Simulation in Critical Care Medicine

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Objectives

- Define teaching
- Approach to using Simulation in Critical Care Training
- Describe the different types of Simulation available to teach critical care skills
- Discuss the future of critical care simulation
Define Teaching

Webster’s dictionary – the act of imparting knowledge

A. Excellent definition

B. Adequate definition

C. Poor definition
Teaching

Teacher Centered (Traditional approach)

- Lecture based, dependent upon presenter
- Learn passively, absorbing concepts /taking notes
- Outcomes based upon essays and exams
The Teacher as a Manager of Resources

- Develops a curriculum with clear, measurable objectives
- Organizes a variety of learning experiences
- Motivates students to become self-directed learners
- Evaluates student performance
- Provides immediate feedback

Characteristics of Adult Learners

- Self-directed - the teacher acts as a facilitator guiding students to knowledge rather than supplying it.

- Goal oriented - students have predetermined goals and enjoy a curriculum that helps them attain those goals.

Bloom’s Taxonomy
Characteristics of Adult Learners

- Relevancy oriented – learning must be applicable to training them for their jobs
- Respected – in medical education this includes voicing opinions about management and defending their judgement
- Motivated
- Require feedback

Adapted from Malcolm Knowles
Create Educational Objectives

Apply Bloom’s Taxonomy

Utilize Various Teaching Techniques

Evaluate Performance

Give Appropriate and Effective Feedback

New Material

Learning Success!
Developing Educational Objectives

- An objective is a statement of purpose
- They describe specifically what the learner is to learn
- This includes three domains
  - Cognitive – intellect “brain / the knowing”
  - Affective – values “heart / the feeling”
  - Psychomotor – skills “hands / the doing”
Sample Educational Objectives

❖ Be able to manage unresponsive patients

OR

❖ Check for pulse immediately, check blood glucose, inquire about opiate use, administer 40ug narcan, provide bag-mask ventilation if airway not protected
Sample Educational Objectives

✧ Manages respiratory distress

OR

✧ Check respiratory rate, place pulse oximeter, start 100% non-rebreather, call for rapid response team
Feedback Definition

- Method of controlling a ”system” by reinserting into the system the results of its performance
- Providing the learner with specific information about their performance to reinforce or change behavior
- Formative (qualitative feedback)
- Summative (educational outcomes)
Feedback Purpose

- The most powerful teaching tool an instructor has

- Provides a basis for maintaining or improving performance
- Provides a mechanism for assessing needs and providing learning experiences
Feedback Timing and Setting

- Established during orientation that feedback will be provided immediately following assessment
- Will be provided daily
- Should be an expected part of the learning experience
Characteristics of Effective Feedback

- Begin with clear, unambiguous, specific, achievable goals
- Inform the learner to expect feedback as part of the educational process
- Base feedback on first hand observation
- Delivered as a two way conversation soliciting the learners comments
- Must be credible to the learner
Characteristics of Effective Feedback

- Base feedback on behavior not interpretations of behavior
- Provide feedback privately
- Provide the learner with the way to succeed
- Do not give positive feedback before giving feedback that is intended to change behavior
Without Feedback

In surveys one of the most frequently cited deficiencies of an educational program is the lack of feedback:
- Failure to effectively evaluate performance
- Concern it will lead to an unpleasant emotional response
- May damage learner-teacher relationship

Mistakes go uncorrected

Good performance goes unreinforced

Students generate their own feedback by attacking importance to unintended clues
Final Word: That college lecture is so yesterday

All I can say is this: It's a little late.

I read the other day that colleges and universities are looking into the idea that lectures, as a style of teaching, should either be abandoned or at least retooled.

Could they not have thought about this, say, about 40 years ago?

Most of us can remember sitting through lectures we thought would never end. We also can recall the professor who not only didn't communicate very well but didn't articulate very well, either. What is he saying?

One professor quoted in this lectures-are-passe article even confessed that just because teachers say something at the front of the classroom doesn't mean students learn. Bless her little academic soul.

As for this lecture thing, it appears students today want to be involved. They want to be active, not passive. In short, they don't want to be lectured to.

What's happening is that many lectures today can just as easily be delivered over YouTube or iTunes. Lucky students. I remember sitting there pretending I was not only listening but writing down what was being said. I also smiled a lot.

