




Accreditation Council for Graduate Medical Education

## Realizing the Promise of Big Data: Learning Analytics in Competency-Based Medical Education


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## Disclosures

- Paid employee of ACGME
- Adjunct Professor at Northwestern University, Chicago (*unpaid*)
- Adjunct Professor at University of Ottawa, Canada (*unpaid*)

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## Outline

- 1) A Review of Milestones
- 2) Learning Analytics
- 3) Future Directions

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## Outline

- 1) A Review of Milestones
  - 1) Purpose
- 2) Learning Analytics
- 3) Future Directions

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Milestones can help us with...

## PROFESSIONAL ACCOUNTABILITY

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THE NEW ENGLAND JOURNAL OF MEDICINE

SPECIAL REPORT

### The Next GME Accreditation System — Rationale and Benefits

Thomas J. Nasca, M.D., M.A.C.P., Ingrid Philibert, Ph.D., M.B.A., Timothy Brigham, Ph.D., M.Div., and Timothy C. Flynn, M.D.

In 1999, the Accreditation Council for Graduate Medical Education (ACGME) introduced the six domains of clinical competency to the profession,<sup>1</sup> and in 2009, it began a multistep process of restructuring its accreditation system to be based on educational outcomes in these competencies. The result of this effort is the Next Accreditation System (NAS), scheduled for phased implementation beginning in July 2013. The aims of the NAS are threefold: to enhance the ability of the peer-review system to prepare physicians for practice in the 21st century, to accelerate the ACGME's movement toward accreditation on the basis of educational outcomes, and to reduce the burden associated with the current structure.

**LIMITATIONS OF THE CURRENT SYSTEM**

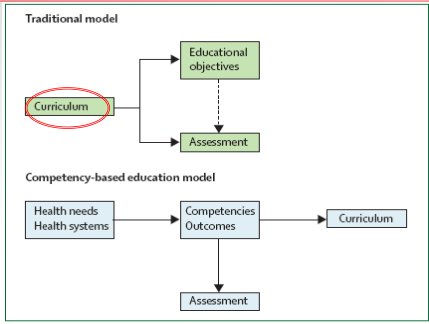
The current GME environment was facing two major stresses: variability in the quality of resident education<sup>2</sup> and the cumulative consequences of subspecialty education. In response, the ACGME's approach emphasized program structure, increased the amount and quality of formal teaching, fostered a balance between service and education, promoted resident evaluation and feedback, and required financial and benefit support for trainees. These dimensions were incorporated into program requirements that became increasingly more specific during the next 30 years.

N ENGL J MED 368:11 NEW.ORG MARCH 15, 2012 1051

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N Engl J Med. 366:1051-6;2012.

### Why We Need a Competency-Based Approach

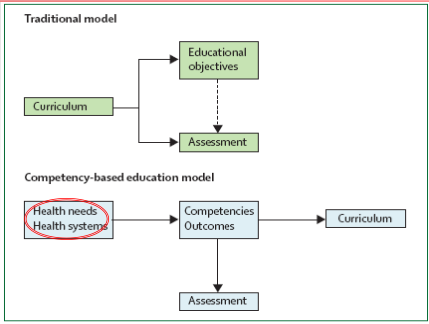


Frank J. Health professionals for a new century: transforming education to strengthen health systems in an interdependent world. Lancet. 2010

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### Why We Need a Competency-Based Approach



Frank J. Health professionals for a new century: transforming education to strengthen health systems in an interdependent world. Lancet. 2010

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### Domains of Competence

- What do they know? (Medical Knowledge)
- What can they do? (Patient Care)

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### Competence is Multi-Dimensional

- What do they know? (Medical Knowledge)
- What can they do? (Patient Care)
- **How do they conduct themselves?** (Interpersonal and Communication Skills, Professionalism)
- **Are they critical and reflective?** (Practice-based Learning and Improvement, Systems-based Practice)

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### Dreyfus Developmental Model of Learning

Dreyfus Stage	Description
Novice	Rule driven; analytic thinking; little ability to prioritize information
Advanced beginner	Able to sort through rules based on experience; analytic and non-analytic for some common problems
Competent	Embraces appropriate level of responsibility; dual processing of reasoning for most common problems; can see big picture; Complex problems default to analytic reasoning. Performance can be exhausting.
Proficient	More fully developed non-analytic and dual process thinking; comfortable with evolving situations; able to extrapolate; situational discrimination; can live with ambiguity
Expert	Experience in subtle variations; distinguishes situations

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### Sample Milestones...

