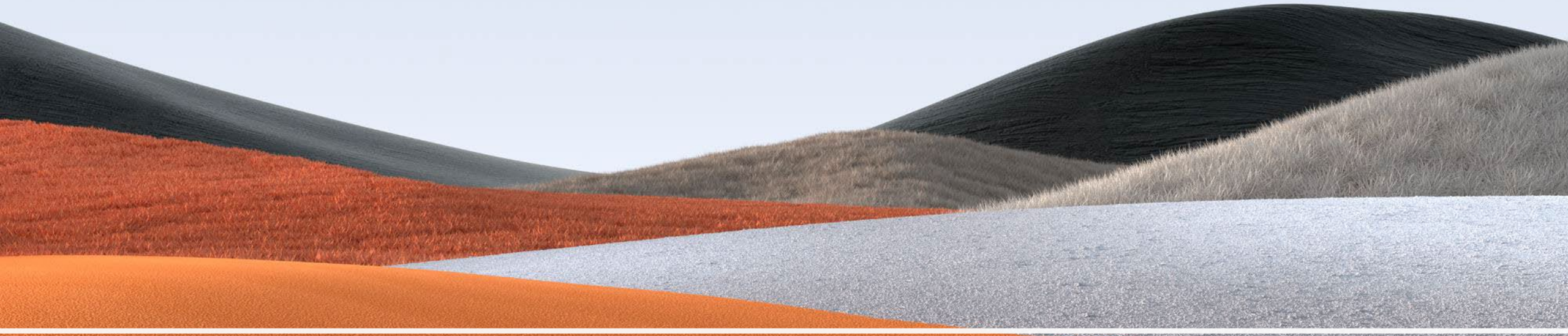


SimBites

June 7, 2024



The Landscape of Healthcare Simulation Research





Objectives



Categorize translational science outcomes for simulation-based healthcare education research



List applications of simulation-based healthcare research apart from educational outcomes



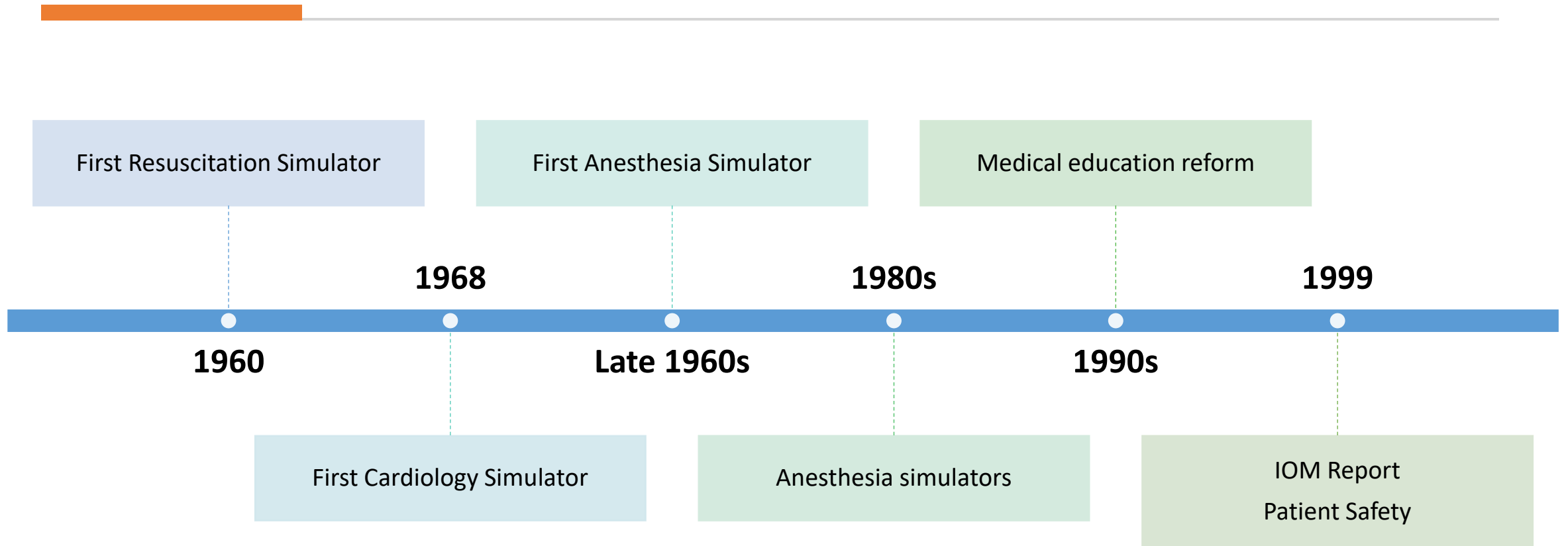
Assess the evidence around trending simulation-based healthcare modalities



