Teaching procedures: improving "see one, do one, teach one"

Diane M. Birnbaumer, MD, FACEP

> Practice does not make perfect. Only *perfect* practice makes perfect.
>
> —Vince Lombardi

In the realm of medical education, teaching procedural skills involves imparting a cognitive conceptualization and a manual skill. To teach procedures successfully, medical educators must focus on teaching both a thorough understanding of the cognitive aspects of the procedure and the "hands on" component (Table 1).[1–3] Procedural skill acquisition is best addressed by first mastering simple procedures such as suturing or incision and drainage and then building on those skills to perform more complicated procedures.

Although the ultimate goal is for the learner to safely perform procedures independently in the clinical setting, learning on actual patients may not be the optimal way to acquire a new skill. A wide variety of models are available, each with its own strengths and drawbacks. This article outlines an approach to teaching both the cognitive and the manual skills necessary to perform procedures and discusses the various models available.

SCENARIO

Your chair asks you to teach medical students how to perform bag-valve-mask (BVM) ventilation. She asks you to investigate the educational approaches to teaching this skill and the cost and efficacy of the models available.

THE COGNITIVE COMPONENT

Before picking up an instrument, learners must understand the proper indications, contraindications, alternatives, steps involved, complications, and documentation needed for its use. Teaching this cognitive component should precede the student using that instrument or device. In fact, the learner should never attempt a skill until after a successful verbal "walk-through" of the procedure. Many procedures are taught in the clinical environment with the teacher simultaneously demonstrating and describing the skill to the learner. To maximize acquisition of the cognitive information, however, some educators suggest that mental and manual skills should not be taught in the same session because learners tend to focus on the hands-on skill at the expense of understanding the thought process involved.

To facilitate learning the cognitive component, checklists provide an organized approach to teaching and learning the components of a procedure. These checklists should include a series of detailed, simple, sequential steps for the procedure being taught. They provide a reference for the learner to review and for the teacher to use while teaching the procedure as well as while watching the learner perform it.

From the Department of Medicine, David Geffen School of Medicine at UCLA, and the Department of Emergency Medicine, Harbor-UCLA Medical Center, Torrance, CA.

Correspondence to: Dr. Diane M. Birnbaumer, Department of Emergency Medicine, Harbor-UCLA Medical Center, 1000 W. Carson Street, Box 21, Torrance, CA 90504; dianeb@emedharbor.edu.

Submitted September 20, 2010; Revised December 6, 2010; Accepted December 7, 2010.

This article has been peer reviewed.

 CJEM 2011;13(6):390-394 DOI 10.2310/8000.2011.110386

Keywords: models, procedures, skills, teaching

Table 1. The essentials of teaching procedures

The cognitive component (''teaching the brain'')

Checklist

- ○ Patient selection
- ○ Indications
- ○ Contraindications
- ○ Alternatives
- ○ Equipment needed
- ○ Steps of the procedure
- ○ Complications
- ○ Documentation
- ○ Aftercare

The manual skill (''teaching the hands'')

Many procedures require multiple observations by the teacher to ensure that the learner becomes proficient.

The ''see one''

- ○ Teacher must demonstrate and verbalize while performing observed procedure
- ○ Teacher must break down any complicated procedure into smaller steps
- ○ Teacher must ensure proper observation point for learner

The ''do one''

- ○ Learner must successfully verbalize all steps first before proceeding to procedure
- ○ Learner should talk through what he or she is doing while performing the procedure
- ○ Teacher should correct mistakes immediately

The ''teach one''

- ○ Teacher must ensure that learner has acquired complete cognitive and manual skill set
- ○ Teacher should observe learner teach a new student to confirm skill acquisition and minimize transfer of erroneous information to new learner

THE DEMONSTRATION: ''SEE ONE''

Watching a golf tournament will not make the viewer a good golfer. Similarly, simply observing a procedure will not provide the observer with expertise in that procedure. When demonstrating a procedure, the educator should use the technique of ''activated demonstration.'' This educational approach efficiently allows the teacher to perform the procedure while giving a detailed and specific explanation of each step for the learner. The skill should be broken down into a series of simple steps that the demonstrator articulates as each is performed: the ''talk through and walk through.'' The teacher should take care to ''uninternalize'' what may have become unconscious from experience and ensure that all steps in the procedure are broken down and explained to the learner during the demonstration. As much as possible, the teacher should ensure that learners view the demonstration from an appropriate vantage point, usually standing behind or beside the instructor. Learners should also be encouraged to interrupt and ask questions as long as this does not interfere with patient care.

