance (measurable accomplishments)

• What do we measure in medicine?
The Path to Expertise

Deliberate Practice

• Focusing on improving small aspects of a procedure/task
• Training drills
• With more experience errors decrease, smoother, less concentration needed (automated)
• 10,000 hours

Medical Expertise

Ericsson. Deliberate practice and the acquisition and maintenance of expert performance in medicine and related domains. Acad Med. 2004
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*** Group Competition
Group Practice
Suture Competition

- **Goal:** Fastest “correct” simple interrupted suture

- **Rules:**
  - All materials start on table separated
  - Participants start and stop their own timer
  - Must drive needle, puncture banana, tie 4 ties and cut string
  - Cannot use fingers
  - Any suture technique is permitted (instrument, single handed, double handed)
  - Maximum 3 attempts
  - “Correctness” determined by judges (tight knot, square knot, orientation)

- **Prize:** fastest suturer gets Starbucks card
Suture Competition

- Would this be an effective training technique?
- Was it fun?
- Do you need a prize?
Summary

3 levels of learners

- Beginner
  - Automation hard to teach
- Intermediate
  - Cue recognition often forgotten
- Advanced
  - Hypothetical situations are fun
- Master
  - Deliberate practice is paramount
Thank You

Questions/Discussion?

An expert is one who knows more and more about less and less.

Nicholas M. Butler

An expert is somebody who is more than 50 miles from home, has no responsibility for implementing the advice he gives, and shows slides.

Edwin Meese
References:


References:


