In 2001, the Institute of Medicine (IOM) presented a compelling case for its claim that the difference between the “health care we have and the care we could have” represents much more than a gap, but rather a chasm, and that the health care quality chasm persists alarmingly unchecked. Unfortunately, a chasm also exists between the medical education that we have and that which we could have. The IOM identified “reform of health professions education critical to enhancing the quality of health care in the United States.”

The challenge is to create a system in which the following are true:

- The care of every patient has the potential to improve the care of all patients yet to come
- Competencies are integrated into the routine practice of daily care
- Decision making regarding care of the patient is guided by the best evidence available
- The quality of health care is positively related to the quality of medical education.

The IOM recommended that to address the chasm in health care quality, all health care organizations, professional groups, and private and public purchasers pursue six Aims for Improvement in health care. These “dimensions of quality” describe a health care system that is safe, timely, effective, efficient, equitable, and patient centered.

The Healthcare Matrix was developed that links the IOM aims for improvement and the six ACGME Core Competencies. The matrix provides a blueprint to help residents to learn the core competencies in patient care, and to help faculty to link mastery of the competencies with improvement in quality of care.

Background: In 2001, the Institute of Medicine (IOM) recommended six Aims for Improvement; the dimensions of quality describe a health care system that is safe, timely, effective, efficient, equitable, and patient centered. In 1999, the Accreditation Council of Graduate Medical Education (ACGME) adopted six core competencies that physicians in training must master if they are to provide quality care. The matrix provides a blueprint to help residents to learn the core competencies in patient care, and to help faculty to link mastery of the competencies with improvement in quality of care.
In 1999, the Accreditation Council of Graduate Medical Education (ACGME) focused on the shortcomings of graduate medical education (GME) and set the following goals:

- The content of graduate education is aligned with the changing needs of the health system
- Residency programs use sound outcome assessment methods for both the residents’ and programs’ achievement of educational outcomes

The ACGME adopted six core competencies that physicians in training must master if they are to provide quality care. The American Board of Medical Specialties (ABMS) has adopted these same competencies as the basis for the standards of certification and maintenance of certification for all specialty boards, making this framework equally valuable for all practicing physicians.

This article introduces a Healthcare Matrix that links the IOM Aims for Improvement and the six ACGME Core Competencies. The matrix provides a blueprint to help residents to learn the core competencies in their daily work of caring for patients and to help faculty to link mastery of the competencies with improvement in quality of care. The matrix also provides a framework for educators to use in curriculum and program redesign. Data collected in completing the matrix can be used to generate new knowledge for operational and outcome improvements and research for both resident education and the delivery of care.

### Challenge of Teaching and Assessing the Core Competencies

Teaching and evaluating the core competencies essential for quality health care is an evolutionary process without a prescribed formula. Most academic institutions have focused on identifying summative assessment tools to evaluate residents’ acquisition of the competencies, which presumes that the competencies are being taught and learned effectively. In reality, teaching and assessing the less formally defined competencies—professionalism, communication and interpersonal skills, systems-based practice, and practice-based learning and improvement—has been problematic even for experienced clinicians and educators. Teaching system-based practice and practice-based learning and improvement has been especially daunting for faculty without experience in quality improvement. For these reasons, and acknowledging the dependency of quality medical education on the presence of quality medical care and improvement, we introduce a formative approach to the presentation of the core competencies to residents, which in turn is having an effect on the faculty and their patient care.

### The Healthcare Matrix

The Healthcare Matrix (Figure 1, page 101) is a response to the challenge of linking all six competencies mandated by ACGME with the realities of the current system of medical education, which is usually more focused on the acquisition of medical knowledge. It is a conceptual framework that projects an “episode of care” as the large and complex picture that it is yet provides a glimpse into the interaction between quality outcomes (IOM Aims for Improvement) and the skills, knowledge, and attitudes (ACGME Core Competencies) necessary to affect those outcomes. The matrix is intended to make readily apparent the tight linkage between competencies and outcomes.

The first row (Patient Care) is meant to be an assessment of the quality of the care. For example, was care safe? If the answer is “yes,” this is written in that cell. Was care timely? If it wasn’t, the cell gets a “no.” Next, for each column that receives a “no,” the four specific ACGME competencies (medical knowledge, professionalism, system-based practice, and interpersonal and communication skills) are examined in terms of their contributions to the care of the patient. Finally, suboptimal performance is synthesized into the implementation of improvement strategies (practice-based learning and improvement).