THE MANUAL COMPONENT: ''DO ONE''

Before allowing the learner to use an instrument or device, educators should first have the student do a ''verbal walk-through'' of the steps he or she will follow during the procedure. If the student cannot do this correctly, he or she should not be allowed to proceed. While performing the procedure, the learner should talk through each step while performing it. To prevent errors from becoming part of the learner's ''muscle memory,'' the teacher must immediately correct any errors, preferably before the error is made. A useful technique to impart initial muscle memory is the ''hand over hands'' technique, where the teacher places his or her hands over those of the learner and guides the learner through the motions of performing the procedure.

TEACHING OTHERS: ''TEACH ONE''

To confirm mastery of a procedure, the learner should teach it to others while being observed by the teacher. Prior to this step, the teacher must ensure that the learner has a thorough grasp of both the cognitive and manual skills for the procedure. If not, there is a significant risk of perpetuating errors as the new learners acquire flawed information or techniques.

It is important to remember that performing a procedure once successfully does not constitute mastery of the procedure. Supervised practice is needed to ensure proficiency with the skill, particularly with learners who have recently acquired the skill or experienced learners who rarely perform a specific procedure.

MODELS FOR INSTRUCTION

Although the ultimate goal is for the learner to perform the procedure on an actual patient, previously learning a procedure on an inanimate model facilitates acquisition of the skill and improves patient safety. There are various models for teaching procedures, including human models (live patients, volunteers, the newly deceased, and fresh frozen and fixed cadavers), animal models, ''homemade'' models, computers, and

https://doi.org/10.2310/8000.2011.110386 Published online by Cambridge University Press

simulation using low-tech and high-fidelity manikins. Table 2 lists the advantages and disadvantages of the various models available.

Patients

Until recently, patient attitudes regarding the practice of medical learners learning procedures on them in the clinical setting were not formally addressed. Too often the inexperience of the learner is not communicated to the patient. In the past decade, surveys have shown that the majority of patients do not want medical learners to perform their first procedure on them. In fact, up to half of patients prefer that medical students never perform a procedure on them.[4] The educational conundrum is obvious: there will always be a "first time" that a medical learner performs a procedure on a real patient. If the procedure requires patient consent,

Table 2. Models for teaching procedures

Model	Advantages	Disadvantages
Patients	Learning in actual clinical situation	Patient preference for experienced operators Consent issues
Newly dead	Closely mirrors actual clinical situation	Ethical issues, e.g., family consent
Cadavers, fresh	Consent already given Reflects actual human anatomy	Expensive Limited availability Requires laboratory and staffing Limited time for effective use Potential for disease transmission Some students may have personal concerns
Cadavers, fixed	Consent already given Reflects actual human anatomy	Expensive Limited availability Requires laboratory and staffing Tissues less realistic owing to fixation Some students may have personal concern
Live animals	Realistic model for invasive procedures	Expensive Requires veterinary staff and laboratory Anatomic and physiologic differences may not provide accurate simulation Ethical issues related to using live animals
Animal parts	Provides tissue model for procedures such as cricothyrotomy, suturing, umbilical line, and intraosseous line placement	Animal anatomy may vary significantly from human anatomy
Low-tech manikins	Available to teach many different procedures Adjuncts (e.g., fake blood) can make them more realistic No consent issues Allow for repeated practice Can be relatively inexpensive Potential 24/7 availability	Limited realism Do not reflect patient variations seen in practice Performance in artificial environment Can be expensive Can break Require periodic maintenance
High-fidelity manikins	Available to teach many different procedures Simulate actual patients (physical findings, real-time changes based on procedure or intervention) Some allow performance of invasive procedures No consent issues Allow for repeated practice	Somewhat limited realism May not reflect patient variations seen in practice Performance in artificial environment Expensive Can be fragile Require periodic maintenance Require training to use Limited availability
Volunteers	Usually readily accessible Useful for noninvasive procedures	Can be expensive Limited to noninvasive or minimally invasive procedures