Using new technologies, students can now make a sandwich while T. S. Eliot's Lovesong of J. Alfred Prufrock is being dissected, so it's not a complete waste of time.
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Final Word
By Craig Wilson

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Using new technologies, students can now make a sandwich while T. S. Eliot's Lovesong of J. Alfred Prufrock is being dissected, so it's not a complete waste of time.
“I hear, and I forget
I see, and I remember
I do, and I understand”

- Confucius
Simulation for Critical Care Education

- Simulation “Any training device that duplicates artificially the conditions likely to be encountered in an operation” – Webster’s
  - Low Tech
  - Partial task Trainers
  - Simulated patients
  - Computer based
  - Realistic patient simulators
Partial Task Trainer
Whole Body Simulation

 الإسلامي

- Is an efficient means of teaching a large group of trainees
- Allows trainees to experience rare, life-threatening conditions
- Allows trainees to make medical errors without harmful consequences to patients
- Enables faculty to provide feedback
- Permits trainees to repeat performances until educational objectives are mastered
Fourth Year CCM Clerkship

Dr Paul Rogers
ACLS Guidelines

Figure 4
Circular ACLS Algorithm

Adult Cardiac Arrest

Shout for Help/Activate Emergency Response

Start CPR
- Give oxygen
- Attach monitor/defibrillator

2 minutes

Check Rhythm

Return of Spontaneous Circulation (ROSC)

Post-Cardiac Arrest Care

Drug Therapy
- IV/IO access
  - Epinephrine every 3-5 minutes
  - Amiodarone for refractory VF/VT

Consider Advanced Airway
- Quantitative waveform capnography

Treat Reversible Causes

CPR Quality
- Push hard (≥2 inches [5 cm]) and fast (≥100/min) and allow complete chest recoil
- Minimize interruptions in compressions
- Avoid excessive ventilation
- Rotate compressor every 2 minutes
- If no advanced airway, 30:2 compression-ventilation ratio
- Quantitative waveform capnography
  - If PetCO₂ <10 mm Hg, attempt to improve CPR quality
- Intra-arterial pressure
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality

Return of Spontaneous Circulation (ROSC)
- Pulse and blood pressure
- Abrupt sustained increase in PetCO₂ (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Shock Energy
- Biphasic: Manufacturer recommendation (eg, initial dose of 120-200 J);
  - If unknown, use maximum available. Second and subsequent doses
    should be equivalent, and higher doses may be considered.
- Monophasic: 360 J

Drug Therapy
- Epinephrine IV/IO Dose: 1 mg every 3-5 minutes
- Vasopressin IV/IO Dose: 40 units can replace first or second dose
  of epinephrine
- Amiodarone IV/IO Dose: First dose: 300 mg bolus. Second dose: 150 mg.

Advanced Airway
- Suprachlavian advanced airway or endotracheal intubation
- Waveform capnography to confirm and monitor ET tube placement
- 8-10 breaths per minute with continuous chest compressions

Reversible Causes
- Hypovolemia
- Hypoxia
- Hypoglycemia
- Hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary

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Simulation Sessions

- Respiratory Distress
- Pulseless Rythymns
- Acute Coronary Syndrome
- Stable and Unstable supraventricular arrhythmias
- Septic Shock
- Anaphylaxis
- Status Epilepticus
- Hypertensive crisis
Simulation

Exemplary Care  Cutting-edge Research  World-class Education
Simulation

Exemplary Care  Cutting-edge Research  World-class Education
Simulation
Simulation-based Approaches to Graduate Medical Education: Mechanical Ventilation SAGE-MV

- First step in micro-simulation based technology
- Provides current ventilator settings and waveforms
- Identifies goals of therapy
- Allows goal directed titration of therapy
- Describes any adverse outcomes
- Stores success rates
- Explores cognitive processing and allows for self-directed learning
Initial presentation of standardized patient case

<table>
<thead>
<tr>
<th>Mode (1=VCV, 2=PCV)</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push to change ventilator mode</td>
<td></td>
</tr>
<tr>
<td>Tidal volume, L</td>
<td>0.3</td>
</tr>
<tr>
<td>PEEP</td>
<td>10</td>
</tr>
<tr>
<td>Peak inspiratory flow rate, lpm</td>
<td>60</td>
</tr>
<tr>
<td>Frequency</td>
<td>20</td>
</tr>
<tr>
<td>Inspiratory pause duration, s</td>
<td>0</td>
</tr>
<tr>
<td>Inspired fraction of oxygen, %</td>
<td>40</td>
</tr>
</tbody>
</table>

