In North America, there is a growing shift toward competency-based medical education, in which trainees complete their training only when competence has been demonstrated through objective milestones. Pressure is mounting to embrace competency-based medical education because of the perception that it provides more transparent standards and increased public accountability. In response to calls for reform from leading bodies in medical education, competency-based medical education is rapidly becoming the standard in training of physicians.


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arguing that traditional models of postgraduate medical education fail to meet current healthcare demands of society. Although competency-based education is not new, its application to medical education is in its early stages.

The Accreditation Council for Graduate Medical Education and the Royal College of Physicians and Surgeons of Canada have developed educational frameworks outlining core competencies that all residents are expected to attain during their training. These frameworks have been widely adopted into accreditation standards, objectives for training, examination blueprints, and final in-training evaluations. The Accreditation Council for Graduate Medical Education’s patient care domain and the Royal College of Physicians and Surgeons of Canada’s medical expert domain require residents to be technically competent and possess the necessary knowledge to deliver effective patient care. Supporters of competency-based medical education believe that conventional training emphasizes knowledge rather than the skills and attitudes necessary for practice. Major theories of motor learning and expertise suggest that procedural skills should be broken down into logical progressive benchmarks of ability, consisting of descriptive anchors spanning from novice to mastery, that will facilitate tailoring of educational experiences to trainee ability level and delivery of specific feedback during practice. Competency-based medical education will provide the framework to focus both on the acquisition and assessment of procedural skills and expertise.

Competency-based medical education may accelerate training, allow progress that is based on individualized learning curves, and improve standardization among residency programs. Variations in operative experience during residency can affect whether trainees feel prepared to practice independently immediately after graduation. This has been observed in general surgery, leading to concerns about insufficient knowledge and skill acquisition among general surgery graduates. Educational leaders have responded with the creation of a national standardized curriculum. Graduating plastic surgery residents are satisfied with the quality of their residency training; however, many residents also pursue additional fellowship training rather than enter practice directly. Traditional training may have to be adjusted to meet the demands placed on future plastic surgeons, taking into account a steadily expanding body of knowledge and rapid rate of innovation in our field. As educators responsible for the training of competent specialists, exploring the role and potential benefits of competency-based medical education in plastic surgery residency training is timely.

RESISTANCE TO COMPETENCY-BASED MEDICAL EDUCATION

Although exploring resistance to competency-based medical education is not the focus of this article, we will attempt outline and address some of the main concerns. Resistance to competency-based medical education has been shown to revolve around five themes:

1. Lack of interest in change. Educators who fail to embrace new training standards often express lack of interest in any change in medical education. The majority of graduates successfully complete their training and proceed to independent practice; however, this does not absolve us from critically evaluating and improving training programs when necessary. Similar to evidence-based medicine in the practice of surgery, curricular decisions should be driven by contemporary learning theory and evidence-based educational strategies.
2. Concerns regarding evidence. Competency-based education gained broad acceptance nearly 40 years ago and has a long history in vocational and trade schools, demonstrating effectiveness in those settings. Early surgical pilot programs have also been promising, demonstrating improved scores on assessment of knowledge and procedural skills. In some instances, training has been shortened by more than a year.

3. Administrative burden. Pilot programs have required large amounts of resources and administrative support. As competency-based medical education becomes more commonplace, sharing of resources and strategies will, it is hoped, reduce this burden. In addition to considering use of educators or nonfaculty assessors, this transition will require extensive faculty development. A greater challenge will be finding financial resources to cover additional administrative and faculty support.

4. Financial concerns. “The challenge facing ... medicine is to evolve its educational continuum to produce high-quality graduates with the right skills in the shortest and least expensive manner.” Competency-based medical education may be cost-effective because of shorter training periods and integration of subspecialty training into postgraduate programs; however, this remains to be seen. Consequently, educators are appropriately concerned about the financial burden. Although there are no easy solutions, some authors have made recommendations to reduce anticipated financial barriers (Table 2). These efforts will require a coordinated approach to overhaul the entire process of becoming a physician. As educators, we must also rethink some long-standing traditions while drawing on creativity and perseverance to “extend faculty, clinic, and patient resources and more efficiently integrate teaching systems with the clinical systems that [trainees] must negotiate.”

5. Balancing service requirements with education. “The commitment to staffing a residency service is fixed, because patient needs are constant, the service cannot be sometimes staffed and sometimes not.” Hospitalists may provide continuity regardless of fluctuations in trainees, and some clerical work, such as booking cases and filling out paperwork, could be reallocated to administrative assistants or nonphysician support staff. Perhaps programs will become less reliant on residents; however, more realistically, trainees will simply need to continue their service duties.