https://doi.org/10.2310/8000.2011.110386 Published online by Cambridge University Press

it is reasonable to inform the patient about who will be performing the procedure and his or her level of experience. Even if the procedure does not require consent, patients should be made aware of the level of experience of the provider. Patients may be more likely to allow a novice to do the procedure if they are assured that the learner has performed the skill in another setting (e.g., a laboratory or simulation)[5] and that the instructor will remain in the room and will step in if any difficulties arise.

The newly dead

Teaching procedures on the newly dead offers a realistic model without the risk of causing harm to a patient, but it does involve the risk of disease transmission to the teacher or the learner. In the past, this long-standing practice was frequently done without obtaining permission from the family members of the newly deceased. In 2002, the American Medical Association's Council on Ethical and Judicial Affairs recommended that permission from the family be obtained.[6] The need for health care providers to learn how to perform potentially lifesaving procedures must be balanced with the dignity and right to privacy of the newly deceased, and it is now recommended that consent be obtained before using the newly dead to teach procedures.[7,8]

Cadavers: fresh and fixed

Individuals who donate their bodies for medical education solve the ethical dilemma of teaching on the newly deceased. Cadavers provide an anatomic model with tissues approximating the pliability of living persons.[9] Fresh cadavers are not preserved and have a relatively short "shelf-life." This can be improved by flash-freezing newly deceased cadavers and thawing them when procedures are to be learned and practiced. Cadavers preserved using a fixative approximate living tissue but become stiff and unrealistic. Neither fresh nor fixed cadavers bleed, so they cannot completely simulate a real-life situation. Both fresh and fixed cadavers are expensive, and accessing them requires appropriate laboratory space and staffing.

Animal models

Teaching on live animal models simulates the stress encountered when performing a procedure on a living organism.[10] Using live animal models can be costly and requires access to laboratory space designed, and staff trained, for working with live animals. Animal models may not adequately approximate human anatomy. Furthermore, there is the ethical dilemma of harming live animals for medical education. In fact, long-standing courses such as Advanced Trauma Life Support have stopped using live animals for training purposes in the face of objections from both layman and physician groups.

Some animal parts (e.g., tracheas, skin, eyes, and chicken legs) provide realism, particularly for teaching suturing and introsseous line placement, but anatomic variations between humans and animals may limit the utility of this model for other procedures.

Computers

Videotaped demonstrations of procedures are an excellent way to both learn the cognitive aspects of a procedure and observe the procedure. An ever-increasing number of these videos can be accessed through open websites on the Internet.[11,12] Viewing can be done on the learner's own time and away from the clinical setting, although this should not be considered a substitute for actual hands-on practice.

Low-tech manikins

Low-tech manikins have been used for decades and are an easily accessible, useful, and cost-effective approach to teaching procedures such as intravenous access, cardiopulmonary resuscitation, and airway management skills. Although anatomically accurate, these models often do not simulate real human tissue. Using these models does not require special laboratory space or staffing, and they are usually easily portable. They offer the opportunity to repeatedly practice procedural skills when the learner's needs arise and are relatively inexpensive (ranging from several hundred to a few thousand dollars).

High-fidelity manikins

The combination of high-fidelity manikins, computers, and audio- and videotaping allows for the teaching of procedures in a virtual setting.[11] These manikins have physical findings (e.g., breath sounds, heart sounds), can verbalize, and allow invasive

https://doi.org/10.2310/8000.2011.110386 Published online by Cambridge University Press

procedures to be performed. Simulation centres with experienced technicians provide realistic medical scenarios using these complicated manikins. Real-time video and audio projection allows for feedback, education, and observation.[13] These models can be prohibitively expensive to purchase, require maintenance, and are fragile.

The enthusiasm for this new technology has led to teaching a broad range of procedures and clinical situations using these high-fidelity simulators. In some cases, these costly simulators may be no more effective in teaching specific procedures than low-tech alternatives.[14] Although current research suggests that they are most useful in developing critical management skills and teamwork,[14] further research is needed to determine the best use of this expensive technology.

