

Using Simulation-based Education to Pinpoint Curriculum Deficiencies in an Anesthesiology Teaching Program

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Introduction

The aim of this study was to use Objective Structured Clinical Examination (OSCE)-driven modalities as a teaching/testing tool of simulation-based medical education[1-3], in order to pinpoint and define deficiencies in teaching. The anesthesia fields/domains tested and evaluated were operating room (OR) mishaps, trauma, and resuscitation[2].

Methods and Materials

The examination was administered to 66 residents in postgraduate years (PGY) 2-4 (Table 1). The residents were tested in crisis management in 3 major anesthesia domains (Tables 2-4). Each scenario (#1 or #2, in each field) was evaluated according to a preset checklist for performance evaluation.

Residents received a "pass" score on the scenario if they successfully performed 70% of the station's checklist items, including all critical actions/ items. In each scenario and in every domain, the error rate and performance grade for each item were calculated in each PGY group and for all residents. If the error rate was >0.3 or performance grade <0.7 for any item – for PGY-4 residents or all residents – we further investigated the particular “problematic” item.

Results

The error rate for all residents in Trauma and Resuscitation fields was lower than OR domain, and lower in Resuscitation than Trauma (Table 5); and the error rate was lower for PGY-4 residents compared to PGY-2 residents in each domain, and also in each scenario – except in scenario OR #1 and Trauma #2, where the error rate was relatively high in all PGY groups (Table 5).

When we analyzed the specific type of deficiencies (= performance grade <0.7), we found that:

- In the OR domain (Table 2), most (15/22) deficiencies were related to thinking process and differential diagnosis, but none of these deficiencies was critical;
- in the Resuscitation domain (Table 3), most (8/9) deficiencies were related to basic knowledge of treatment, and >half of them (5/8) were critical
- in the Trauma domain (Table 4), most deficiencies were equally distributed and related to either decision on a choice of action/intervention (5/9) or basic knowledge of treatment (4/9), and most of them (7/9) were not critical.

Table 1 Distribution of residents in each postgraduate year (PGY-2 to PGY-4), each field (Operating Room, Trauma, and Resuscitation), and each scenario (Type 1 and Type 2) within each field (including number of items tested, and the technical, non-technical & critical items in each scenario and field).

Scenario	OR			Trauma			Resuscitation		
	Type 1	Type 2	Field	Type 1	Type 2	Field	Type 1	Type 2	Field
PGY-2	3	5	8	3	5	8	4	3	7
PGY-3	5	4	9	3	4	7	3	4	7
PGY-4	4	3	7	4	2	6	4	3	7
No. of items	20	20	40	14	12	26	17	17	34
No. of basic knowledge/technical items (BK/T)	7	7	14	8	7	15	13	13	26
No. of cognitive/nontechnical items (C/NT)	13	13	26	6	5	11	4	4	8
Critical items	3	2	5	5	4	9	11	11	22

Table 2 Performance grades for all items in OR scenarios by PGY level for all residents