Outcomes from your settings
- Machine tidal volume: 0.3
- Measured minute ventilation: 6.0
- Peak Airway Pressure: 31.0
- Mean Airway Pressure: 14.0
- I/E ratio: 0.3
- Plateau pressure: 28.0
- End expiratory pressure: 10.0

Push to run simulation with new inputs

Push to generate new patient simulation when starting or if targeted outcomes are satisfied

Push to generate new patient simulation if unable to attain targeted outcomes

Arterial Sat, % | PaO2 | pH | PaCO2 | cHCO3
--- | --- | --- | --- | ---
Blood gas data | 87 | 56 | 7.24 | 67 | 27
Mean arterial pressure: 60

GOALS
- Minimum saturation: 90
- Minimum pH: 7.25
- Maximum pH: 7.45
- Maximum Pplateau: 30
- Minimum mean arterial pressure: 65

YOUR PATIENTS OXYGEN SATURATION IS
- Too low

YOUR PATIENTS BLOOD PRESSURE IS
- Too low

YOUR PATIENTS PLATEAU PRESSURE IS
- Acceptable

YOUR PATIENTS PH IS
- Too low

YOUR PATIENTS MIXED VENOUS OXYGEN SATURATION IS LOW
Oops– bad choice

**GOALS**
- Minimum saturation: 90
- Minimum pH: 7.25
- Maximum pH: 7.45
- Maximum Pplateau: 30
- Minimum mean arterial pressure: 65

**Mode (1=VCV; 2=PCV)**
1

**Push to change ventilator mode**
- Tidal volume, L: 0.35
- PEEP: 10
- Peak inspiratory flow rate, lpm: 60
- Frequency: 40
- Inspiratory pause duration, s: 0
- Inspired fraction of oxygen, %: 40

**Outcomes from your settings**
- Machine tidal volume: 0.4
- Measured minute ventilation: 14.0
- Peak Airway Pressure: 26.0
- Mean Airway Pressure: 18.0
- I/E ratio: 0.9
- Plateau pressure: 25.0
- End expiratory pressure: 11.0

**Push to run simulation with new inputs**

**Push to administer fluid bolus**

**YOUR PATIENTS OXYGEN SATURATION IS**
Acceptable

**YOUR PATIENTS BLOOD PRESSURE IS**
Too low

**YOUR PATIENTS PLATEAU PRESSURE IS**
Acceptable

**YOUR PATIENTS PH IS**
Acceptable

**YOUR PATIENTS MIXED VENOUS OXYGEN SATURATION IS LOW**

**Arterial Sat,%  PaO2  pH  PaCO2  cHCO3**
- Blood gas data: 94 77 7.28 44 20
- Mean arterial pressure: 50

**Push to completely reset tool**
Interventions have corrected pH

GOALS

Minimum saturation 90
Minimum pH 7.25
Maximum pH 7.45
Maximum Pplateau 30
Minimum mean arterial pressure 65

YOUR PATIENTS OXYGEN SATURATION IS
YOUR PATIENTS BLOOD PRESSURE IS
YOUR PATIENTS PLATEAU PRESSURE IS
YOUR PATIENTS PH IS

YOUR PATIENTS MIXED VENOUS OXYGEN SATURATION IS LOW

Push to change ventilator mode

Mode (1= VCV, 2=PCV) 1

Push to administer fluid bolus

Tidal volume, L 0.35
PEEP 10
Peak inspiratory flow rate, lpm 60
Frequency 20
Inspiratory pause duration, s 0
Inspired fraction of oxygen, % 40

Outcomes from your settings

Machine tidal volume 0.4
Measured minute ventilation 7.0
Peak Airway Pressure 32.0
Mean Airway Pressure 15.0
I/E ratio 0.3
Plateau pressure 29.0
End expiratory pressure 10.0

Push to generate new patient simulation when starting or if targeted outcomes are satisfied

Arterial Sat,% PaO2 pH PaCO2 cHCO3

Blood gas data 89 59 7.31 54 26

Mean arterial pressure 58
Too low
Too low
Acceptable
Acceptable

Push to completely reset tool

Push to run simulation with new inputs
Interventions have corrected pH and SaO₂

GOALS
- Minimum saturation: 90
- Minimum pH: 7.25
- Maximum pH: 7.45
- Maximum Pplateau: 30
- Minimum mean arterial pressure: 65

Outcomes from your settings
- Machine tidal volume: 0.4
- Measured minute ventilation: 7.0
- Peak Airway Pressure: 33.0
- Mean Airway Pressure: 17.0
- I/E ratio: 0.3
- Plateau pressure: 29.0
- End expiratory pressure: 12.0