Two examples are provided to illustrate our pilot work with the Healthcare Matrix in two different resident learning settings. A facilitator [D.C.Q.] first attends a typical case or mortality and morbidity (M&M) conference and documents the presentation and discussion on a blank matrix framework. She then shares the matrix with the group as a means of discussing the six competencies, highlighting what was missed of the competencies. Sometimes the matrix is sent to the resident for additional reflections (see Example 2, page 103). Eventually, the residents will use the matrix to prepare their case presentations and M&M conferences. The most beneficial
### Healthcare Matrix for a Patient with Pregnancy and Disseminated Intravascular Coagulopathy

#### Figure 1.
The use of the Healthcare Matrix to analyze a complex episode of care that took place in the course of 18 hours and involved a life-threatening situation is described in Example 1. The most important cells are outlined. ACGME, Accreditation Council of Graduate Medical Education; IOM, Institute of Medicine; IV, intravenous; OR, operating room. The IOM dimensions of care and the ACGME Core Competencies are explained in the legend for Figure 2.

<table>
<thead>
<tr>
<th>ACGME</th>
<th>IOM</th>
<th>SAFE</th>
<th>TIMELY</th>
<th>EFFECTIVE</th>
<th>EFFICIENT</th>
<th>EQUITABLE</th>
<th>PATIENT-CENTERED</th>
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<tbody>
<tr>
<td>I. PATIENT CARE</td>
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<td>II. a MEDICAL KNOWLEDGE</td>
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<td>II. b INTERPERSONAL AND COMMUNICATION SKILLS</td>
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<td>II. c PROFESSIONALISM</td>
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<td>II. d SYSTEM-BASED PRACTICE</td>
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<td>(On whom do I depend and who depends on me)</td>
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<td>III. PRACTICE-BASED LEARNING AND IMPROVEMENT</td>
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<td>(How must I improve)</td>
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**Assessment of Care**

- **I. PATIENT CARE**
  - Despite direct medical attention, patient nearly died from hemorrhagic shock.
  - Life saving treatment was delayed for variety of reasons.
  - Delays in treatment impaired effectiveness of therapy.
  - Resources (blood products, staff time) were not utilized in an efficient manner.
  - Patient’s ethnicity, socio-economic, education status influence the level of care she received? Did the time of night influence care?

- **II. a MEDICAL KNOWLEDGE**
  - Hemorrhagic shock at life-threatening emergency.
  - Prompt diagnosis, recognize urgency, initiate therapy, inc. timely transport to OR.
  - Diagnosis was made late. No urgency to treat. Delay in contacting Anesth.
  - Inadequate assistance in transport to OR.
  - Death in postpartum hemorrhage requires aggressive IV resuscitation: always consider combining procedures (start IV while drawing blood sample for transfusion cross match).

- **II. b INTERPERSONAL AND COMMUNICATION SKILLS**
  - Safety is jeopardized unless team members are fully apprised of patient’s condition.
  - Blood cross match must be prioritized and fully implemented in a timely fashion.
  - Effectiveness of life-saving intervention depends on effective communication between team members.
  - Communications of a defensive or argumentative nature are counter-productive to efficient and safe care.
  - The focus should be patient care, with analysis of misunderstandings at a later time.
  - Must communicate patient’s condition and intervened interventions (blood transfusion, emergency hysterectomy), and in a way that is understandable and useful to the patient, respecting patient autonomy.

- **II. c PROFESSIONALISM**
  - System must ensure that appropriate consultants are notified when needed to ensure safety in life-threatening medical condition.
  - During postpartum bleeding, type & cross match must be drawn, sent, and verified promptly.
  - Failure to do so threatens life.
  - Failures to draw, send, and verify cross match blood sample jeopardizes effectiveness of life-saving therapy.
  - Standard of care should not vary due to differences in staffing that results from time of day / night (availability of lab medicine, physician, timely transport of blood samples, adequate number & expertise of obstetrics, anesthesia, & nursing staff).