Level 1	Level 2	Level 3	Level 4	Level 5
Performs history and physical examination on patients with brain tumor	Explains risks and benefits of craniotomy for brain tumor	Formulates diagnosis and treatment plan for patient with brain tumor	Adapts standard techniques to special circumstances, e.g. recurrence, bone marrow suppression	Leads interdisciplinary tumor board discussion
Performs lumbar puncture, assists with craniotomy for opening and closing	Assists with craniotomy for brain tumor	Performs craniotomy for brain tumor	Performs complex craniotomy for brain tumor	Performs expert craniotomy for brain tumor
Provides routine peri-operative care for brain tumor patient	Recognizes and initiates work up for complications, e.g. brain edema, JSF, leuk	Manages complex complications, e.g. herniation, hydrocephalus	Manages complex complications	Utilizes patient outcome data for quality improvement and development of adjunctive therapy protocols

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## Milestones: Key Points

- Articulate shared understanding of expectations
- Describe trajectory from a beginner in the specialty to an exceptional resident or practitioner
- Set aspirational goals of excellence
- Organized under six domains of clinical competency
- Used as one indicator of a resident's educational progress

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## Qualitative Evaluation\*: General Themes

### Benefit to the Program Director:

- Changes in the remediation process
  - Catching struggling residents earlier
  - Targeted improvements for individual learners
  - Identifying gaps in otherwise high performers
- Structuring of learning goals
- Making defensible decisions
  - Milestones provide "built-in" documentation

\*Conforti et al. The effect and use of Milestones in the assessment of neurological surgery residents and residency programs. J Surg Educ. 2018;75(1):147-55.

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## Patient Care

List of PC Sub-Competencies_TY	
PC01	History
PC02	Physical Examination
PC03	Differential Diagnosis and Assessment
PC04	Clinical Management
PC05	Urgent and Emergent Medical Conditions
PC06	Care of Diverse Patients

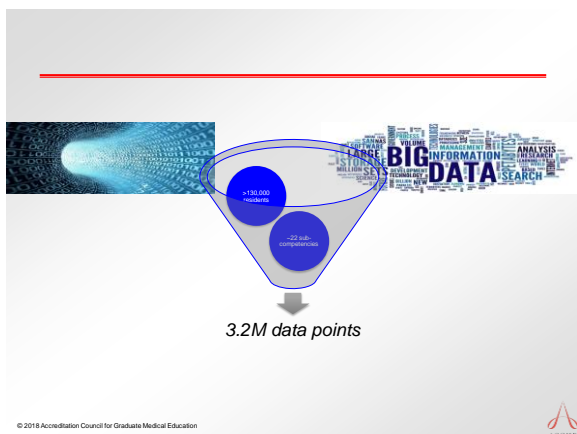
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## # of Sub-Competencies per Specialty

Specialty	Total # Sub-comp	PC	MK	SBP	PBLI	PROF	ICS
Neurosurgery	24	8	8	2	2	2	2
Orthopedic Surgery	41	16	16	3	2	2	2
Emergency Medicine	23	14	1	3	1	2	2
Diagnostic Radiology	12	2	2	2	3	1	2
Urology	32	9	1	4	7	6	5
Internal Medicine	22	5	2	4	4	4	3
Pediatrics	21	5	1	3	4	6	2
Transitional Year	23	7	2	3	3	4	4
..average:	22	5	5	3	3	3	3

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## Outline

- 1) A Review of Milestones
- 2) Learning Analytics
  - 1) Concepts
  - 2) Examples
  - 3) Implementation
- 3) Future Directions

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Learning Analytics...

## CONCEPTS

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## “Entrustability”

- Can we develop a system to ensure residents and fellows are ready for unsupervised practice by graduation?