Scenario – OR Type 1	Function Tested	PERFORMANCE GRADE			
		PGY-2	PGY-3	PGY-4	All
Hypotension developing in the OR:					
Initial response - Fluid challenge	BK/T + C/NT	0.33*	0.8	0.75	0.67*
Differential diagnosis (at least 3)	C/NT	0.67	0.8	1	0.83
Decision re monitoring/labs	C/NT	0.67*	1	0.5*	0.75
Fluid balance as a cause	C/NT	1	0.8	1	0.92
Drug effect (anesthesia) cause	C/NT	1	0.8	0.75	0.83
Assess cardiac reason/diagnosis	C/NT	0.33*	0.2*	0.75	0.42* ‡
Assess pulmonary reason/diagnosis	C/NT	0.33	0.8	1	0.75
Assess drug sensitivity/hormonal effect	C/NT	0.33*	0.4*	0.5*	0.41* ‡
Assess metabolic reason/MH	C/NT	0*	0.2*	0.5*	0.25* ‡
Final diagnosis/treatment	C/NT	1	0.8	0.75	0.83
Blood Reaction:					
↑ Pulmonary inspiratory pressure; hypoxemia developing					
Administer oxygen for hypoxia	BK/T	0.67*	0.6*	0.75	0.67*
Clinical diagnosis – Pulmonary sounds	BK/T	1	1	1	1
Evaluate mechanical problem (systematically)	BK/T	0.67	0.6	1	0.83
Evaluate airway resistance with capnography	BK/T	0.67*	1	0.5*	0.75
Evaluate anesthesia level	C/NT	0.67*	0.6*	0.75	0.67* ‡
Suspect allergic reaction – Skin	C/NT	0*	0.2*	0.25* ‡	0.17* ‡
Change parameters in mechanical ventilation	BK/T	0.67	0.6*	0.25*	0.5*
Decision on final diagnosis	C/NT	1	0.6*	0.5*	0.67* ‡
Treatment - Pharmacological agents/Groups	BK/T	1	0.8	0.75	0.83
Agent choice & doses for treating bronchospasm	C/NT	0.33*	0.6*	0.5*	0.5* ‡
Scenario – OR Type 2					
Hypertension					
Initial response - Check anesthesia level	BK/T	0.6*	0.75	1	0.58*
Initial treatment before differential diagnosis - Oxygen for desaturation	BK/T	1	0.75	0*	0.67*
Differential diagnosis (at least 3)	C/NT	0.8	0.75	1	0.83
First treatment after differential diagnosis – Adjust anesthesia level	BK/T	0.8	1	1	0.92
Assess & adjust fluid balance	C/NT	0.4*	0.25*	0.33* ‡	0.33* ‡
Consider drug effect (anesthesia level)	C/NT	0.6	0.75	1	0.75
Consider cardiac reason/diagnosis	C/NT	0.2*	0*	0.33* ‡	0.17* ‡
Consider pulmonary reason/diagnosis	C/NT	0.8	0.75	0.67*	0.75
Consider drug sensitivity/hormonal effect	C/NT	0.4*	0*	0.33* ‡	0.25* ‡
Consider metabolic reason/MH	C/NT	0.4*	0.75	1	0.67* ‡
Decision on final diagnosis/treatment	C/NT	0*	0.75	1	0.5* ‡
Decision – Treat HTN and HR pharmacologically	C/NT	0.4*	1	1	0.75
Drug combination treatment: Vasodilators + Beta blockers	BK/T	0.4*	0.25*	1	0.5*
Additional invasive monitoring – Possible location of AL	C/NT	0.6*	1	1	0.83
“Overshoot” interpretation of AL	BK/T	0.2*	0.5*	1	0.5*
Additional invasive monitoring – CVP	BK/T				
Invasive monitoring CVP complication	BK/T	0.8	0.75	1	0.83
CVP level interpretation – Fluid challenge directed	C/NT	0.8	0.25*	0.33* ‡	0.5* ‡
Arterial blood gas interpretation	C/NT	1	1	0.67	0.92
Chest x-ray interpretation	C/NT	0.8	0.75	1	0.83

*Performance Grade <0.7 for PGY groups and/or all residents; † Critical item; ‡ Performance grade <0.7 for PGY-4 group and/or all residents in the frame of C/NT BK/T = Basic knowledge/treatment; C/NT=cognitive/non-technical; MH=malignant hyperthermia; HTN=hypertension; HR=heart rate; AL=arterial line; CVP=central venous pressure

Table 3 Performance grades for all items on the Resuscitation scenarios by PGY level for all residents