- **III. PRACTICE-BASED LEARNING AND IMPROVEMENT**
  - Policy and procedure changed for Mom/Child in trouble.
  - Revise the criteria for and system of communicating urgent/emergent request for Anesthesiology consultation.
  - Departmental Teaching Conference on management of parturient with D.I.C.
  - Procedure outlined for fastest prep for OR
  - Increased awareness of need to consider patient centered care even in emergent or crisis situations. Communication with father / family members when appropriate and possible.
learning comes from the residents having to think about each cell as it relates to their presentation.

Example 1. Anesthesiology Resident

The first example presents the learning experience of a resident who used the Healthcare Matrix to analyze a complex episode of care that took place in the course of 18 hours and involved a life-threatening situation. The matrix prompted the resident and other team members to look beyond the compelling medical issues to explore the significance of competencies and dimensions of care that represented the real threats to life in this case. Ultimately, this exercise led to consideration of process changes designed to improve care.

A senior anesthesiology resident and her supervising attending [M.R.G.] were summoned urgently in the middle of the night to provide anesthesia for a young mother who had delivered a healthy term infant an hour earlier. Postpartum bleeding necessitated uterine exploration under anesthesia. Initial assessment revealed hypovolemic shock and continuing vaginal bleeding but only a single intravenous (IV) line. A call to the blood bank revealed that no blood was immediately available because the patient’s blood sample had been received only five minutes earlier. Suspecting disseminated intravascular coagulopathy (DIC), the anesthesia team immediately placed a large-bore IV and began aggressive resuscitation with IV fluid and type-specific but uncrossmatched blood products. Within 15 minutes the patient’s vital signs stabilized and her symptoms of shock resolved. During the next 1½ hours, she underwent a life-saving peripartum abdominal hysterectomy, with > 5 liters of blood loss and a total of 7 liters of IV fluid and 31 units of various blood products transfused. She subsequently experienced pulmonary edema on the first postoperative day, a further decrease in hematocrit (requiring additional blood transfusions), and symptomatic hypocalcemia due to massive transfusion, yet was discharged home on her fourth postoperative day.

This highly complex episode of care was replete with learning points in all core competencies and dimensions of care—medical knowledge and patient care issues (chorioamnionitis, pathophysiology and treatment of DIC, massive transfusion, and so on), professionalism/ethical issues, equity, timeliness of communication, effectiveness of teams, systems (protocols for consultation and crisis prevention and management), and practice-based improvement. In fact, although the DIC was a life-threatening development, these other system-related factors lay at the heart of this near miss. Considering the patient’s age and parity, it must be argued that the catastrophe was not completely averted because her fertility was permanently sacrificed.

The case formed the basis of an extended resident learning exercise. The attending asked the resident to write a detailed account of the peripartum course, including all clinical details, events, team communications, and time line. The resident was also to compile an exhaustive list of “important learning topics and issues prompted by reflection of the details of this case (no particular order).” The attending anesthesiologist performed the same exercise independently.

The resident’s list of learning topics was as follows:
1. DIC—what is it?
2. DIC in pregnancy—what are the causes?
3. Fibrinolysis in DIC (significance of an in vitro clot test)
4. Local anesthetic toxicity
5. Postpartum hemorrhage with regional anesthesia versus general anesthesia
6. Pulmonary edema secondary to massive transfusion/volume resuscitation
7. Hypocalcemia from massive transfusion
8. Blood-tinged epidural aspirate—significance?
9. Carbo-prost, misoprostol, and methylergonovine maleate—indications and uses
10. Third-spacing—can specific IV fluids prevent it?
11. Arterial-line indications—use with massive transfusions or not?
12. Who needs a type and cross? Why does it take 30 minutes?

Of the 12 learning points, all but one (point 12) focused entirely on the intersections between the competencies medical knowledge and patient care and the dimensions effectiveness and safety—representing only 4 of the 36 cells of health care. Learning point 12 included the Systems/Timeliness cell.

The attending physician inserted his recollections into the resident’s narrative, focusing especially on the team interaction and communication issues omitted.
from the resident’s draft. He then asked the resident to use the Healthcare Matrix to discuss the individual competencies and dimensions and the implications of the intersecting cells. He explained how this episode of care and other episodes of care could be viewed in terms of each of the cells, with reflection on what was done and how the various facets of care contribute to the outcome, and ultimately consideration of what was done well and what was suboptimal and could benefit from improvement.