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## Learning Analytics

“Learning analytics refers to the interpretation of a wide range of data produced by and gathered on behalf of students in order to assess academic progress, predict future performance, and spot potential issues”

-U.S. Dept of Ed 2012

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Learning Analytics...

## EXAMPLES

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## Generic Milestones Template

Milestone Description: Template				
Level 1	Level 2	Level 3	Level 4	Level 5
What are the expectations for a beginning resident?	What are the milestones for a resident who has advanced over entry, but is performing at a lower level than expected at mid-residency?	What are the key developmental milestones mid-residency?  What should they be able to do well in the realm of the specialty at this point?	What does a graduating resident look like?  What additional knowledge, skills & attitudes have they obtained?  Are they ready for certification?	Stretch Goals – Exceeds expectations
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comments:				

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Level 4 is designed as the graduation target and **does not represent a graduation requirement. Making decisions about readiness for graduation is the purview of the residency program director.** Study of milestone performance data will be required before the ACGME and its partners will be able to determine whether Level 4 milestones and milestones in lower levels are in the appropriate level within the developmental framework, and whether milestone data are of sufficient quality to be used for high stakes decisions.

Allows for a QI approach...

## LEVEL 4 IS NOT A REQUIREMENT

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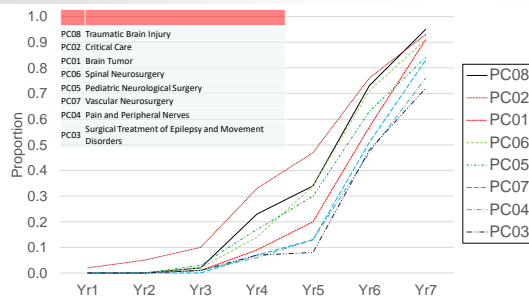
Cross-Sectional Analysis

**(1) AT THE SPECIALTY LEVEL...**

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Proportion of Residents Attaining Level 4 or Higher:  
PC Sub-Competencies (June 2015) – Neurological Surgery



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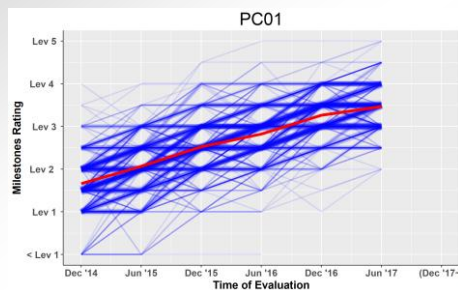
Longitudinal Analysis

**(2) AT THE INDIVIDUAL LEVEL...**

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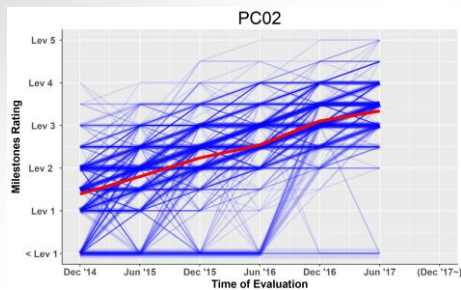
Resident-Level Trajectories of Milestones Ratings -  
Pathology



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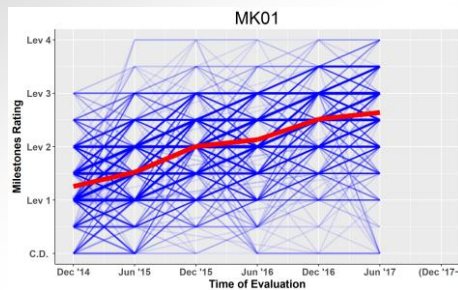
Resident-Level Trajectories of Milestones Ratings -  
Pathology



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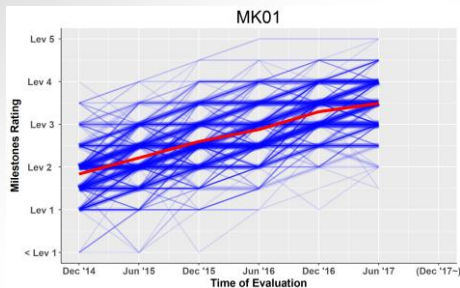
Resident-Level Trajectories of Milestones Ratings -  
Surgery



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### Resident-Level Trajectories of Milestones Ratings - Pathology

