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Exhibit Selection

A Surgical Skills Training Curriculum for PGY-1 Residents

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A paradigm shift is currently taking place in orthopaedic surgical skills education[1]. Traditionally, surgical skills have been acquired through an apprenticeship method, which has produced skilled surgeons. However, recent reports have attributed over 60% of errors in the operating room (OR) to technical problems[2,3]. Incoming orthopaedic residents have little to no surgical training, and it is virtually impossible to assess the surgical skills aptitude of individual residency candidates[4]. An increased focus on patient safety, the mandate for trainee work-hour restrictions, and the advent of more skills-intensive technology have driven the need to develop standardized skills training curricula. Other surgical specialties such as general surgery have required simulation training and have developed skills curricula that are used in residency training[5].

The Residency Review Committee (RRC) for Orthopaedic Surgery and the American Board of Orthopaedic Surgery (ABOS) have recently mandated that residency training programs implement a structured surgical skills curriculum for resident education in postgraduate year (PGY)-1[6]. The curriculum must include skills required for emergency orthopaedic care and provide initial training in basic skills of orthopaedic surgery.

In advance of these new requirements, our Department of Orthopaedics and Rehabilitation developed and piloted a one-month surgical skills course with a structured curriculum for PGY-1 orthopaedic residents. The curriculum incorporated multiple instructional elements, including background reading and didactic teaching (cognitive knowledge), live and video-recorded expert demonstrations, expert-guided and independent dedicated practice (skills training), and multiple opportunities for assessment and critical feedback. We herein describe the course from its initial planning through curriculum development and finally to its implementation. Lessons learned from the experience and potential areas for improvement are highlighted.

Source of Funding

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Background

Conceptualization

The department has thirty orthopaedic residents. The six PGY-1 residents rotate through clinical services that fulfill program requirements mandated by the orthopaedic RRC and the ABOS. In the 2012 to 2013 academic year, with permission

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- Sterile Technique/ OR Setup
- Techniques of Fluoroscopy
- Musculoskeletal Traction
- Compartment Syndrome
- Soft Tissue Handling Techniques
- Techniques in Hand Trauma
- Knot Tying/ Suturing Techniques
- Basic Techniques in ORIF
- Bone Handling Techniques (Osteotomy)
- Joint Aspiration/ Ultrasound Techniques
- Research Methods 1
- Fracture Reduction Techniques
- External Fixation Techniques
- Upper Extremity Arthroscopy
- Splinting/Casting
- Basic Hip Arthroplasty
- Basic Knee Arthroplasty
- Basic Spine Techniques
- Lower Extremity Arthroscopy
- Research Methods 2

Fig. 1
Modules utilized in January 2013 course.

from the ABOS, the PGY-1 curriculum was changed to pilot the newly mandated nationwide program requirements that would begin the following year. This change included development of a new surgical skills training program for PGY-1 residents. With the support of the department chairman and the faculty, the residency program director planned for and scheduled a one-month period (January 2013) free from clinical responsibilities ("protected") during which PGY-1 residents took a surgical skills course. This concept was initially introduced at a faculty meeting approximately one year prior to the course. The department committed to support the project financially, and a group of faculty agreed to develop the course content.

Curriculum Development

A preliminary meeting of interested faculty was convened nine months prior to the skills month. Representing the spectrum of orthopaedic subspecialties, this group shared in developing the curriculum utilized later in implementing the course. The content that was developed focused on basic orthopaedic skills required for emergency care and basic to more advanced surgical procedures that are performed by mid-to-senior-level orthopaedic residents. Eighteen separate skills topics were identified, forming the basis of the month-long curriculum. Two additional modules were dedicated to "Research Methods and Design"; these included both self-study through a set of modules published by the American Orthopaedic Association (AOA) and a didactic half-day guided by a faculty member (Fig. 1).

The eighteen skills topics were organized into a modular format that facilitated focused skills development and offered flexibility in scheduling. The faculty agreed that the modules should incorporate "low-tech" teaching methods, span all specialties in orthopaedics, meet or exceed the impending RRC requirements, include assessments, and allow dedicated time for practicing basic skills. Modules were planned to be of progressively increasing skill complexity, and as the month progressed, later modules attempted to reinforce the more basic concepts that had been learned previously. The faculty agreed to develop written material for each module by following a basic template and, where appropriate, to produce video material to facilitate the module (Fig. 2).