The resident returned a matrix that was much richer, now including entries in 17 of 36 cells (Figure 1). The resident chose to use this case for a one-hour, departmental senior resident case presentation identifying the learning points she wished to include. Approximately two-thirds of her presentation focused on the scientific and clinical aspects of normal and abnormal homeostasis, and the management of DIC. The final third of her presentation centered on the systems, communication, and team issues that contributed to the near-catastrophic outcome, introducing these by way of the Healthcare Matrix model. During the 15-minute discussion period, questions and comments offered by faculty and residents in attendance concerned the many cells representing the intersections of competencies (especially communication, systems-based practice, professionalism, practice-based learning and improvement) and dimensions of care (especially safety, timeliness, patient-centeredness, equitability, effectiveness).

The resident’s presentation of this case prompted the obstetrical anesthesiology faculty to partner with the obstetricians and obstetric nursing staff to improve the team’s processes involved in responding to urgent obstetrical situations. During a debriefing interview with one of the authors [D.C.Q.], the resident reflected on the learning exercise and the matrix’s usefulness in contributing to her learning. The resident viewed the Matrix as pivotal to opening her eyes to the many competencies other than medical knowledge which are critical to optimal healthcare delivery. Based on this presentation, the Department of Anesthesia will use the Matrix to frame M&M conferences.

Example 2. Psychiatry Resident

In a second example, the Healthcare Matrix was used to enhance learning in a psychiatry resident case conference. In the matrix for this example (Figure 2, page 104) the resident’s additional content is initialed [WHJ]. The psychiatry residents now use the matrix to prepare their case conference presentations, and the program director uses it to ask questions during the presentations. Two lessons learned by the residents are that not all cells need be filled in and that it is helpful to border the most important cell(s) in red.

Creating and Reinforcing a Culture of Learning

The matrix is intended to help consider patient care in terms of the IOM Aims and the ACGME Core Competencies rather than make these dimensions add on to an already compressed duty-hour week. Faculty use the matrix to enhance the learning experience for every resident. We are slowly creating an environment where learning can occur with other members of the team, where data are gathered and reviewed, and where decisions are made in a collaborative manner rather than in an environment characterized by “embarrassment, blame, shame and sometimes humiliation” for the residents. This new learning environment represents a shift in culture that acknowledges the resident as part of a system of care, in which he or she learns in and about the system of care.

The matrix provides a common framework for evaluating and improving patient care across all disciplines. For example, pediatrics residents are teaming up with the nursing staff and managers to improve the residents’ continuity clinic. The residents had identified many system issues in care of a child with asthma, and when they brought this to the attention of the nursing manager, she stated that a team was already working on those issues. The pediatric residents were then invited to be part of the process flow team. When the matrix was used to analyze suboptimal outcomes associated with femoral vein cannulation, faculty and residents established a multidisciplinary team to decide on orders, policies, and procedures for venous cannulation.

Ongoing Work and Research Agenda

The Healthcare Matrix is being used in a variety of settings and is the focus of a research agenda.
### Healthcare Matrix for Care of a Patient with Schizophrenia (and Auditory Hallucinations)

<table>
<thead>
<tr>
<th>ACME</th>
<th>SAFE</th>
<th>TIMELY</th>
<th>EFFECTIVE</th>
<th>EFFICIENT</th>
<th>EQUITABLE</th>
<th>PATIENT-CENTERED</th>
</tr>
</thead>
<tbody>
<tr>
<td>patient care overall assessment</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>this patient is at risk for suicide</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>not timely from adolescence and too many providers delayed good care</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>medication regime NOT effective</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>not efficient in medication use</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>not sure this was a problem</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>minority mask who had prison record</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>many different healthcare systems failed this person</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>

### medical knowledge (what i must know)
- Medications: significant part of treatment. Knowledge of type, dosage, when to add, what other drugs that can prevent suicide (e.g., antipsychotic). 
- Suicide ideation at each visit but formal suicidality plan developed with patient and mother would be beneficial.

### professionalism (how i must act)
- Family MD had sleep apnea and was totally inadequate, created more delays in helping him.
- WHO knowing standard of care for patients with schizophrenia is duty of physician.

