Simulation-based Competency Assessment in Resuscitation: A Framework for Assessment from Emergency Medicine

Andrew K. Hall†, J. Damon Dagnone†, Will Pickett‡, Don A. Klinger*

†Department of Emergency Medicine
‡Department of Community Health and Epidemiology
*Faculty of Education
Queen’s University, Kingston, ON

Health Sciences Education Rounds
Thursday October 16, 2014

andrew.hall@queensu.ca
Objectives

After participating in these rounds, the attendee will be able to:

- Describe the current evidence supporting simulation for competency-based assessment
- Build an argument for the validity of an assessment tool, as outlined for the Queen’s Simulation Assessment Tool (QSAT)
- Understand potential uses of simulation for assessment of trainees in the future.
My background:

Queen’s Medical School (2008)

Queen’s FRCPC Emergency Medicine (2012)

University of Dundee MMEd Candidate

Sim-based Education:
Interprofessional JR Resuscitation Rounds
EM SR Resuscitation Rounds
Sim-based Assessment of Resuscitation and Procedural Competence for EM Residents
Post-graduate Assessment of Competence
#4 Integrate Competency-Based Curricula in Postgraduate Programs

The recommendation states:

Develop, implement, and evaluate competency-based, learner-focused education to meet the diverse learning needs of residents and the evolving healthcare needs of Canadians.

#6 Implement Effective Assessment Systems

The recommendation states:

Assess competence and readiness to practice through a combination of formative and summative feedback and assessments.
Performance in assessment: Consensus statement and recommendations from the Ottawa conference

KATHARINE BOURSICOT¹, LUCI ETHERIDGE², ZERYAB SETNA³, ALISON STURROCK², JEAN KER⁴, SYDNEY SMEE⁵ & ELANGO SAMBANDAM⁶

Ottawa, Ontario, Canada
April 25-29, 2014
Transforming Healthcare through Excellence in Assessment and Evaluation

2014
16th OTTAWA CONFERENCE
12th CANADIAN CONFERENCE ON MEDICAL EDUCATION

KEYNOTE ADDRESS

Keynote Address: The Focus on Competencies and Individual Learner Assessment as Emerging Themes in Medical Education Research

ACADEMIC EMERGENCY MEDICINE 2012;

Stanley J. Hamstra, PhD

The Assessment of Individual Cognitive Expertise and Clinical Competency: A Research Agenda

Linda Spillane, MD, Emily Hayden, MD, Rosemarie Fernandez, MD, Mark Adler, MD, Michael Beeson, MD, Deepi Goyal, MD, Rebecca Smith-Coggins, MD, John Boulet, PhD
Royal College of Physicians and Surgeons – Competency by Design

The Draft CanMEDS 2015
Physician Competency Framework

Simulation in Medical Education

Trauma
High-Fidelity Sim-Based Assessment

- Direct assessment of performance
- Knowledge, clinical reasoning, skill performance, teamwork
- Potential to satisfy the need for Competency-Based Assessment

Adapted from: Miller (1990) – Levels of Competence
How is simulation being used for assessment of competence?

Procedural

Comprehensive / Medical Expert

Crisis Resource Management (CRM)
Procedural-Skills Assessment

Objective structured assessment of technical skill (OSATS) for surgical residents

J. A. Martin, G. Regehr, R. Reznick, H. Macrae, J. Murnaghan, C. Hutchison and M. Brown

British Journal of Surgery 1997, 84, 273–278

OSATS

• 3 scoring systems:
  • Task-specific checklist
  • Global Rating Scale
  • Pass/fail judgment

• Six station exam
  • Bench model (Simulation)
  • Animal model

• OSATS Scoring:
  • Reliable and Valid
  • GAS better than checklist
  • Bench model comparable to live animals
Crisis Resource Management (CRM) Assessment

Ottawa “GRS”
- 5 categories of CRM and one overall GAS
- 7-point Likert scale
- Excellent reliability and validity
- Subsequently further studied
Comprehensive / Medical Expert Assessment Tools

Development and evaluation of a simulation-based resuscitation scenario assessment tool for emergency medicine residents
Andrew Koch Hall, MD*; William Pickett, MSc, PhD*; Jeffrey Damon Dagone, MD, MMEd*

Reliability and validity of a scoring instrument for clinical performance during Pediatric Advanced Life Support simulation scenarios
Aaron Donoghue a,b,c,e, Akira Nishisaki a,c, Robert Sutton a,c, Roberta Hales e, John Boulet d