SCENARIO – Resuscitation Type 1	Function Tested	PERFORMANCE GRADE			
		PGY-2	PGY-3	PGY-4	All
Wide complex tachycardia w/hypotension:					
Address the patient	BK/T	1	1	1	1
Clinical assessment	BK/T	1	1	1	1
Administer oxygen	BK/T	1	1	1	1
Consider NIV	BK/T	0.5*	0.67*	0.75*	0.64*
Correct application of NIV	BK/T	0.75	1	1	0.91
ECG interpretation – Acute ischemia	C/NT	1	1	1	1
Chest x-ray interpretation – Pulmonary congestion/edema	C/NT	1	0.67*	1	0.91
Recognition – No plethysmogram 1 st arrhythmia	BK/T	1	1	1	1
Clinical assessment – BP & pulse evaluation	BK/T	1	1	1	1
Consider defibrillation – Nonsync, energy level, attempts	BK/T	0*	0.67*	0.75*	0.45*
Clinical assessment before intubation – BP & pulse evaluation	BK/T	1	1	1	1
Prepare equipment for tracheal intubation	BK/T	0.75*	0.33*	0.75*	0.64*
Prepare medications for tracheal intubation	BK/T	1	1	1	1
Atrial (flutter/fibrillation) arrhythmia, no hypotension:					
Recognition 2 nd arrhythmia – Clinical assessment: BP & pulse	BK/T	1	1	1	1
Rate control agents (Amiodarone; doses)	BK/T	0.25	1	1	0.73
Sequence of action – 1 st cardiac arrhythmia	C/NT	1	1	1	1
Sequence of action – 2 nd cardiac arrhythmia	C/NT	1	1	1	1
Scenario – Resuscitation Type 2					
Atrial tachycardia w/hypotension:					
Address the patient	BK/T	1	1	1	1
Clinical assessment	BK/T	1	1	1	1
Administer oxygen	BK/T	0.67*	1	1	0.9
Consider NIV	BK/T	0.33*	0.5*	0.67*	0.5*
Correct application of NIV	BK/T	1	0.75	1	0.9
ECG interpretation – Acute ischemia	C/NT	1	0.75	1	0.9
Chest x-ray interpretation – Pulmonary congestion/edema	C/NT	0.67*	1	1	0.9
Recognition – Irregular 1 st arrhythmia	BK/T	0.67*	1	1	0.9
Clinical assessment – BP & pulse evaluation	BK/T	0.33*	0.5*	1	0.6*
Consider defibrillation – Sync, energy level, attempts	BK/T	0.33*	0*	0.33*	0.2*
Clinical assessment before intubation – BP & pulse evaluation	BK/T	0.67*	0.75	1	0.8
Prepare all equipment for tracheal intubation	BK/T	0.33*	1	0.67*	0.7*
Prepare medications for tracheal intubation	BK/T	0.67*	1	1	0.9
Atrial (flutter/fibrillation) arrhythmia, no hypotension:					
Recognition 2 nd arrhythmia – clinical consciousness level, BP & pulse	BK/T	0.33*	1	0.67*	0.7*
Rate control agents (i.e., Amiodarone; doses)	BK/T	0.67	0.75	1	0.8
Sequence of action – 1 st cardiac arrhythmia	C/NT	0.67*	0.75*	0*	0.5* ‡
Sequence of action – 2 nd cardiac arrhythmia	C/NT	1	1	1	1

*Performance grade <0.7 for PGY groups and/or all residents BK/T = Basic knowledge/treatment; C/NT=cognitive/non-technical; BP=blood pressure; NIV=noninvasive ventilation

Table 4 Performance grades for all items on the Trauma scenarios by PGY level for all residents

SCENARIO – Trauma Type 1	Function Tested	DIFFICULTY GRADE			
		PGY-2	PGY-3	PGY-4	All
Chest & neck injury:					
Address the patient	BK/T	1	1	1	1
Clinical assessment – Neck, auscultation	BK/T	0.67*	0.67*	1	0.8
Administer oxygen for desaturation	BK/T	0.67*	1	1	0.9
Additional needed assessment (labs, x-ray)	C/NT	1	1	1	0.9
Additional needed work-up (IV, blood work)	C/NT	0.67*	1	1	0.9
Decision about intercostal drain/needle	C/NT	0.33*	1	1	0.8
Development of tension pneumothorax:					
Clinical assessment – Neck, auscultation	BK/T	0.33*	0.67*	1	0.7
Hemodynamic assessment/evaluation	BK/T	0.67*	1	0.75	0.8
Needle insertion (location, technique)	BK/T	0.67*	1	1	0.9
Deterioration – Hypoxia:					
Chest x-ray interpretation – Tension pneumothorax	C/NT	0.67*	1	1	0.9
Intercostal drain (location, technique)	BK/T	0.67*	0.67*	1	0.8
Equipment for tracheal intubation	BK/T	0.33*	0.67*	0.75	0.6*
Consider intubation post-pneumothorax (sedation; spontaneous vs. positive-pressure ventilation)	C/NT	0*	0.33*	0.75	0.4* ‡
Decision – Surgical airway after failed intubation	C/NT	1	0.67	0.75	0.8
Scenario – Trauma Type 2					
Head & neck injury:					
Address the patient	BK/T	1	1	1	1
Clinical assessment – Neck evaluation (collar removal), auscultation	BK/T	1	0.75	0.5*	0.82
Administer oxygen for desaturation	BK/T	0.8	0.5*	0*	0.55*
Additional needed assessment (labs, x-ray)	C/NT	0.6*	0.75	1	0.73
Additional needed work-up (IV, blood work)	C/NT	0.2*	1	0.5* ‡	0.55* ‡
Decision about intubation (with mental deterioration)	C/NT	1	0.75	0.5* ‡	0.82
Deterioration – Hypoxia:					
Prepare equipment for tracheal intubation	BK/T	0.6*	0.5	1	0.64*
Prepare medications for tracheal intubation	BK/T	0.6*	0.75	1	0.73
Intubation technique (cricoid pressure)	BK/T	1	1	1	1
Intubation technique (neck stabilization)	BK/T	0.6*	0.75	1	0.73
Opinion about other (vascular) surgery	C/NT	0.4*	0.75	1	0.64* ‡
Intraoperative cerebral monitoring consideration for non-neurosurgical procedure	C/NT	0.2*	0.25*	0* ‡	0.18* ‡