Arterial Sat, %  PaO₂  pH  PaCO₂  cHCO₃
- Blood gas data: 92  67  7.31  54  26
- Mean arterial pressure: 55
  - Acceptable

YOUR PATIENTS OXYGEN SATURATION IS
- Acceptable

YOUR PATIENTS BLOOD PRESSURE IS
- Too low

YOUR PATIENTS PLATEAU PRESSURE IS
- Acceptable

YOUR PATIENTS PH IS
- Acceptable

YOUR PATIENTS MIXED VENOUS OXYGEN SATURATION IS LOW
Acidosis, hypoxia, and hypotension repaired: Learner commits to settings

Mode (1= VCV, 2=PCV)  
1

Push to change ventilator mode

Tidal volume, L  
0.35

PEEP  
12

Peak inspiratory flow rate, lpm  
60

Frequency  
20

Inspiratory pause duration, s  
0

Inspiratory fraction of oxygen, %  
80

Outcomes from your settings

Machine tidal volume  
0.4

Measured minute ventilation  
7.0

Peak Airway Pressure  
33.0

Mean Airway Pressure  
17.0

I/E ratio  
0.3

Plateau pressure  
29.0

End expiratory pressure  
12.0

GOALS

Minimum saturation  
90

Minimum pH  
7.25

Maximum pH  
7.45

Maximum Pplateau  
30

Minimum mean arterial pressure  
65

Arterial Sat,%  
92

PaO2  
68

pH  
7.31

PaCO2  
54

cHCO3  
26

Blood gas data

Mean arterial pressure  
68

YOUR PATIENTS OXYGEN SATURATION IS Acceptable

YOUR PATIENTS BLOOD PRESSURE IS Acceptable

YOUR PATIENTS PLATEAU PRESSURE IS Acceptable

YOUR PATIENT'S PH IS Acceptable
New virtual patient is immediately presented

Mode (1= VCV; 2=PCV) 1
Push to change ventilator mode

Tidal volume, L 0.5
PEEP 5
Peak inspiratory flow rate, lpm 60
Frequency 20
Inspiratory pause duration, s 0
Inspired fraction of oxygen, % 21

Outcomes from your settings
Machine tidal volume 0.5
Measured minute ventilation 10.0
Peak Airway Pressure 18.0
Mean Airway Pressure 8.0
I/E ratio 0.5
Plateau pressure 11.0
End expiratory pressure 6.0

Push to run simulation with new inputs

Push to administer fluid bolus

GOALS
Minimum saturation 90
Minimum pH 7.35
Maximum pH 7.45
Maximum Pplateau 30
Minimum mean arterial pressure 65

Airway flow

Push to generate new patient simulation when starting or if targeted outcomes are satisfied
Push to generate new patient simulation if unable to attain targeted outcomes

Arterial Sat,%  PaO2  pH  PaCO2  cHCO3
Blood gas data  86  54  7.36  44  24
Mean arterial pressure  85

YOUR PATIENTS OXYGEN SATURATION IS
Too low

YOUR PATIENTS BLOOD PRESSURE IS
Acceptable

YOUR PATIENTS PLATEAU PRESSURE IS
Acceptable

YOUR PATIENTS PH IS
Acceptable

YOUR PATIENTS MIXED VENOUS OXYGEN SATURATION IS LOW
Figure 1: Following simulation based training, practitioners solved a standardized panel of patients with fewer attempts (Panel A) and similar to increased success (panel B), suggesting increased efficiency.
Figure 6: Following simulation based training, practitioners implemented significantly more complex patterns of adjustment at each change in ventilator settings. Panel A: “Complexity” is simply the average number of parameters changed at each step. Panel B: “Weighted complexity” is the sum of setting changes at each intervention, with each setting change weighted by the number of outcome parameters that are affected by that setting. For example, frequency can affect minute ventilation, plateau pressure, oxygenation, minute ventilation, and mean arterial pressure; changes in FiO2 only affect oxygenation. Practitioners qualitatively changed their patterns of practice.
Future of Critical Care Simulation

Measurement Tool for Core Competencies

Osteopathic Philosophy and Osteopathic Manipulative Medicine

Medical Knowledge

Patient Care

Interpersonal and Communication Skills

Professionalism

Practice Based Learning and Improvement

Systems-Based Practice
Future of Critical Care Simulation

- Measurement Tool for Certification
- Measurement Tool for Re-Certification
- Improve Patient Safety and Outcomes
Questions