A Measurement Tool for Simulation-Based Training in Emergency Medicine: The Simulation Module for Assessment of Resident Targeted Event Responses (SMARTER) Approach
(Sim Healthcare 3:170–179, 2008)

Simulation and education
Validation for a scoring system of the ALS cardiac arrest simulation test (CASTest)
Fiona Napier a,b, Robin P. Davies b,c, Catherine Baldock e, Harry Stevens f,d, Andrew S. Lockey c,f, Ian Bullock c,g, Gavin D. Perkins a,b,c,e
Resuscitation 80 (2009) 1034–1038

Comparison of Checklist and Anchored Global Rating Instruments for Performance Rating of Simulated Pediatric Emergencies
Simulation in Healthcare
Vol. 6. No. 1. February 2011
1) Israeli Anesthesia Board Certification – Sim OSCE

2) Maintenance of certification by the American Board of Anesthesiology
Simulation-based Competency Assessment of EM Residents

Educational Objective
To conduct twice annual simulation-based formative OSCEs to assess EM resident resuscitation competency and provide feedback to our residents

Research Objective
To develop and validate an easily modifiable assessment tool for resuscitation simulation-based OSCE stations for EM trainees – the “Queen’s Simulation Assessment Tool” (QSAT)
Methods

QSAT Development

- OSCE Station Development
  - 3x Fall 2010
- OSCE Station Development
  - 3x Spring 2011
- OSCE Station Development
  - 2x Fall 2011
- OSCE Station Development
  - 2x Spring 2012

OSCE Administration
- N = 24 Residents

OSCE Administration
- N = 25 Residents

OSCE Administration
- N = 24 Residents

OSCE Administration
- N = 19 Residents

Video Tape Review / Scoring with QSAT

Video Tape Review / Scoring with QSAT

Video Tape Review / Scoring with QSAT

Video Tape Review / Scoring with QSAT

Data Analysis
**QSAT Development**

- **Novel**
- **Based on checklists**
- **Anchored GAS**
- **4 domains**
- **General anchors included**
- **Specific clinically relevant actions to be added**
- **Modified Delphi revisions**

---

### Queen's Simulation Assessment Tool (QSAT)

<table>
<thead>
<tr>
<th>Station No.</th>
<th>Examinee Identification:</th>
<th>Date of Assessment:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Primary Assessment**

<table>
<thead>
<tr>
<th>Vital signs (HR/BP/O2Sat/RR/Temperature) + Glucose</th>
<th>LOC assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac monitors</td>
<td>Airway assessment</td>
</tr>
<tr>
<td>Intravenous access</td>
<td>Rhythm assessment</td>
</tr>
</tbody>
</table>

![Assessment Scale]

**Diagnostic Actions**

<table>
<thead>
<tr>
<th>History (HPI, PMHx, Meds, Allergies)</th>
<th>Bloodwork:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECG, CXR, other:</td>
<td>Bloodwork:</td>
</tr>
</tbody>
</table>

![Assessment Scale]

**Therapeutic Actions**

| Introduces self and explains clinical situation | Demonstrates leadership in managing crisis |
| Clear and concise orders and direction | Appropriate specialist consultation |
| Prioritizes tasks and anticipates further steps | |

![Assessment Scale]

**Communication**

![Assessment Scale]

**OVERALL PERFORMANCE**

![Assessment Scale]
Queen's Simulation Assessment Tool (QSAT)

Station #2 - Acute Sub-arachnoid Hemorrhage

Examinee Identification: ___________________________  Date of Assessment: _____________
Assessed by: ___________________________

**Primary Assessment**

Vital signs (HR/BP/SpO2/RR/Temperature) + Glucose  LOC assessment
Cardiac monitors  Airway assessment
Intravenous access  Rhythm assessment

Examinee Identification: ___________________________  Date of Assessment: _____________
Assessed by: ___________________________

**Diagnostic Actions**

History (HPI, PMHx, Meds, Allergies)  Bloodwork:
Physical exam
ECG, CXR, other:

Examinee Identification: ___________________________  Date of Assessment: _____________
Assessed by: ___________________________

**Therapeutic Actions**

Neuroprotective rapid-sequence intubation  DRUGS: (Manitol/Hypertonic Saline, RSI Meds, Octaplex, Vitamin K, anti-HTN)
Elevation of head of bed  Ventilator settings (hyperventilation)
BP monitoring and control

Examinee Identification: ___________________________  Date of Assessment: _____________
Assessed by: ___________________________

**Communication**

Introduces self and explains clinical situation  Demonstrates leadership in managing crisis
Clear and concise orders and direction  Appropriate specialist consultation
Prioritizes tasks and anticipates further steps

