

## Supplemental Digital Appendix 1

### Search Strategy for a Systematic Review of the Literature on Using Simulation-Based Assessments as Surrogates for Patient-Related Outcomes, Published Through February 2013

We conducted the search in two stages. The first stage (last update: May 11, 2011) contained terms relevant to the topic (e.g., simulat\*), learner population (med\*, nurs\*, health occupations), and assessment (e.g., assess\*, valid\*). The search strategy was reported in full as an online appendix to: Cook DA, Hatala R, Brydges R, et al. Technology-enhanced simulation for health professions education: a systematic review and meta-analysis. JAMA. 2011;306:978-988. The second stage of our strategy is reported in full below (last update: 26 February 2013).

#### Scopus

((((TITLE-ABS-KEY(((simulator\* OR simulation\* OR manikin\* OR mannikin\* OR mannequin\* OR virtual OR multimedia) AND (medicine OR medical OR pediatric\* OR paediatric\* OR surgery OR surgical OR surgeon\* OR internist\* OR orthopedic\* OR orthopaedic\* OR cardiovasc\* OR endoscop\* OR laparoscop\* OR anesthes\* OR anesthet\* OR emergency OR trauma OR dental OR dentist\* OR nursing OR nurse\* OR endovascular OR colonoscop\* OR sigmoidoscop\* OR intravenous OR arterial OR gastroenterology OR "minimally invasive" OR suture\* OR diagnostic\* OR ultrasound\*)) AND (resident\* OR residenc\* OR internship OR trainee OR student\* OR professional\* OR practitioner\* OR "health care" OR physician\* OR nurse OR nursing OR clinical OR bedside) AND (acquisition\* OR training OR teaching OR mastery OR skill\* OR retention OR learn\* OR educat\* OR expert\* OR competen\* OR "high fidelity" OR "low fidelity" OR competen\* OR novice\* OR proficien\*)))) AND ((random\* OR blind\* OR valid\* OR outcome\* OR adverse\* OR complicat\* OR error\* OR observ\* OR cohort\* OR video\*)) AND NOT "patient simulat\*" OR "virtual patient\*" OR curricul\* OR "standardized patient\*" AND ORIG-LOAD-DATE > 20110511) AND (((perform\* OR correlat\* OR assess\* OR evaluat\* OR regress\* OR chi) AND (clinical OR intraoperativ\* OR patient\*)) AND (compar\*)) AND NOT (PMID(1\* OR 2\* OR 3\* OR 4\* OR 5\* OR 6\* OR 7\* OR 8\* OR 9\*)) AND (LIMIT-TO(PUBYEAR,2013) OR LIMIT-TO(PUBYEAR,2012) OR LIMIT-TO(PUBYEAR,2011) ) = 331

#### Ovid MEDLINE

1. (simulat\* or virtual).mp. or computer simulation/ or manikin\*.mp. or mannikin\*.mp. or mannequin\*.mp. or cadaver\*.mp. or models, anatomic/ or animals/ or harvey.mp. or (sim adj man).mp. or laerdal.mp. or vrmist.mp. or ((vr adj mist) or mistels).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
2. exp education, medical/ or exp education, nursing/ or exp students, health occupations/ or exp students, nursing/ or exp students, medical/
3. (simulat\* or virtual).mp. or computer simulation/ or manikin\*.mp. or mannikin\*.mp. or mannequin\*.mp. or cadaver\*.mp. or models, anatomic/ or animals/ or harvey.mp. or (sim adj man).mp. or laerdal.mp. or vrmist.mp. or ((vr adj mist) or mistels).mp.
4. Education, Medical, Undergraduate/ or Clinical Clerkship/ or Students, Medical/
5. "Internship and Residency"/

6. exp specialties, medical/ed or exp specialties, surgical/ed
7. exp \*education, medical/ or exp \*education, nursing/ or exp \*students, health occupations/ or exp \*students, nursing/ or exp \*students, medical/ or (\*Education, Medical, Undergraduate/ or \*Clinical Clerkship/ or \*Students, Medical/) or \*"Internship and Residency"/ or (exp \*specialties, medical/ed or exp \*specialties, surgical/ed)
8. 1 or 3
9. 7 and 8
10. clinical competence/ or performance.mp. or assessment.mp. or observ\*.mp. or validation studies/ or cex.mp. or rating\*1.mp. or grade\*.mp. or rotation.mp. or iter.mp. or live.mp. or intraoperative.mp. or actual.mp. or score\*.mp. or skill\*1.mp. or patient\*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
11. 10 or evaluat\*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
12. 9 and 11
13. 12 and sn.fs.
14. "reproducibility of results"/
15. 12 and 14
16. (correlat\* or regression or chi or statistical\* or alpha or kappa or valid\* or reliability or cohort\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
17. 12 and 16
18. 13 or 15 or 17
19. ..1/ 18 yr=2011-2013
20. ((standardized or simulat\*) adj2 patient\*).tw.
21. 19 not 20
22. 21 not \*patient simulation/
23. ("e" adj learning).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
24. 22 not 23

### **Ovid EMBASE**

1. (simulat\* or virtual).mp. or computer simulation/ or manikin\*.mp. or mannikin\*.mp. or mannequin\*.mp. or cadaver\*.mp. or models, anatomic/ or animals/ or harvey.mp. or (sim adj man).mp. or laerdal.mp. or vrmist.mp. or ((vr adj mist) or mistels or inanimate).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]
2. exp education, medical/ or exp education, nursing/ or exp students, health occupations/ or exp students, nursing/ or exp students, medical/
3. (simulat\* or virtual).mp. or computer simulation/ or manikin\*.mp. or mannikin\*.mp. or mannequin\*.mp. or cadaver\*.mp. or models, anatomic/ or animals/ or harvey.mp. or (sim adj man).mp. or laerdal.mp. or vrmist.mp. or ((vr adj mist) or mistels).mp.