*Performance Grade <0.7 for PGY groups and/or all residents BK/T = Basic knowledge/treatment; C/NT=cognitive/non-technical; IV=intravenous

Table 5 Mean difficulty (Performance grade) and error rates for each scenario by PGY level and for all residents

	PGY-2	PGY-3	PGY-4	All
SCENARIO – OR Type 1:				
Hypotension developing in the OR				
Mean difficulty ± SD	0.62 ± 0.33*	0.66 ± 0.25*	0.69 ± 0.24*	0.66 ± 0.22*
Error rate	0.38*	0.34*	0.31*	0.34*
SCENARIO – OR Type 2:				
Hypertension				
Mean difficulty ± SD	0.58 ± 0.28*	0.63 ± 0.33*	0.77 ± 0.33	0.64 ± 0.22*
Error rate	0.4*	0.35*	0.22†	0.35*
SCENARIO – Resuscitation Type 1:				
Wide complex tachycardia w/hypotension				
Mean difficulty ± SD	0.84 ± 0.31	0.90 ± 0.20	0.96 ± 0.1	0.90 ± 0.17
Error rate	0.16	0.1	0.04†	0.10
SCENARIO – Resuscitation Type 2:				
Atrial tachycardia w/hypotension				
Mean difficulty ± SD	0.67 ± 0.26	0.81 ± 0.27	0.84 ± 0.29	0.78 ± 0.22
Error rate	0.33	0.19	0.16†‡	0.22†
SCENARIO – Trauma Type 1:				
Chest & neck injury				
Mean difficulty ± SD	0.62 ± 0.29	0.83 ± 0.22	0.93 ± 0.12	0.80 ± 0.16
Error rate	0.38	0.17†	0.07†	0.19
SCENARIO – Trauma Type 2:				
Head & neck injury				
Mean difficulty ± SD	0.71 ± 0.27	0.70 ± 0.22	0.73 ± 0.41	0.71 ± 0.23
Error rate	0.33*	0.27	0.29†	0.30†‡

*Performance grade <0.7 or Error rate >0.3 for PGY-4 group and/or all residents

† vs. PGY-2 Group

‡ vs. Scenario 1

Conclusions

- The differences in deficiencies found between the 3 domains tested (Table 5) and the lower success rate/performance grade found more in the OR>Trauma>Resuscitation fields can be related to the increased “missed” items associated with decision and choice of action or advanced knowledge[3] rather than to basic knowledge or treatment.
- The differences in success rate/performance grade between scenarios #1 and #2 in Trauma can be explained on the same basis.
- It appears that even though **only 45% of the tasks/items were in the frame of advanced knowledge**, these tasks were more “problematic” to learn or teach to most of the residents, including the graduating PGY-4 residents.
- It also appears that there is a real need for improvement not only in evaluating the performance of anesthesia nontechnical skills, but also in teaching goals directed to enhance this aspect.

References

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