Organizing the modules into a month-long curriculum required extensive planning. Calendar days or half-days that would fit the schedules of the responsible faculty were identified. Faculty prepared their portion of the syllabus and planned the required equipment for each module. They had to coordinate their efforts with other aspects of the course. Individual faculty created supplemental videos and presentations to support their specific modules. This often was accomplished by the faculty during one or more trial sessions of the proposed module(s) conducted to assure smooth execution while becoming cognizant of the final edited product. The curriculum format and schedule were finalized six months prior to the course to enable the faculty to adjust their clinical schedules (Fig. 3).

Implementation

The Arthroscopy and Surgical Skills Laboratory is a 600-ft^2 (56-m^2) facility located within the department that was reserved for the entire month. This facility provided many features of an OR environment, including arthroscopy towers, operative tables, and instruments, and it supported the use of cadaveric specimens as required by each module.

Substantial foresight was needed to assure that required materials were present for each module. This responsibility was delegated to the faculty member responsible, who worked closely with laboratory personnel. The availability of equipment, supplies, and specimens for each module was organized prior to the month. Despite this planning, on several occasions ensuring that equipment was available for a module necessitated last minute "scrambling" by dedicated laboratory personnel, especially in the case of less common items. Availability, storage, and thawing of the cadavers were challenging, given that the cadavers were

- Set aside dedicated practice time for learners
- Obtain appropriate space for instruction
- Convene task force bridging Orthopaedic sub-specialties
- Choose topics, a template, and assign modules
- Organize modules logically, fitting into faculty schedules
- Plan modules, creating/gathering instructional content
- Order necessary equipment and models
- Coordinate equipment/instruments/supplies
- Confirm and communicate plan prior to module(s)

Fig. 2
Essential points in planning the curriculum.

January 2013 PGY1 Surgical Skills Course Schedule				
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
	1	2	3	4
	Offices Closed	Orientation	Sterile Technique/ OR Setup *Noiseux* *Wolf*	Techniques of Fluoroscopy *Marsh/Karam* *Anderson*
7	8	9	10	11
Musculoskeletal Traction *Dietz* Compartment Syndrome *Karam/Ilgenfritz*	Soft Tissue Handling Techniques *Lawler* *Miller*	Techniques in Hand Trauma *Shah* *Lawler*	Knot Tying/ Suturing Techniques *Femino* *Shah*	Basic Techniques in ORIF *Marsh* *Karam*
14	15	16	17	18
Bone Handling Techniques (Osteotomy) *Phisitkul*	Joint Aspiration/ Ultrasound Techniques *Hall*	Research Methods *Anderson*	Fracture Reduction Techniques *Karam* *Marsh*	External Fixation Techniques *Femino*
21	22	23	24	25
OFF (Holiday)	U.E. Arthroscopy *Wolf*	Splinting/Casting Techniques *Ilgenfritz*	Basic Hip Arthroplasty *Noiseux* *Willenborg*	Basic Knee Arthroplasty *Noiseux* *Willenborg*
28	29	30	31	
Basic Spine Techniques *Mendoza*	Lower Extremity Arthroscopy *Wolf*	Research Methods *Anderson*	Debriefing	

Fig. 3

Calendar showing the format and order of the course. U.E. = upper extremity.

expensive and perishable. Anticipation of the needs of various modules and coordination between modules were essential to optimize cadaver utilization.

During the entire month, the six PGY-1 residents worked full time on the surgical skills course and were free of clinical responsibilities other than weekend call. They were provided with the standardized syllabus and electronic media one week prior to the initiation of the first module. This included an orientation letter, a list of all modules, and a written description of each module based on a standard template. These module descriptions included goals and objectives, suggested readings, descriptions of the laboratory modules, descriptions of techniques and procedures, common errors and prevention strategies, expert performances (video-recorded as available), recommendations for motor skills practice, information regarding supplies and station set-up, the suggested duration of the modules, and methods of performance assessment (Fig. 4).

Typically, faculty would begin the day of the module by providing a brief overview of the module and reviewing the goals and objectives. Often, they demonstrated techniques and guided the PGY-1 residents during practice while providing critical feedback and assessment. Dedicated skills practice and repetition were encouraged for most of the modules. Resident assessment is critical as it enhances skills development and provides an objective metric of improvement of technical performance; this metric can be used to determine adequate proficiency[7].