Describe priorities for future simulation-based healthcare educational research



Development of Modern Clinical Simulation



Development of Modern Clinical Simulation

First Resuscitation Simulator

1960

First Car



on reform

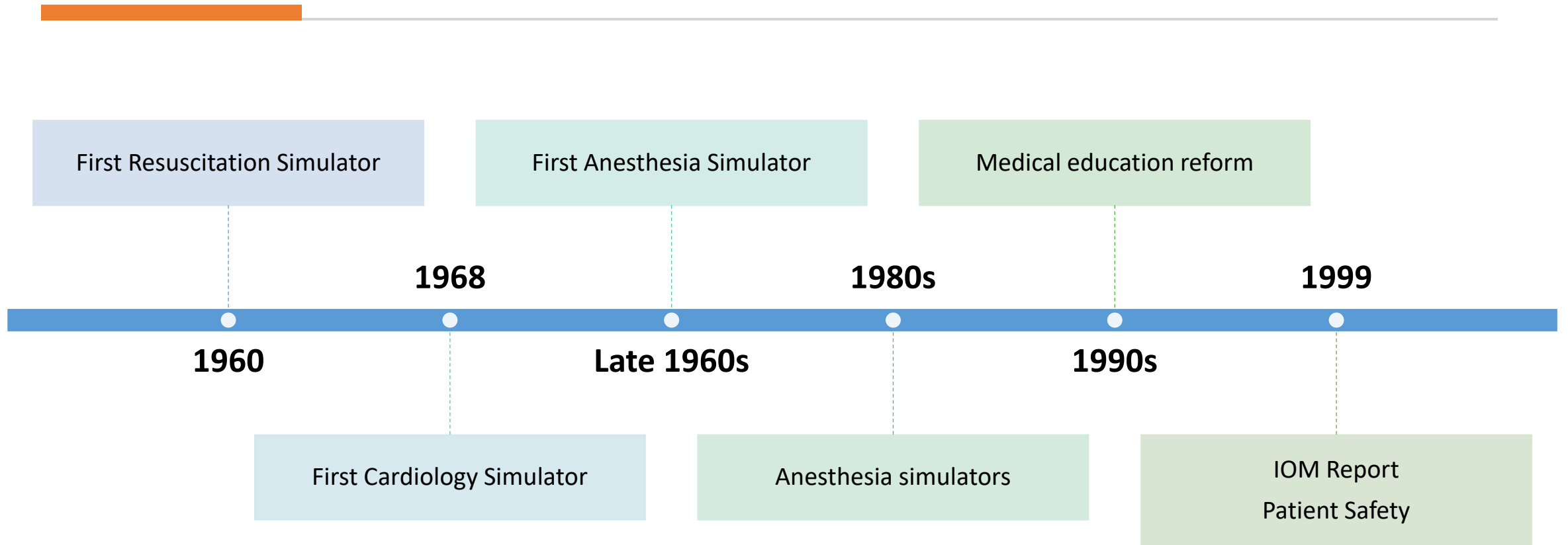
1999

S

IOM Report
Patient Safety



Development of Modern Clinical Simulation





Development of Modern Clinical Simulation

First Resuscitation Simul