Scenario follow-up

After investigating the options, you decide to teach BVM ventilation to the medical students using a low-tech intubation manikin. You develop a checklist detailing the steps of the procedure that you hand out to the students to study before the training session. You use activated demonstration to show the students the technique, talking through each step of the procedure. Then, after having the students verbally describe the steps of the procedure to you, you observe each of them perform BVM on the manikin, offering suggestions immediately on identifying a mistake and using the "hand on hands" technique to guide the student through the procedure. Finally, you observe the students teaching other students to ensure mastery of the skill.

CONCLUSION

Teaching procedures poses a unique challenge to the educator because it requires the learner to acquire not only the cognitive information related to the procedure but also the necessary manual skill. Teachers should keep in mind that most procedures need multiple repetitions of the "see one, do one, teach one" cycle to ensure proficiency in the skill.

Competing interests: None declared.

REFERENCES

1. Tabas JA, Rosenson J, Price DD, et al. A comprehensive, unembalmed cadaver-based course in advanced medical procedures for medical students. *Acad Emerg Med* 2005;12:782-5, doi:10.1111/j.1553-2712.2005.tb00948.x.
2. Rosenson J, Tabas JA, Patterson P. Teaching invasive procedures to medical students. *JAMA* 2004;291:119-20, doi:10.1001/jama.291.1.119.
3. Wald DA. Teaching techniques in the clinical setting: the emergency medicine perspective. *Acad Emerg Med* 2004;11:1028e1-8.
4. Graber MA, Pierre J, Charlton M. Patient opinions and attitudes toward medical student procedures in the emergency department. *Acad Emerg Med* 2003;10:1329-33, doi:10.1111/j.1553-2712.2003.tb00006.x.
5. Graber MA, Wyatt C, Kasparek L, et al. Does simulator training for medical students change patient opinions and attitudes toward medical student procedures in the emergency department? *Acad Emerg Med* 2005;12:635-9, doi:10.1111/j.1553-2712.2005.tb00920.x.
6. Council on Ethical and Judicial Affairs of the American Medical Association: performing procedures on the newly deceased. *Acad Med* 2002;77:1212-6.
7. Moore G. Ethics seminars: the practice of medical procedures on newly dead patients—is consent warranted? *Acad Emerg Med* 2001;8:389-92, doi:10.1111/j.1553-2712.2001.tb02119.x.
8. Oman KS, Armstrong JD II, Stoner M. Perspectives on practicing procedures on the newly dead. *Acad Emerg Med* 2002;9:786-90, doi:10.1111/j.1553-2712.2002.tb02165.x.
9. Oxentenko AS, Ebbert JO, Ward LE, et al. A multidimensional workshop using human cadavers to teach bedside procedures. *Teach Learn Med* 2003;15:127-30, doi:10.1207/S15328015TLM1502_10.
10. Custalow CB, Kline JA, Marx JA, et al. Emergency department resuscitative procedures: animal laboratory training improves procedural competency and speed. *Acad Emerg Med* 2002;9:575-86, doi:10.1111/j.1553-2712.2002.tb02294.x.
11. Vozenilek J, Huff JS, Reznek M, et al. See one, do one, teach one: advanced technology in medical education. *Acad Emerg Med* 2004;11:1149-54, doi:10.1111/j.1553-2712.2004.tb00698.x.
12. Chenkin J, Lee S, Huyng T, et al. Procedures can be learned on the web: a randomized study of ultrasound-guided vascular access training. *Acad Emerg Med* 2008;15:949-54, doi:10.1111/j.1553-2712.2008.00231.x.
13. Lammers RL, Davenport M, Koelye F, et al. Teaching and assessing procedural skills using simulation: metrics and methodology. *Acad Emerg Med* 2008;15:1079-87, doi:10.1111/j.1553-2712.2008.00233.x.
14. Wang EE, Quinones J, Fitch MT, et al. Developing expertise in emergency medicine—the role of simulation in procedural skill acquisition. *Acad Emerg Med* 2008;15:1046-57, doi:10.1111/j.1553-2712.2008.00218.x.