Example Module

One of the modules, "Basic Techniques in ORIF" (open reduction and internal fixation), provides an example of a curriculum module (Fig. 5). In this module, learners reviewed supplemental video prior to practicing basic drill, depth gauge, and screw techniques on PVC (polyvinyl chloride) pipe and simple synthetic bone surrogate models. It was emphasized to the residents that practice of instrument techniques such as use of a depth gauge is necessary. Senior residents often struggle with these basic techniques. The videos guided the residents through the specific skills exercises without continuous faculty supervision. Exercises were performed on progressively more realistic models.

In the afternoon, residents rotated among a set of skill practice stations, one of which included cadaver ankles and a mini-C-arm fluoroscope, and they were individually assessed at a separate station. At the station with the fluoroscope, residents practiced the task of placing a screw in precise positions on a cadaver leg. They were instructed to use small incisions and fluoroscopic control for precisely placing screws with use of the drill, depth gauge, and screw techniques previously practiced on the simpler models. This more advanced model more closely represented the OR environment. The residents practiced the techniques on these specimens with guidance by faculty, video, and peers, as well as independently. At the assessment station, a senior surgeon observed and graded each resident individually on the same tasks with use of a modified OSATS

ABOS / AAOS Orthopaedic Motor Skills Curriculum Template
(Modified from the ACS/APDS, NCSI, and ASSET Curriculum Templates)
September 14, 2012

***Step 1:* Problem Identification and Needs Assessment**

A. Identification of targeted learners
B. Identification of need or problem for targeted learners
C. Current educational approach to address need or problem
D. Ideal educational approach to address need or problem

***Step 2:* Goals and Objectives**

A. List specific educational goals of skills module
B. Define specific cognitive, affective, and / or psychomotor task objectives (as necessary for this particular module)

***Step 3:* Syllabus Development**

A. Assumptions (include prerequisite knowledge and motor skills)
B. Suggested readings
C. Description of laboratory module
D. Description of techniques and procedure
E. Common errors and prevention strategies
F. Demonstrate expert performance / video
G. Recommendations for motor skills practice
H. Supplies and station setup
I. Suggested duration for completion of module
J. Estimated budget for this module

***Step 4:* Learner Evaluation and Feedback**

A. Describe method(s) of performance assessment
B. Suggest proficiency benchmarks (i.e., passing score(s) for module completion)
C. Define method(s) for learner de-briefing and for feedback from learner

***Step 5:* Periodic Curriculum Review, Module Evaluation, Metric Validation and Refinement, Continuous Program Update and Improvement**

Fig. 4
Outline of the template utilized for the modules. (Reproduced with permission of the American Board of Orthopaedic Surgery.)

(Objective Structured Assessment of Technical Skills) scoring system. These performances were video-recorded for critical review at a later date. In this series of basic trauma exercises, residents were allowed time for dedicated practice, used models of progressively increasing fidelity, learned from errors and repetition, trained to a level of proficiency, and were prepared with the skills necessary to participate at a basic level in actual trauma cases.

Outcomes

The Experience

Survey data indicated that the one-month-long surgical skills training course was enthusiastically received by all six of the PGY-1 learners (Fig. 6). The involved faculty believed that the goals were accomplished and that the residents showed improved skills. These positive endorsements, from residents and faculty alike, have solidified the role of this course as a fundamental feature of our resident education program. A compilation of video clips illustrates various features of the month (Video 1 [online]).

The de novo creation and execution of a dedicated PGY-1 orthopaedic surgical skills course required motivated and dedicated faculty, residents, support staff, and funding. The month of skills training was relatively expensive (Fig. 7)[8]. The expenses, totaling $21,864, were partially covered by resident education grants, a private donor, and some corporate donations (Fig. 8). However, the department covered the majority of the burden. Perhaps not surprisingly, faculty time was the single largest

Fig. 5
Two faculty members teaching six residents on the day of the ORIF module.

Outcomes: Surgical Skills Resident Survey	Satisfaction
Overall	100.0%
Module Format	100.0%
Did it help your surgical skill set?	90.0%
Did you feel prepared?	83.2%
Did you feel like it enhanced your Orthopaedic training program?	100.0%
Did you feel it will enhance safety in the OR?	86.6%
How do you feel your skill set ranks against your peers at other institutions?	70.0%
Did you have the right amount of practice time?	100.0%
Did you have the right amount of assessments?	83.3%
Do you feel this should be a permanent part of surgical education?	100.0%
Average Comprehensive Satisfaction:	**91.3%**

Fig. 6

Results on the questionnaire administered at the end of the course.

investment, although it is not reflected in the accounting of expenses provided here. Between meetings, development, and instruction, faculty time averaged roughly ten hours per module. Creating new supporting video and supplemental material took between two and ten hours for the video technician who shot and edited the content. Many of these costs were incurred to develop the course, and subsequent courses should cost considerably less.