1960

Fir

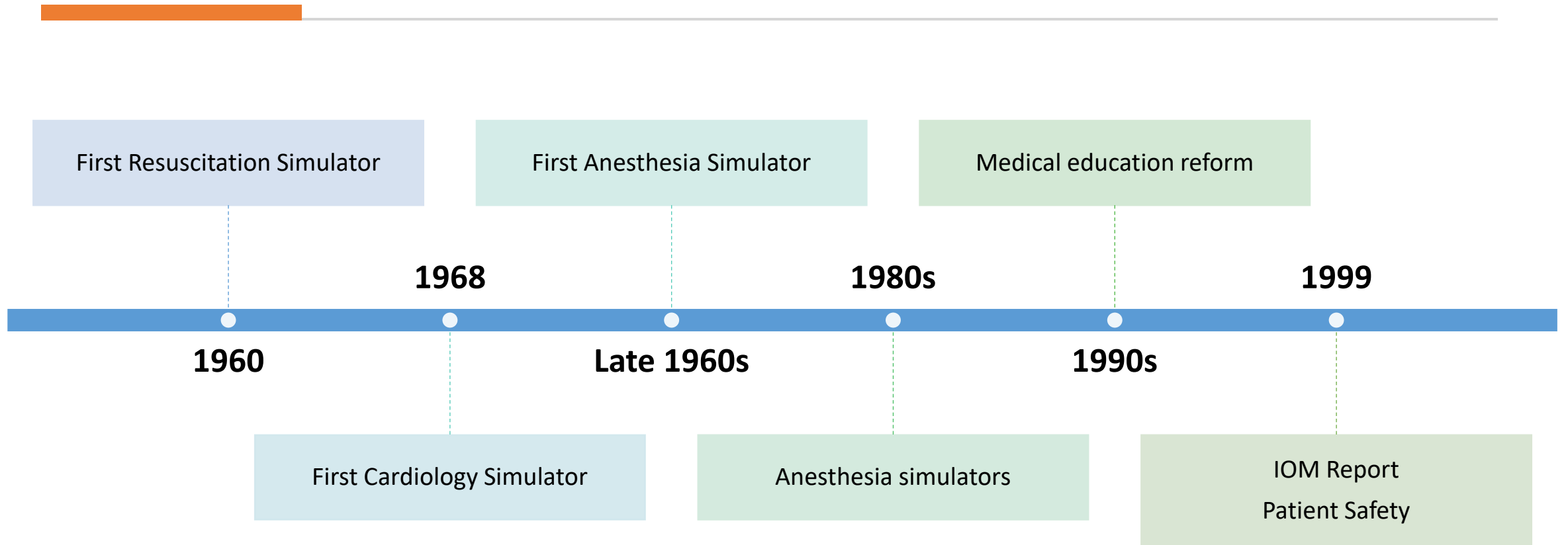


1999

IOM Report
Patient Safety



Development of Modern Clinical Simulation

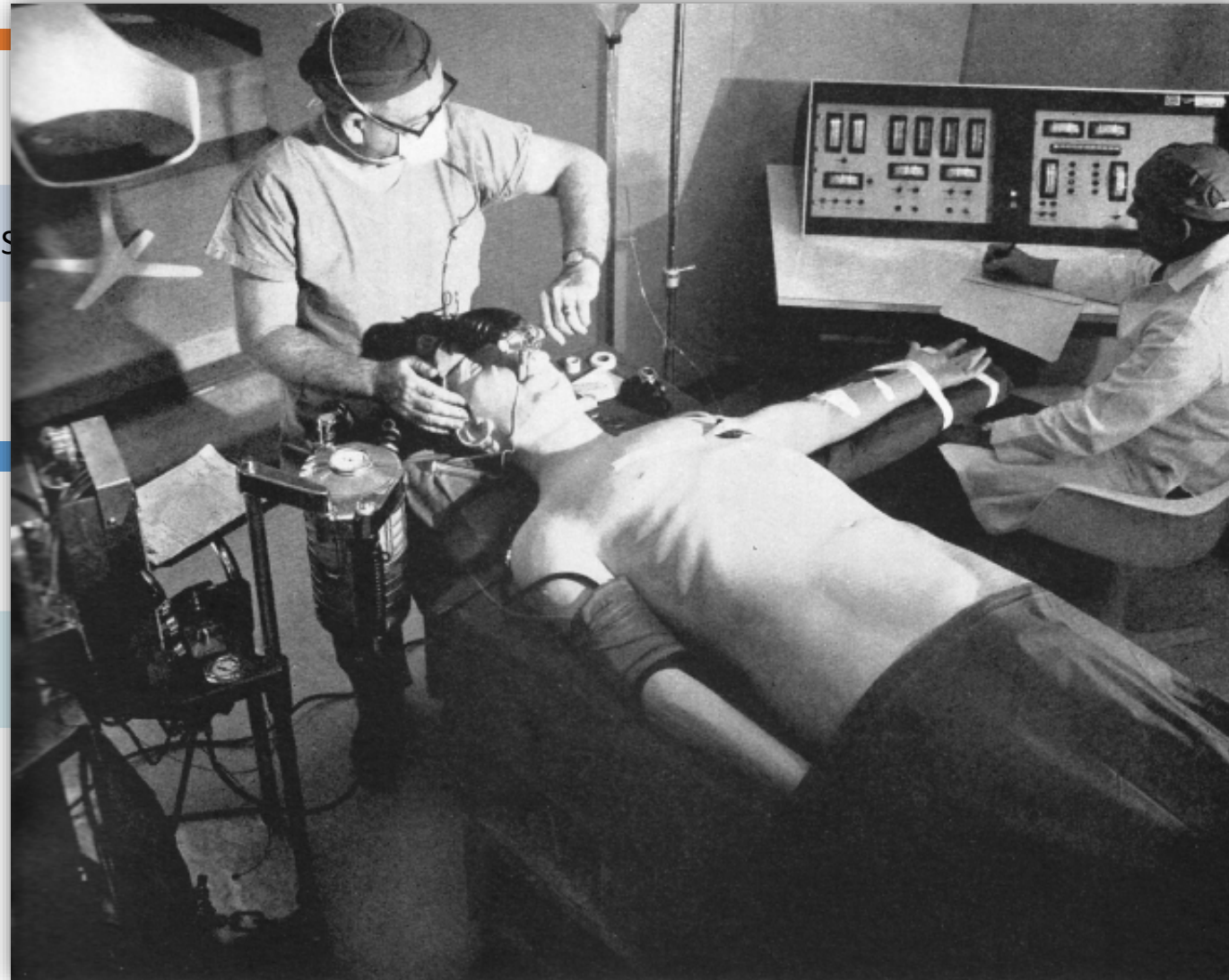




Development of Modern Clinical Simulation