### interpersonal and communication skills (what i must say)
- Suicidal ideation: Accusation of vaccination led to overdose of meds, feels "hander" which is key symptom to watch.
- Seeing patient on regular schedule - discuss frequency of logs with supervisor/team, leave open communication with caregivers, have a family involved.

### system-based practice: (on whom do i depend and who depends on me)
- Support groups to help him understand his illness.
- WHO patient should be assigned to one of the clinic groups, communication lines between PCPs, consulting physicians could be improved to allow external non-psychiatric/psychiatric providers means with which to quickly contact psychiatrists. Should need arise, social worker liaison would be very beneficial in this specialty.

### continued
Multiple Uses in Different Specialties

The Healthcare Matrix is being piloted at Vanderbilt University Medical Center and elsewhere in many specialties, including not only anesthesiology, psychiatry, and nephrology but also emergency medicine and internal medicine–ambulatory. It is also being used as a framework for transforming traditional M&M conferences into Morbidity and Mortality and Improvement conferences. The Children’s Hospital at Vanderbilt University Medical Center has created a structured title Performance Management and Improvement (PM & I) that includes use of the matrix for team learning. We have some positive preliminary data on how the matrix is helping to expand the context of learning for the residents and faculty, but more data will be gathered to further validate the tool.

Enhancing Personal and Professional Development

Dreyfus and Dreyfus teach us that novices benefit from algorithms and structured approaches to learning. Residents learn heuristics from textbooks, mentors, chief residents, faculty, and others. For example, all students learn to take a complete history and perform a thorough physical examination, a time-consuming process. When they know more about patient assessment, students are able to perform a focused version of the “history and physical.” Likewise, the resident struggles with this matrix at first, but with experience becomes more facile with the tool, taking less time to complete matrix cells. The matrix provides a valuable technique for the clinician-educator to zero in on the aspects of care that are most important in the presentation of a given case.

Figure 2. This Healthcare Matrix was used to enhance learning regarding the case presented as Example 2. The most important cells are outlined. ACGME, Accreditation Council of Graduate Medical Education; IOM, Institute of Medicine; Dx, diagnosis; EBM, evidence-based medicine; CAPOC, Child/Adolescence psychiatric outpatient care; Tx, treatment; ETOH, alcohol; PCP, primary care physician; TNCARE, Tennessee’s Medicaid managed care system; HC, health care.
At the conclusion of an episode of care, a resident and his or her attending physician debrief with the following questions, which address all cells in the matrix:

1. Was care for this patient as good as it could be?
2. What improvements in the competencies of the resident and faculty and changes in the system of care would result in improved care for the next patient?

Although a completed matrix provides a large amount of information, focusing learning at the “cell” level keeps the learner from feeling overwhelmed with all the dimensions of care. It is useful to ask “Relative to this patient condition, what knowledge do physicians need to know to improve patient safety?” or, “What cell or few cells had the greatest impact on this outcome, and why?”

Completing the matrix cells should itself teach all the core competencies. As learners seek to improve the systems, they will become competent in practice-based learning and improvement. A recent article by Ogrinc et al., which describes a framework for teaching medical students and residents about practice-based learning and improvement, should help residents use the matrix.

Documenting Learning

A completed Healthcare Matrix documents the ability to reflect on outcomes for a patient or panel of patients in terms of the gap between the care provided and the care that could be provided and encourages reflection on how this knowledge can be used to improve care. As improvements in care are made, patient outcome can be compared to assess their effectiveness. The matrix also provides a useful basis for documenting formative feedback as part of a summative evaluation. Instead of the faculty having to decide if the learner demonstrated the competencies, the resident will provide faculty with his or her portfolio and the learning/reflections related to patient care. We are developing an electronic portfolio to accommodate required data (duty hours, procedures, and so on) and data from the Healthcare Matrix.

Research Agenda

The Healthcare Matrix provides a framework for clinicians and teams to improve care of patients. Collecting and analyzing a series of matrices provides the foundation for systematic change in patient care and medical education, as well as a rich source of data for operational and improvement research. We are planning a qualitative research project in which examination of the completed matrices for each specialty will help identify the “quality characteristics” important for each specialty. We hope to be able to identify evaluation tools appropriate for each specialty. We are now tracking data over time from cells from matrices completed by ambulatory medicine residents to create a balanced set of measures to assess progress in patient care and resident education.

References