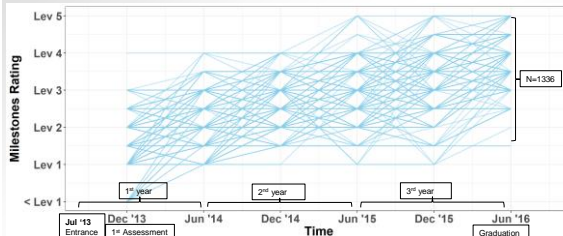


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### Mapping Individual Trajectories

Residents' Milestones trajectories over time (e.g., Wound Management)

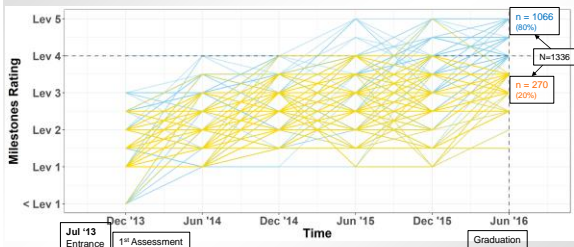


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### Results – EM Wound Management

Milestones trajectories for those who attained Level 4 and those who did not

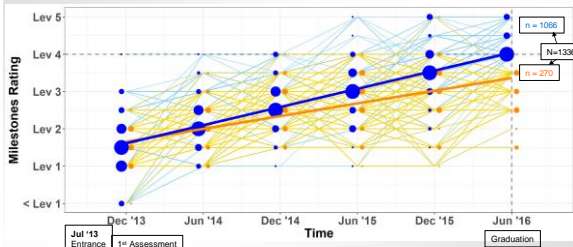


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### Results – EM Wound Management

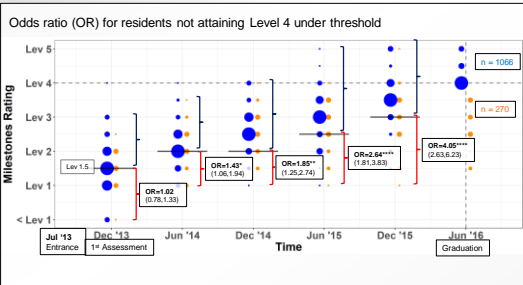
Milestones trajectories for those who attained Level 4 and those who did not



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### Milestone Level Thresholds



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Qualitative Research

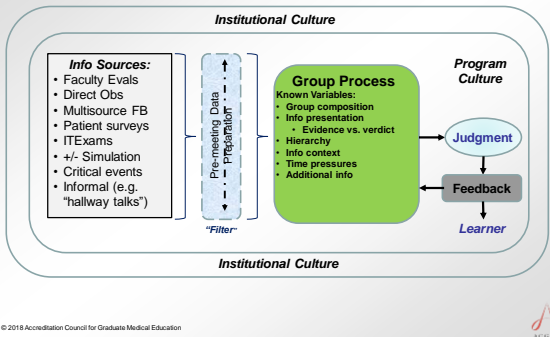
### (3) HOW DO RATERS MAKE DECISIONS?

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### Milestones Guide Group Judgments



### Typical Evaluation Form

Diagnosis (PC1)	0	1	2	3	4
Not observed	Unable to perform an accurate H+P	Performs a focused, efficient and accurate H+P of all patients including critically ill patients	Accurately diagnoses most common conditions and initiates management of some	Accurately diagnoses and initiates management for most common conditions	Recognizes atypical presentations of a large number of conditions
Post-op care (PC2)	0	1	2	3	4
Not observed	Does not recognize or manage common post op problems	Manages common post op problems with a senior physician present	Manages common post op problems with a senior available by phone	Manages common and complex post op problems independently	Supervises junior residents managing common and complex postoperative problems
Technical skills (PC3)	0	1	2	3	4
Not observed	Lacks basic surgical skills (e.g. knot tying, NG tube, Foley, I&D, art line)	Has basic surgical skills (e.g. knot tying, NG tube, Foley, I&D, art line)	Has respect for tissue and developing instrument handling	Proficient at most instrument handling and exhibits efficiency	Proficiency in use of all instruments and equipment essential operations
Knowledge about diseases (MK1)	0	1	2	3	4
Not observed	Lacks basic knowledge expected of a medical student	Understands signs, symptoms and treatment of some common conditions	Basic knowledge and recognizes variations in presentation of most common conditions	Significant knowledge of many common conditions	Comprehensive knowledge of many conditions and basic knowledge of advanced conditions
Knowledge about operations (MK2)	0	1	2	3	4
Not observed	Does not know steps of common operations	Basic knowledge of steps of common operations	Basic knowledge of steps and perioperative care for most common operations	Significant knowledge of common operations, basic knowledge of some complex operations	Comprehensive knowledge of common operations, basic knowledge of many complex operations