Examinee Identification: ___________________________  Date of Assessment: _____________
Assessed by: ___________________________

**OVERALL PERFORMANCE**

All skills require significant improvement  All skills require significant improvement
Most skills require moderate or significant improvement  Most skills require moderate or significant improvement
Some skills require moderate improvement  Some skills require moderate improvement
Yes, if any skills require only minor improvement  Yes, if any skills require only minor improvement

Examinee Identification: ___________________________  Date of Assessment: _____________
Assessed by: ___________________________
OSCE Station Development

• Content blueprinting to EM curriculum
• Expert panel review, revision, piloting in lab

<table>
<thead>
<tr>
<th>Year</th>
<th>Stations</th>
</tr>
</thead>
</table>
| 2010 Summer OSCE | S1 STEMI with VFib Arrest  
                               S2 Hyperkalemia with Bradycardia 
                               S3 Multidrug Overdose (TCA and Oral Hypoglycemic) |
| 2011 Winter OSCE | S4 Acute CHF Exacerbation  
                               S5 Acute Subarachnoid Hemorrhage  
                               S6 Sympathomimetic Overdose |
| 2011 Summer OSCE | S7 Meningitis with Status Epilepticus |
| 2012 Winter OSCE | S8 Upper Gastrointestinal Bleed, PEA Arrest  
                               S9 Paediatric Drowning  
                               S10 Paediatric Vomiting, Dehydration, Intussusception |
OSCE Administration

- 20-26 EM residents per OSCE from FRCPC and CCFP-EM training programs
- Standardized actors, tech, cues, vis stim, events, timing
- Videotaped resident performance
QSAT Scoring and Analysis

- External raters x3 - blinded to level of training
- Trained and oriented with standardized videos
- Sequential scoring of all performance
- Data analysis
  - Discriminatory capabilities (CCFP-EM / R1-2 / R3-5) – Analysis of Variance
  - Inter-rater reliability – Correlational Analysis
  - G-Study / Variance Component Analysis
Results

Discriminatory capability = EXCELLENT

*p < 0.05 in all by S9
## Results

Inter-rater reliability = GOOD

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Stations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>((\rho))</td>
<td>0.74</td>
<td>0.83</td>
<td>0.79</td>
<td>0.73</td>
<td>0.72</td>
<td>0.76</td>
<td>0.87</td>
<td>0.68</td>
<td>0.74</td>
<td>0.63</td>
</tr>
<tr>
<td>Each 2/3 Station</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSCE ((\rho))</td>
<td>0.87</td>
<td>0.88</td>
<td>0.86</td>
<td>0.72</td>
<td>0.73</td>
<td>0.74</td>
<td>0.63</td>
<td>0.72</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>TOTAL QSAT (ICC)</td>
<td>0.75</td>
<td>0.80</td>
<td>0.70</td>
<td>0.65</td>
<td>0.68</td>
<td>0.56</td>
<td>0.87</td>
<td>0.62</td>
<td>0.73</td>
<td>0.58</td>
</tr>
</tbody>
</table>
## Results

### G-study / Variance Component Analysis

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Trainee</td>
<td>13.87 (54.6)</td>
<td>7.85 (41.2)</td>
<td>10.36 (45.6)</td>
<td>6.12 (35.2)</td>
</tr>
<tr>
<td>Judge</td>
<td>0.07 (0.3)</td>
<td>3.10 (16.3)</td>
<td>0.37 (1.6)</td>
<td>0.34 (2.0)</td>
</tr>
<tr>
<td>Scenario</td>
<td>0.00 (0.0)</td>
<td>0.80 (4.2)</td>
<td>3.79 (16.7)</td>
<td>2.05 (11.8)</td>
</tr>
<tr>
<td>Trainee x Judge</td>
<td>1.56 (6.1)</td>
<td>0.14 (0.7)</td>
<td>0.53 (2.3)</td>
<td>1.34 (7.7)</td>
</tr>
<tr>
<td>Trainee x Scenario</td>
<td>5.14 (20.2)</td>
<td>3.59 (18.8)</td>
<td>4.32 (19.0)</td>
<td>3.94 (22.7)</td>
</tr>
<tr>
<td>Judge x Scenario</td>
<td>1.55 (6.1)</td>
<td>0.44 (2.3)</td>
<td>0.00 (0.0)</td>
<td>0.38 (2.2)</td>
</tr>
<tr>
<td>Error</td>
<td>3.22 (12.7)</td>
<td>3.15 (16.5)</td>
<td>3.37 (14.8)</td>
<td>3.21 (18.5)</td>
</tr>
<tr>
<td>G-coefficient</td>
<td>0.84</td>
<td>0.83</td>
<td>0.78</td>
<td>0.67</td>
</tr>
</tbody>
</table>
## Results