The logistical hurdles of coordinating multiple individualized schedules, examinations, and fellowship applications are also significant deterrents from adoption of a pure competency-based medical education model. In our opinion, a more practical approach may be a hybrid system focusing on attainment of competence while following a system of modular time-based rotations. An individual finishing a module early could then allocate time toward flexible activities (e.g., research, studying, remediation, or elective exposure to subspecialty areas) without disrupting patient care or creating excessive logistical burden.

MILESTONES

The initial stages of this educational paradigm shift are already apparent. The Next Accreditation System, a logical extension of the Accreditation Council for Graduate Medical Education outcomes project, requires creation of benchmarks of ability (known as milestones) to facilitate instruction and evaluation of performance within each core specialty.

Table 2. Recommendations to Promote Efficiency of Training and Reduce Anticipated Financial Burdens Associated with Competency-Based Medical Education

<table>
<thead>
<tr>
<th>Recommendation</th>
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<tbody>
<tr>
<td>1. Restructuring the entire existing medical education curriculum into a shorter span of time while reexamining the curricular elements required for independent practice (i.e., offload some of the burden of postgraduate training to earlier phases)</td>
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<tr>
<td>2. Investing in development of a national curriculum to promote standardization and offload faculty time through online modules and learner self-study/practice</td>
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<tr>
<td>3. Examining the feasibility of shortening residency or fellowship training through earlier career differentiation by creation of customized training programs for trainees with specific career interests (e.g., plastic surgery previously created a combined 5-year training program that eliminated 2 years from the traditional five-plus-two approach)</td>
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<tr>
<td>4. Using nonphysician educators (trained assessors and standardized patient experiences) and educational technology (online learning platforms and simulation) to decrease medical education labor costs</td>
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<tr>
<td>5. Dispersing trainees to less costly outpatient training venues if and when appropriate</td>
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competency domain. Similarly, the next iteration of the Royal College of Physicians and Surgeons of Canada competencies will require each specialty to develop specific benchmarks of ability reflective of progression within each domain. In anticipation of these changes, the Accreditation Council for Graduate Medical Education Residency Review Committees and the Royal College of Physicians and Surgeons of Canada Specialty Training Committees have identified milestones for each of the domains within each specialty. For plastic surgery, the wide breadth of operations performed presents unique challenges.

COMPETENCY-BASED MEDICAL EDUCATION FOR PLASTIC SURGERY: WHERE DO WE START?

The process of defining and assessing competency has already begun, beginning with the work of the Accreditation Council for Graduate Medical Education Residency Review Committee for plastic surgery and previously published work on teaching and assessing core competencies. The next steps will involve integrating existing teaching tools into a competency-based medical education curriculum (Table 3).

With respect to establishing a competency-based medical education curriculum for procedural skills, initial efforts will require plastic surgery to overcome three challenges: identifying important principles and procedures, modeling new teaching strategies, and developing assessment models. The following discussion provides proposals for how these challenges may be addressed and the educational rationale behind each proposal.

IDENTIFICATION OF PRINCIPLES AND PROCEDURES

Richard Bell defines the prototypical graduate as being one “who can care competently and professionally for patients … and who can skillfully perform a defined set of procedures.” More recently, others have argued that surgical competency implies a “readiness for independent performance of the procedure.”

This “competency as performance” discourse is widely prevalent throughout postgraduate surgical education; however, critics caution against emphasis on rote performance of a long list of routine skills. Because of differences in training programs and a wide number of procedures, it is not possible to gain exposure to every technique that residents would be expected to be able to perform independently after graduation. Consequently, plastic surgery is often referred to as a principles-based discipline. Trainees are not expected to demonstrate competence with every procedure, but rather they must demonstrate an understanding and application of surgical principles that will prepare them for new procedures they will encounter in future practice.

Although the initial process of establishing milestones for all of the competency domains is under way, educators are now faced with the obstacle of determining how the milestones will be operationalized and assessed. One method is through identification of entrustable professional activities that are representative of “essential professional work” that trainees would perform independently when in practice. Entrustable professional activities are well suited to surgical disciplines; an example would be the independent performance of a specific operative procedure. The Accreditation Council for Graduate Medical Education will soon require procedural specialties to identify and assess residents’ technical abilities to perform certain index procedures (entrustable professional activities) as part of demonstration of competency. Therefore, the ideal curriculum should provide residents with exposure to all of the core principles of plastic surgery while providing focused instruction in those procedures that trainees will be most likely to perform unsupervised during independent practice.