4. Education, Medical, Undergraduate/ or Clinical Clerkship/ or Students, Medical/
5. "Internship and Residency"/
6. exp physicians/ or exp medical personnel/
7. exp \*education, medical/ or exp \*education, nursing/ or exp \*students, health occupations/ or exp \*students, nursing/ or exp \*students, medical/ or (\*Education, Medical, Undergraduate/ or \*Clinical Clerkship/ or \*Students, Medical/) or \*"Internship and Residency"/ or (exp \*specialties, medical/ed or exp \*specialties, surgical/ed)
8. 1 or 3
9. 7 and 8
10. clinical competence/ or performance.mp. or assessment.mp. or observ\*.mp. or validation studies/ or cex.mp. or rating\*1.mp. or grade\*.mp. or rotation.mp. or iter.mp. or live.mp. or intraoperative.mp. or actual.mp. or score\*.mp. or skill\*1.mp. or patient\*.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]
11. 10 or evaluat\*.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]
12. 9 and 11
13. 12 and sn.fs.
14. "reproducibility of results"/
15. 12 and 14
16. (correlat\* or regression or chi or statistical\* or alpha or kappa or valid\* or reliability or cohort\*).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]
17. 12 and 16
18. 13 or 15 or 17
19. ..1/ 18 yr=2011-2013
20. ((standardized or simulat\*) adj2 patient\*).tw.
21. 19 not 20
22. 21 not \*patient simulation/
23. ("e" adj learning).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]
24. 22 not 23
25. 24 not (curriculum/ or course evaluation/)
26. 25 not curriculum development/

Supplemental Digital Table 1

**Methodological Quality and Errors in 33 Studies Using Simulation-Based Assessments as Surrogates for Patient-Related Outcomes, Published Through February 2013**

Scale item	Subscale (no. points, if present)	No. studies (% of 33)
<b>Medical Education Research Study Quality Instrument (MERSQI)<sup>a</sup></b>		
Study design (maximum 3)	1-group post-only (1)	6 (18)
	1-group pre-post (1.5)	20 (61)
	Non-randomized 2-group (2)	1 (3)
	Randomized 2-group (3)	6 (18)
Sampling: no. institutions (maximum 1.5)	1 (0.5)	28 (85)
	2 (1)	1 (3)
	➤ 2 (1.5)	4 (12)
Sampling: follow-up (maximum 1.5)	< 50% or not reported (0.5)	8 (24)
	50%-74% (1)	2 (6)
	≥ 75% (1.5)	23 (70)
Type of data: outcome assessment (maximum 3)	Objective (3)	32 (97)
	Subjective (1)	1 (3)
Validity evidence (maximum 3)	Content (1)	12 (36)
	Internal structure (1)	13 (39)
	Relations to other variables (1)	33 (100)
Data analysis: appropriate (maximum 1)	Appropriate (1)	32 (97)
Data analysis: sophistication (maximum 2)	Beyond descriptive analysis (2)	33 (100)
Highest outcome type (maximum 3)	Behavior (2)	27 (82)
	Patient/health care outcomes (3)	6 (18) <sup>b</sup>
<b>Other methodological indicators</b>		
Patient demographic information	Reported	2 (6)
Evaluate association between simulation-based and patient-related assessment is a study objective	Primary objective	17 (52)
	Secondary objective	3 (9)
	Listed as objective, no priority	1 (3)
	Not listed as objective	12 (36)
Identification of primary analysis	1 analysis per outcome	8 (24)
	> 1 analysis per outcome, 1 identified as primary	2 (6)
	> 1 analysis per outcome, no prioritization	23 (70)

Supplemental digital content for Brydges R, Hatala R, Zendejas B, Erwin PJ, Cook DA. Linking simulation-based educational assessments and patient-related outcomes: a systematic review and meta-analysis. Acad Med.

Power calculation for analysis involving patient-related outcome	Reported	3 (9)
Unit of analysis: patient-related outcomes	Appropriate	25 (76)
	Inappropriate (error)	1 (3)
Unit of analysis: simulation-based outcomes	Not defined	7 (21)
	Appropriate	23 (70)
	Inappropriate (error)	3 (3)
	Not defined	7 (21)

<sup>a</sup> MERSQI total score (maximum 18): mean 13.4 (standard deviation 1.4), median 13.5 (range 11-16.5).

<sup>b</sup> 1 study reported a direct patient effect outcome but did not report correlation with this outcome.