First Resuscitation S

1960



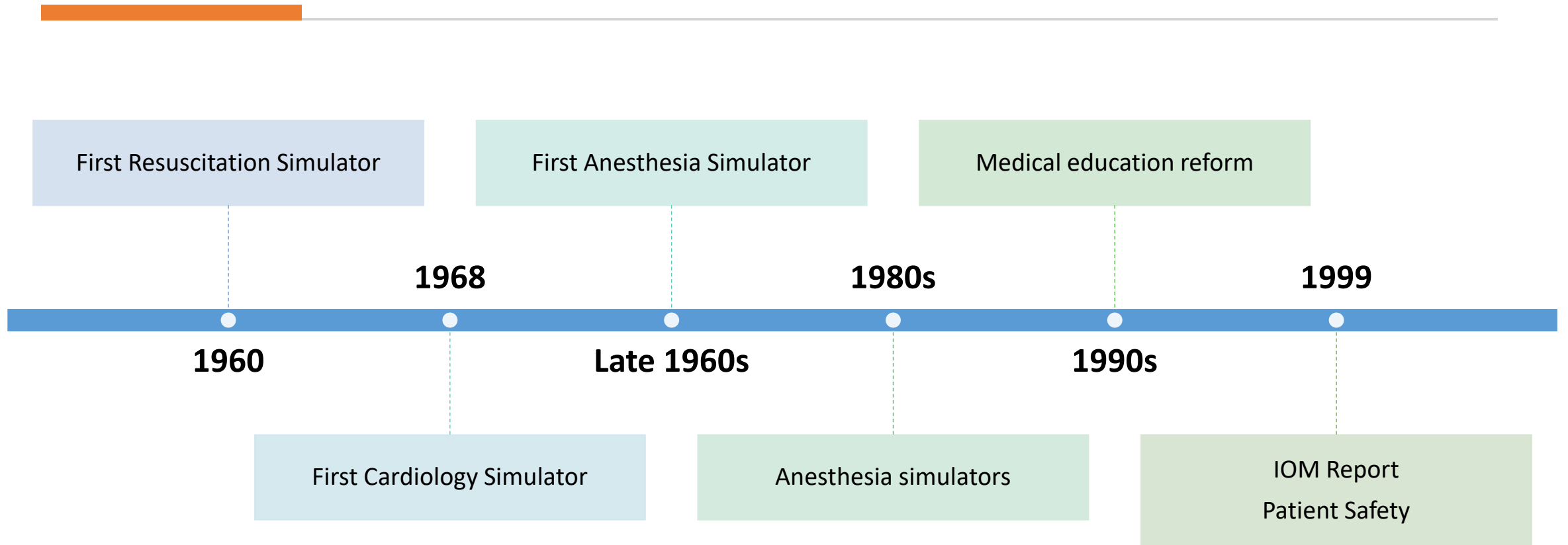
reform

1999

IOM Report
Patient Safety



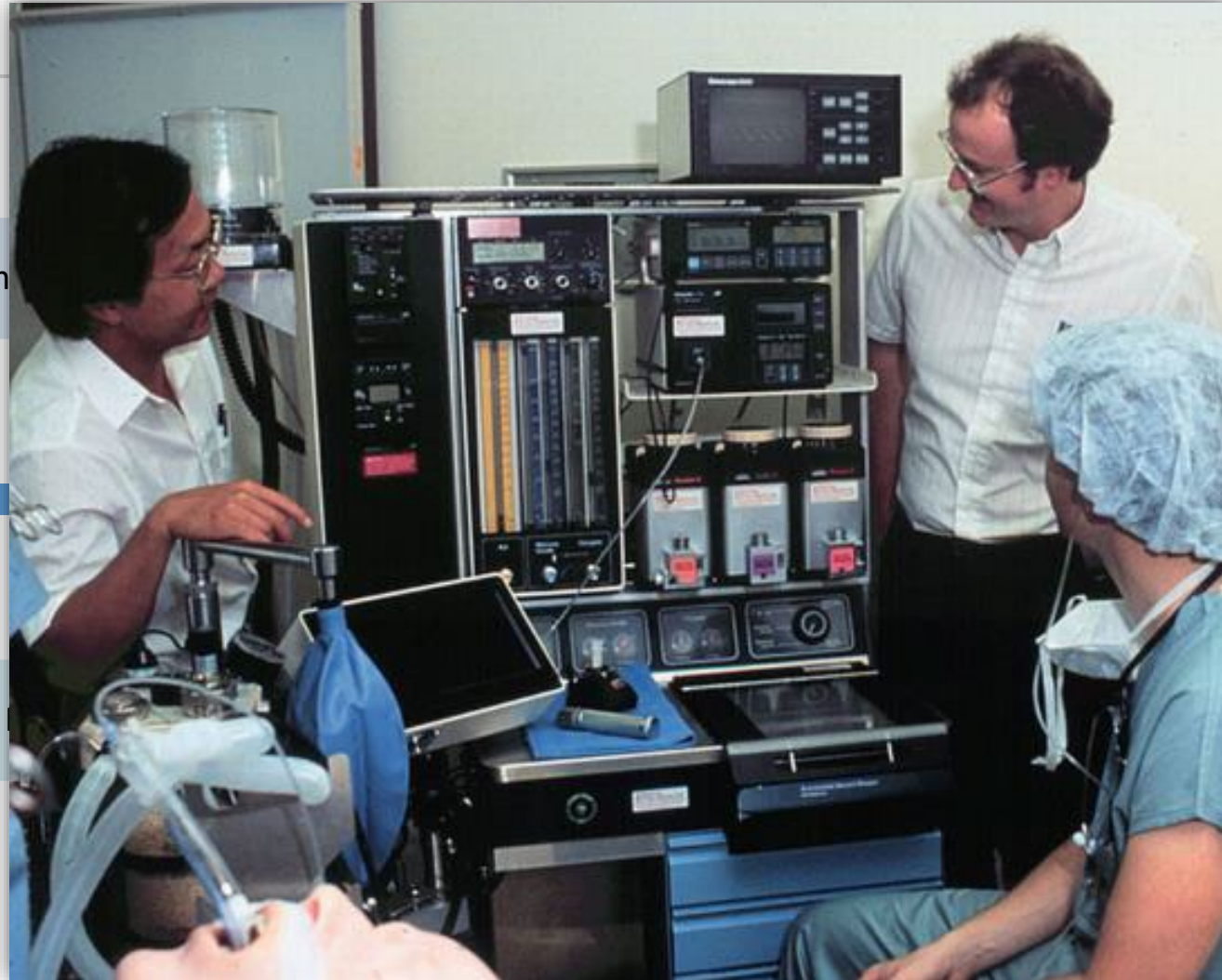
Development of Modern Clinical Simulation