Previously described frameworks for establishing competencies (Fig. 1) can also be used to identify and prioritize competencies for plastic

Table 3. Steps in Planning a Competency-Based Medical Education Curriculum for Plastic Surgery*

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Identify specifically what is expected of graduating plastic surgery residents (competencies)</td>
</tr>
<tr>
<td>2.</td>
<td>Break down these competencies into a logical stepwise series of markers of ability (milestones)</td>
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<tr>
<td>3.</td>
<td>Identify or develop educational strategies to facilitate instruction of these skills</td>
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<tr>
<td>4.</td>
<td>Develop assessment tools that are easy to use and yet capable of accurately placing trainees along this continuum of achievement</td>
</tr>
<tr>
<td>5.</td>
<td>Perform an outcomes evaluation to determine the effectiveness of competency-based medical education for achieving competencies and provide feedback for program improvement</td>
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</table>

surgery. Similar initiatives have been successful for other specialties. 52–54 Initial efforts should focus on identifying all procedures performed by plastic surgeons that trainees may be exposed to. Subsequently, a national consensus exercise of the leaders in plastic surgery will help to define those abilities required to prepare graduates to function as independent practitioners.1,9,55 Establishing a list of core principles and identifying index procedures will focus instructional and evaluation efforts. These skills can then be broken into measurable building blocks or milestones reflective of progressive levels of resident ability spanning the entire range of operative ability from novice to master.1 With respect to competency, the first hurdle will be to overcome a lack of expert consensus regarding both the scope of our discipline and expectations of ability for graduating residents.

**NEW INSTRUCTIONAL METHODS**

Traditional instructional methods are becoming less effective because of changes in the educational environment.56 Work-hour restrictions, reduced clinical exposure, expanding medical knowledge, and increased service require residents to learn more material in less time. Pressures for operating room efficiency, increased supervision requirements, fears of litigation, and decreasing tolerance for medical error create difficulties when attempting to provide learners with graded autonomy. Variable operative exposure, regional differences, and a proliferation of subspecialty fellowship programs have created a self-perpetuating cycle in which residents may also need to take advanced training to gain additional experience.57

Many important learning opportunities have moved outside the teaching hospital environment. Specifically, aesthetic surgery, which constitutes an important portion of residency training and board examinations in plastic surgery,58 remains the most inconsistently taught and unstructured portion of training. Patients who pay out of pocket are less likely to accept the training of residents as part of their treatment, and although surgeons teaching residents in their private facilities may be university teaching faculty, the learning process in this setting is often limited to observation.

As a result of these challenges, residents may struggle to gain exposure to all of the necessary learning activities required to demonstrate competence before graduating. To acquire the 10,000 or more hours of deliberate practice required to develop “expertise” in a complex task, a resident would need to engage in 8 hours of deliberate practice every day for 5 years.25,26,34 As opportunities...
for learning skills on patients decrease, alternative opportunities for skills practice will need to be identified.

Simulation laboratories represent a nonthreatening and unhurried environment for supplemental skills training. Although there is no substitute for operative experience, simulation combined with deliberate practice has been effective in acquiring procedural skills\(^5\) that are transferable to the clinical setting.\(^6\) Simulation-based instruction should be tailored to the learner and the goals of the activity. Special attention is paid to the choice of modality (e.g., computer-based, simulated patients, clinical immersion, task trainers, and so on), instructional method (e.g., self-guided or instructor-based), and presentation (e.g., feedback, fidelity, simulator type, and so on).\(^6\)

Unfortunately, only a handful of simulators for plastic surgery procedures exist\(^6\) and additional simulators will need to be developed. Learning gains from low-fidelity simulators approximate those from high fidelity and thus development of a simulated procedural skills curriculum is feasible.\(^6\) Initial efforts should prioritize high-acuity, low-opportunity procedures identified by leaders in plastic surgery as being important to the discipline.\(^6\) In anticipation of competency-based medical education, new teaching strategies need to be developed to ensure training programs meet the needs of trainees while continuing to deliver safe and effective patient care.

### DEVELOPMENT OF ASSESSMENT MODELS

Although many objective measures for assessment of technical skill exist,\(^6\) assessment tools specific to plastic surgery are lacking. Procedural ability is typically assessed indirectly through final in-training evaluation records, operative case logs, or summative examinations of knowledge that encourage residents to emphasize studying at the expense of procedural skills training.

Direct observation of operative performance is one of the most reliable and valid approaches to technical skills assessment\(^7\); however, there are logistical challenges (e.g., lack of appropriate metrics, difficulties evaluating in the operating room, resource concerns) preventing routine assessment in this way. Consequently, most efforts to evaluate procedures have focused on basic techniques.