### D-study

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Judge 3 Scenario</td>
<td>0.76</td>
<td>0.77</td>
<td>0.77</td>
<td>0.62</td>
</tr>
<tr>
<td>2 Judges 3 Scenario</td>
<td>0.82</td>
<td>0.81</td>
<td>0.82</td>
<td>0.71</td>
</tr>
<tr>
<td>3 Judges 3 Scenario</td>
<td>0.84</td>
<td>0.83</td>
<td>0.84</td>
<td>0.74</td>
</tr>
<tr>
<td>1 Judge 6 Scenario</td>
<td>0.82</td>
<td>0.86</td>
<td>0.85</td>
<td>0.71</td>
</tr>
<tr>
<td>2 Judges 6 Scenario</td>
<td>0.88</td>
<td>0.89</td>
<td>0.89</td>
<td>0.79</td>
</tr>
<tr>
<td>3 Judges 6 Scenario</td>
<td>0.90</td>
<td>0.91</td>
<td>0.91</td>
<td>0.83</td>
</tr>
<tr>
<td>1 Judge 9 Scenario</td>
<td>0.85</td>
<td>0.90</td>
<td>0.88</td>
<td>0.74</td>
</tr>
<tr>
<td>2 Judges 9 Scenario</td>
<td>0.90</td>
<td>0.92</td>
<td>0.92</td>
<td>0.83</td>
</tr>
<tr>
<td>3 Judges 9 Scenario</td>
<td>0.92</td>
<td>0.93</td>
<td>0.93</td>
<td>0.86</td>
</tr>
</tbody>
</table>
Results

Questionnaire Data
1) How comfortable do you feel being assessed in a simulation environment?
   • Mean (all) = 3.8 / 5
   • Mean (final year) = 4.6 / 5
2) How well do you feel this OSCE simulated an ER resuscitation?
   • Mean (all) = 4.2 / 5
   • Mean (final year) = 4.4 / 5
3) How valuable do you feel this OSCE was for your personal learning?
   • Mean (all) = 4.6 / 5
   • Mean (final year) = 4.8 / 5
# Unified Argument for Validity

## Validity Element | Evidence
---|---
Content | Development by Expert EM Physicians
Review by Resuscitation Content Experts
Derived from Previously Validated Assessment Tool
Response Process | Rater Training
Internal Structure – Reliability | Inter-Rater reliability
G-study
Relations with Other Variables | Discriminatory Capabilities
Pilot-work showing correlation with written exam
Consequences | Post-exam Trainee Questionnaire (Value + Comfort)

Multicenter Validation 2012-2013

So we can do this at our institution, but...elsewhere?

- Calgary, Halifax, Toronto, Ottawa
Incorporation of Self-Assessment

QueensU Moodle™ platform
Self-Assessment:

Interactive E-Assessment Tool
Summary

• Post-graduate training programs are moving towards competency-based assessment

• There is a need for reliable and valid tools for the assessment of resident competence

• We have developed a standardized tool and methodology for sim-based OSCE assessment which can serve this purpose

• We anticipate the rapid development of local competency-based assessment programs and the incorporation of simulation-based assessment into summative assessment in the future
Future directions

- Develop QSAT Tool for Summative or Milestone-based Assessment
  - Competency thresholds / standard setting / milestones
  - Single-site large Sim-based Resus OSCE for EM Residents
    - 8 scenarios - 30 residents from across Ontario
    - Apr 2015

- Assessment of Resuscitation Competency Across Specialties
  - Development of similar programs for relevant specialties

- Linking assessment in Simulation lab with real-performance outcomes or assessment
  - Correlation of sim-lab assessment with real-resuscitation assessment using QSAT
Other EM Sim-based Assessment Programs

- Assessment of Central-Line Insertion Competency using Hand-motion Tracking
- Assessment of Point-of-care Ultrasound Competency using Hand-motion Tracking
- Assessment of Expertise with Eye-tracking Glasses in Simulated Resuscitations
Thanks!
andrew.hall@queensu.ca
Questions??
References

- Hall AK, Pickett W, Dagnone JD: Development and evaluation of a simulation-based resuscitation scenario assessment tool for emergency medicine residents. CJEM 2012; 14: 139-146.
- The Association of Faculties of Medicine of Canada: The Future of Medical Education in Canada: A Collective Vision for Postgraduate Medical Education. 2012.