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### ACGME Milestone Evaluations - Neurological Surgery

Program Name - Neurological Surgery

Resident Name:  
Year in Program:  
Position Type:  
Start Date:  
Expected End Date:

Select the level corresponding to the resident's knowledge, skills, attitudes, and other attributes in each area below. Your selections should take into account the resident's demonstration of milestones throughout the program with updates to reflect recent progress. Evaluations must be based on evidence with an emphasis on that obtained by direct observation.

Patient Care	Not Yet Reached	Level 1	Level 2	Level 3	Level 4	Level 5
a) Brain Tumor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Critical Care	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
c) Surgical Treatment of Epilepsy and Movement Disorders	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
d) Pain and Peripheral Nerves	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
e) Pediatric Neurological Surgery	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
f) Spinal Neurosurgery	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
g) Vascular Neurosurgery	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
h) Traumatic Brain Injury	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

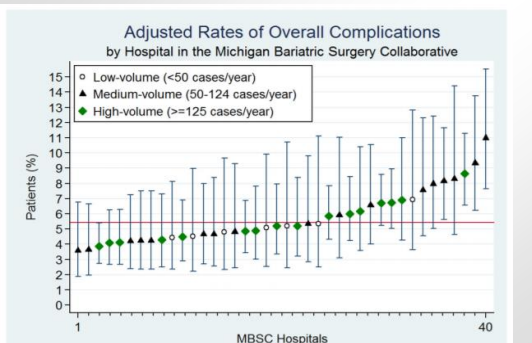
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### Rates of Straight-Lining by Specialty

Specialty	Length of Training	Specialty Name	N Resident	N Subcomp	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8
A21	1	Abdominal radiology	45	13	15.6							
A26	1	Musculoskeletal radiology	29	14	17.2							
A23	1	Neuroradiology	280	14	23.1							
A24	1	Pediatric radiology	55	14	3.6							
A27	1	Vascular and Interventional radiology	294	14	19.7							
A16	5	Interventional radiology - integrated	62	20	18.2	0.0	0.0	6.7	9.0			
A40	5	Surgery	8499	16	23.5	15.9	14.2	16.3	38.8			
A46	2	Complex general surgical oncology	107	23	11.1	17.6						
A45	2	Pediatric surgery	81	23	9.6	9.7						
A42	1	Surgical critical care	262	30	17.6							
A50	2	Vascular surgery	247	31	9.8	5.7						
A51	5	Vascular surgery - integrated	272	31	3.1	3.7	1.7	3.8	10.3			
A60	3	Thoracic surgery (2-year programs)	84	26	11.5	10.3	20.7					
A60	2	Thoracic surgery (3-year programs)	137	26	14.4	26						
A66	1	Congenital cardiac surgery	32	9	8.8							
A61	6	Thoracic surgery - integrated	183	26	8.3	10.8	5.7	7.4	7.4	23.8		
A80	4	Urology	1288	34	9.3	8.0	10.0	17.4				
A86	3	Female pelvic medicine and reconstructive surgery (Urogyn)	35	11	7.1	8.3	22.6					
A85	1	Pediatric urology	24	22	12.5							
999	1	Transitional year	1332	23	15.4							

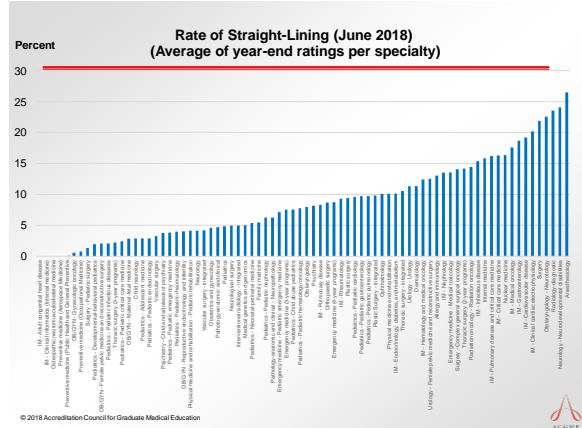
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### The Power of a "QI" Approach



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Pradarelli et al. Surgery. 2016 Apr;159(4):1113-20.