Research and Assessment

The month was also used for skills-based educational research projects. An institutional review board training exemption was granted, and certain modules such as "Basic Techniques in ORIF" and "Fracture Reduction Techniques" were designed to be part of ongoing research projects to answer basic questions about skills acquisition by residents[9]. Additional objective assessment tools, such as an optoelectronic-based hand-motion tracking device[9], computed tomography scans of articular surfaces of models with fracture-fixation constructs, and other assessments of reduction and fixation were introduced into the structure of the course.

The residents were very positive about the incorporated research projects. Assessing the surgical skills of the residents as part of the research projects improved performance intensity. Competition among residents improved their technical skills performance and their ability to demonstrate proficiency on multiple tasks. OSATS, simulator-based, and cognitive assessments were utilized to provide this element of training. Course content was assessed by means of feedback forms filled out by the PGY-1 residents (see Appendix). These have been instrumental in allowing the faculty to further develop and revise the curriculum.

Lessons Learned and Suggestions for Improvement

Optimal utilization of time and resources is imperative. Cadavers were the single largest monetary cost and need to be fully utilized; thoughtful organization of the modules is necessary for the most efficient use of this expensive resource. As there are many ways that a cadaver specimen can be utilized, care should be taken to minimize dissection and thus allow the specimen to be reused for multiple modules. An example of this sequencing involves first making small portals in a cadaver limb in the "External Fixation Techniques" module, then placing percutaneous screws to teach "Basic Techniques in ORIF," before performing more invasive exercises such as fasciotomies on the limb as residents learn how to release compartments in the "Compartment Syndrome" module. Additionally, the cadaver-intensive and expensive junior-resident surgical anatomy course, normally held separately, will be combined with future PGY-1 surgical skills courses and run concurrently. This will serve to decrease the financial burden of these two courses by making dual-purpose use of the cadavers.

Developing the surgical skills course required substantial time commitment by the faculty, and efforts should be made to ease this burden. Material that is now available, such as the ABOS surgical skills modules for PGY-1 residents[10], will allow similar educational programs to be developed with less faculty effort, and the video material should allow residents to be more independent during the course.

Surgical Skills Course Costs:	
Assistant Time	$ 2,500
Fluoro Time	$ 300
Trainee Fee x6	$ 1,200
Equipment Fees	$ 1,000
Animal Models	$ 700
Sawbone Models	$ 8,000
Cadaver Cost(s)	$ 8,164
	$ 21,864

Fig. 7

Sponsor Funding 2013 January		
OMeGA		$3,389
Stemmler		$1,224
OTA		$3,176
Medtronic		$1,500
MTP Solutions		$950
OREF		$750
	Total	$10,988

Fig. 8

Fig. 7 Cost of the month. **Fig. 8** Supporting funding for the month.

Residents were very receptive to skills assessment. Both residents and faculty believed that the assessments were beneficial, increasing the intensity of the skills exercises while providing milestones of resident skill progression. When there is an impending assessment, learners will focus more during dedicated practice time, requiring less oversight by faculty. However, more and better assessments are needed, and these need to be reliable and validated prior to widespread use. In the future, these assessments should allow residents to train to a predetermined level of proficiency prior to undertaking cases in the operating room.

Summary

The curriculum created for this one-month course provides an excellent template for other orthopaedic programs hoping to avoid "reinventing the wheel." Utilizing both this experience and the ABOS curriculum[10], programs can better prepare for the mandated PGY-1 skills training requirements. This style of skills training consolidated the learning into a single time period, which made implementation and scheduling relatively easy and allowed for a focused learning experience for the PGY-1 residents. Scheduling the skills month after the PGY-1 residents had spent a few months in orthopaedics provided the residents with a context in which to enhance their engagement and interest in skills simulation.

Surgical skills training and assessment utilizing simulation and practice outside of the operating room is now required in orthopaedic residencies. This requirement presents a clear means to improve education in technical skills basic to orthopaedics and has great potential to enhance patient safety and increase efficiency in the operating room.

Appendix

(eA) The questionnaire administered at the end of the course is available with the online version of this article as a data supplement at jbjs.org. ■

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