#### Table 4. Assessment Matrix for the Breast Reconstruction Domain Allowing for Demonstration of Exposure to Core Principles of Plastic Surgery while Demonstrating Participation in Key Learning Activities\(^*\)

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<tbody>
<tr>
<td>1 Lecture: breast cancer</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>2 Procedure: breast biopsy</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>3 Procedure: pedicled TRAM</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
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<td>4 Procedure: free TRAM</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
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<td>X</td>
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<td>5 Procedure: Poland’s</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
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<td>6 Procedure: breast augment</td>
<td>X</td>
<td></td>
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<tr>
<td>7 Objective structured clinical examination: breaking bad news</td>
<td></td>
<td>X</td>
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<td></td>
<td>X</td>
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<td>8 Small group activity: breast markings</td>
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<td>X</td>
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<td>Etc.</td>
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<td>Total</td>
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TRAM, transverse rectus abdominis myocutaneous flap.

\(*\)This abbreviated matrix would require expansion to include all learning activities and surgical principles relevant to breast reconstruction. If there is adequate sampling to ensure exposure to all principles, specific learning activities may vary between individual training programs.
general technical ability, or techniques performed outside of the operating room.\textsuperscript{56,69}

Various learning activities (procedural and nonprocedural) illustrate different surgical principles to varying degrees. By sampling from these learning activities, it is possible to demonstrate sufficient exposure to all of the principles while allowing for assessment of competencies required by the Accreditation Council for Graduate Medical Education. An example of an assessment matrix for the breast reconstruction domain is seen in Table 4. Structuring assessment in this way would allow for flexibility among programs while providing standardization across North America.

When assessing specific learning activities within the matrix, it will be necessary to ensure that trainees’ performance can be interpreted meaningfully.\textsuperscript{72} Contemporary views consider all types of validity to be construct validity\textsuperscript{73–77} and suggest that five types of validity evidence (content, response process, internal structure, relation to other variables, and consequences) should be gathered to support or refute the interpretation of assessment data.\textsuperscript{78} The desired interpretive meaning of assessment data should be approached as a context-specific hypothesis to be ruled in or ruled out based on the evidence gathered.\textsuperscript{72} Therefore, assessment tools themselves are not valid or invalid, but rather creation and use of high-quality assessment tools will assist in gathering appropriate validity evidence to support a specific interpretation of assessment data at a specific point in time.

Creation of assessment tools should adhere to an organized evidence-based approach\textsuperscript{69} while “working toward the adoption of a core set of assessment tools that will be used across all programs within a country or region.”\textsuperscript{79} Development of metrics for procedural competencies should begin with identification of index procedures (or entrustable professional activities) for the discipline. These procedures should span all domains of plastic surgery and illustrate the core principles that graduating residents will require for independent practice. Once identified, a design phase consisting of an extensive literature review and an expert consensus-building exercise to identify and prioritize key procedural steps should be performed. This process facilitates identification of the important steps within an operation, allowing creation of an assessment checklist or global rating scale for a specific procedure. Subsequent phases should focus on gathering validity evidence. Tools will need to undergo pilot testing and will likely require extensive revisions. Metrics should be compared with current accepted standards. Each tool will also need to be evaluated for feasibility, acceptability, reliability, and cost-effectiveness. Faculty will require training to improve their assessment skills.\textsuperscript{79}

Consequences (intended or unintended) of assessments on examinees, faculty, patients, and society must be measured. Initial efforts should focus on those abilities deemed most important for residency training, bearing in mind that the procedures chosen for assessment may, out of necessity, change with time as our specialty evolves. Similarly, we may find that addition of new principles is warranted with time. The methods to efficiently develop tools to measure essential competencies, based on our current teaching objectives (as defined by the American Board of Plastic Surgery and Royal College of Physicians and Surgeons of Canada), must be developed.

**SUMMARY**

In the shift toward adoption of competency-based medical education and the emerging reality of numerous surgical specialties encroaching upon various traditional domains of plastic surgery (e.g., aesthetic surgery, microsurgery), it is essential that our specialty leads the field in surgical education and maintains our stronghold on these areas of expertise. A Canadian task force has begun a national consensus exercise to identify core operative procedures while simultaneously piloting methods for creation of assessment metrics for those skills. As these procedures are identified, additional work will need to be done to determine those that will benefit from supplementation with alternative teaching modalities such as simulation. This collaborative effort will provide important groundwork on how surgical competencies can be developed, taught, and evaluated. Our goal is to identify, standardize, and objectify competencies for all procedures we must teach, ensuring the continued training of competent and safe plastic surgeons.

**REFERENCES**

2. Frank JR, Mungroo R, Ahmad Y, Wang M, De Rossi S, Horsley T. Toward a definition of competency-based education in...
17. ten Cate O. Trust, competence, and the supervisor’s role in postgraduate training. BMJ. 2006;333:748–751.