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Learning Analytics...

## IMPLEMENTATION

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## Implementation

- 1) Strategies for Interpretation
  - input from SMEs
- 2) Revisit Overall Purpose
- 3) Revision of Content/Structure

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## Qualitative Evaluation\*: General Themes

### Areas of Milestone Challenges:

- Logistics and data handling
- Assessment processes
  - Need for more faculty development
  - How to map assessments onto a Milestone judgment
- Language in some Milestones
- Time and resources for core faculty
- Better assessment tools (need to be *feasible*)

\*Conforti et al. The effect and use of Milestones in the assessment of neurological surgery residents and residency programs. J Surg Educ. 2018;75(1):147-55.

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Content Validity...

## MILESTONES 2.0

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## Differences – Structure

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
<ul style="list-style-type: none"> <li>• Performs a history and physical examination including a patient's chief complaint, analysis, synthesis, and recommendations</li> <li>• Performs a focused history and physical examination</li> <li>• Performs a complete history and physical examination</li> <li>• Performs a comprehensive history and physical examination</li> <li>• Performs a head-to-toe examination</li> </ul>	<ul style="list-style-type: none"> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> </ul>	<ul style="list-style-type: none"> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> </ul>	<ul style="list-style-type: none"> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> </ul>	<ul style="list-style-type: none"> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> </ul>	<ul style="list-style-type: none"> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> <li>• Obtains and interprets history and physical examination</li> </ul>

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## DIFFERENCES – CONTENT

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**Old Version:**

PC2. Physical Examination: Performs a comprehensive physical examination					
Has not Achieved Level 1	Level 1	Level 2	Level 3	Level 4	Level 5
	Performs a basic physical exam	Performs a comprehensive exam and collects relevant physical findings for the chief complaint	Consistently performs an accurate, thorough, and focused physical examination, and correlates findings with important clinical events	Performs a sophisticated specialty-specific physical exam with effective use of bedside skills	Serves as a role model and educator in the use of specialty-specific exam skills
Comments:					

**New Version:**

Patient Care 2: Physical Examination				
Level 1	Level 2	Level 3	Level 4	Level 5
Performs a basic physical exam accurately	Performs and reports an accurate, organized physical exam, and identifies appropriate physical findings for the chief complaint	Consistently performs an accurate and thorough physical examination, and reports relevant findings in support of likely clinical diagnosis	Consistently identifies and concisely reports subtle physical findings; is proficient with advanced maneuvers	Consistently serves as a role model and educator in the performance of an advanced physical exam
Comments: <span style="float: right;">Not Yet Completed Level 1 <input type="checkbox"/></span>				

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**Outline**

- 1) A Review of Milestones
- 2) Learning Analytics
- 3) Future Directions

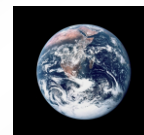
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**Questions to Consider**

1. Reflect on your own context:
  - Consider barriers and facilitators to implementing large data collection system
2. How would Learning Analytics help your learners?
  - Your teachers?
  - Your patients?
3. Share

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**THE FUTURE...**

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**The Art of the Possible**

- What the technology now affords
- Implications/new challenges:
  1. the challenge of interpretation
    - Descriptive summaries of learning trajectories aren't that helpful
    - How do you 'make meaning' from the data?
  2. strategies for communication
    - Translate implications of data to learners and educators
  3. implementation science/KT
    - Engage stakeholders for feedback, data visualization

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**Questions?**



@stanhamstra

- 1) A Review of Milestones
  - purpose
- 2) Learning Analytics
  - Concepts
  - Examples
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