Development of Modern Clinical Simulation

First Resuscitation Sim

1960



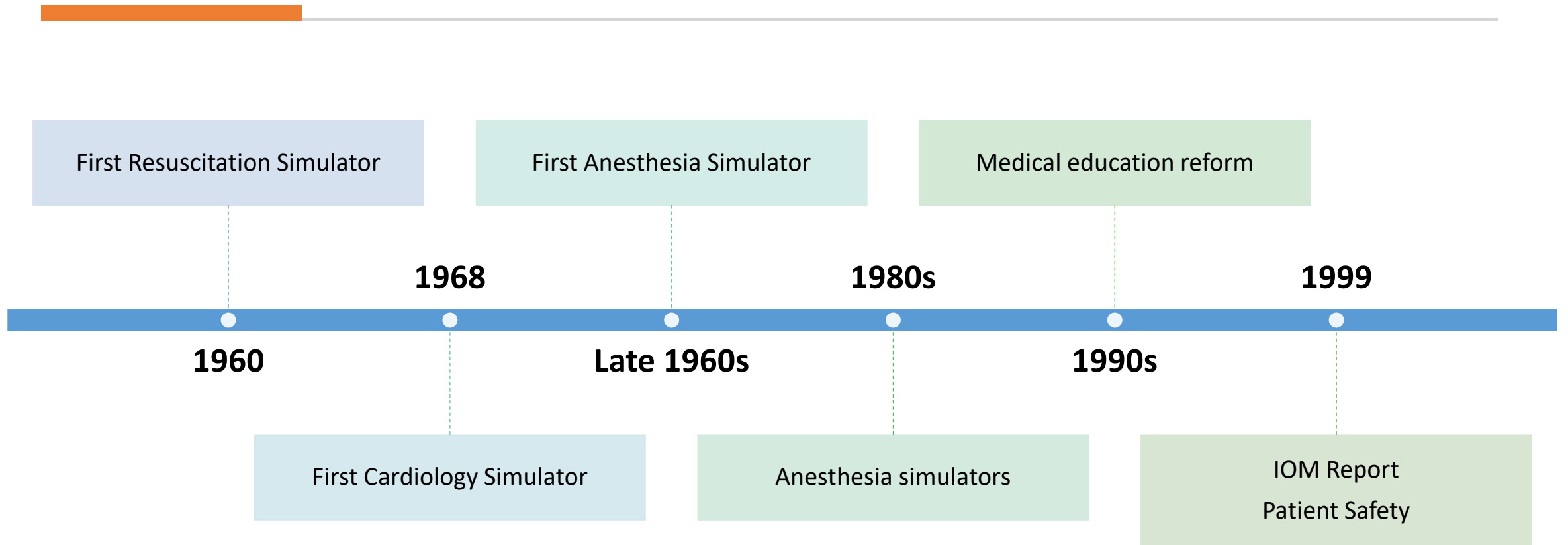
reform

1999

IOM Report
Patient Safety



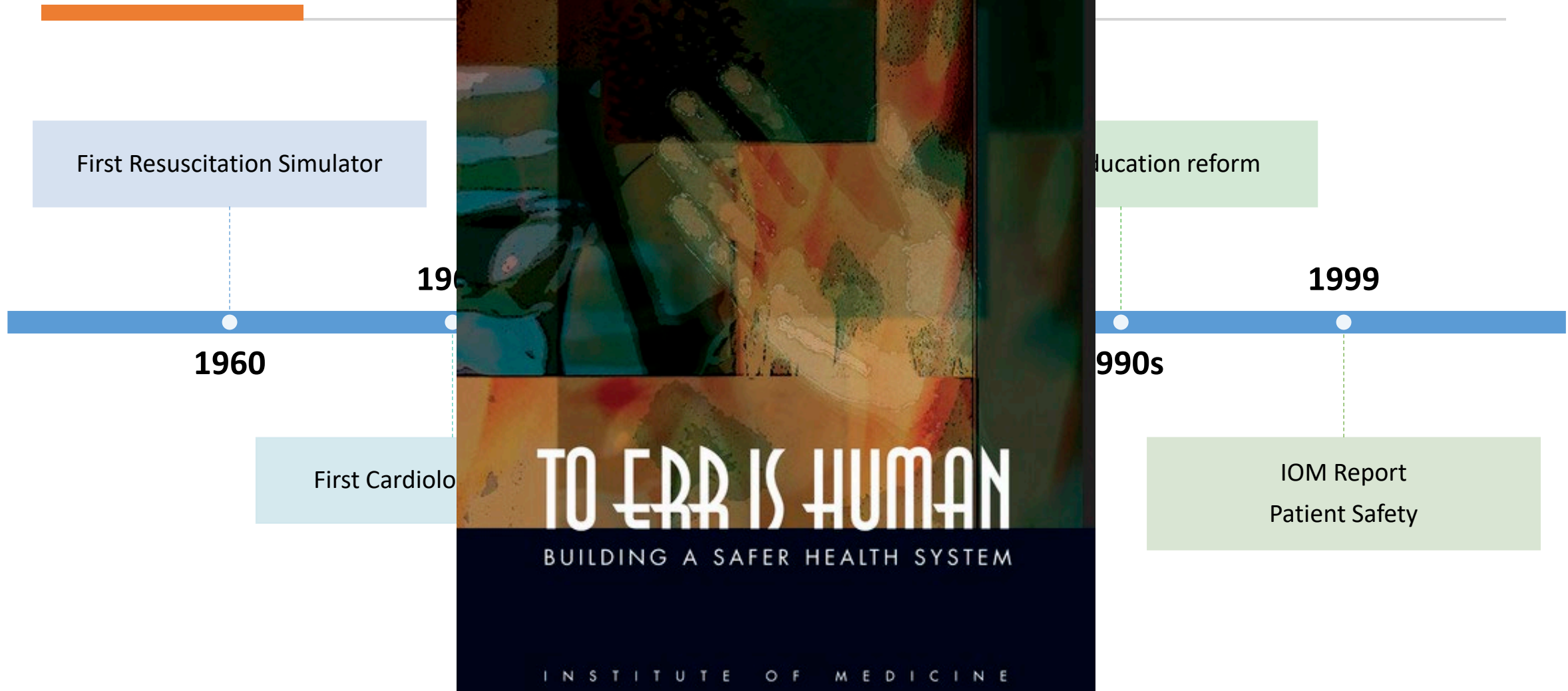
Development of Modern Clinical Simulation





Development

Simulation



First Resuscitation Simulator

1960

1960

First Cardiology Simulator

Education reform

1999

1990s

IOM Report Patient Safety

TO ERR IS HUMAN

BUILDING A SAFER HEALTH SYSTEM

INSTITUTE OF MEDICINE



“...there seems little question that, when used in a sophisticated manner, SBME has the potential to decrease the numbers and effects of medical errors, to facilitate open exchange in training situations, to enhance patient safety, and to decrease the reliance on vulnerable patients for training.”



“While the actual contribution that SBME can make to improving skills awaits empirical study, there seems little question that, when used in a sophisticated manner, SBME has the potential to decrease the numbers and effects of medical errors, to facilitate open exchange in training situations, to enhance patient safety, and to decrease the reliance on vulnerable patients for training.”

Healthcare Simulation Research

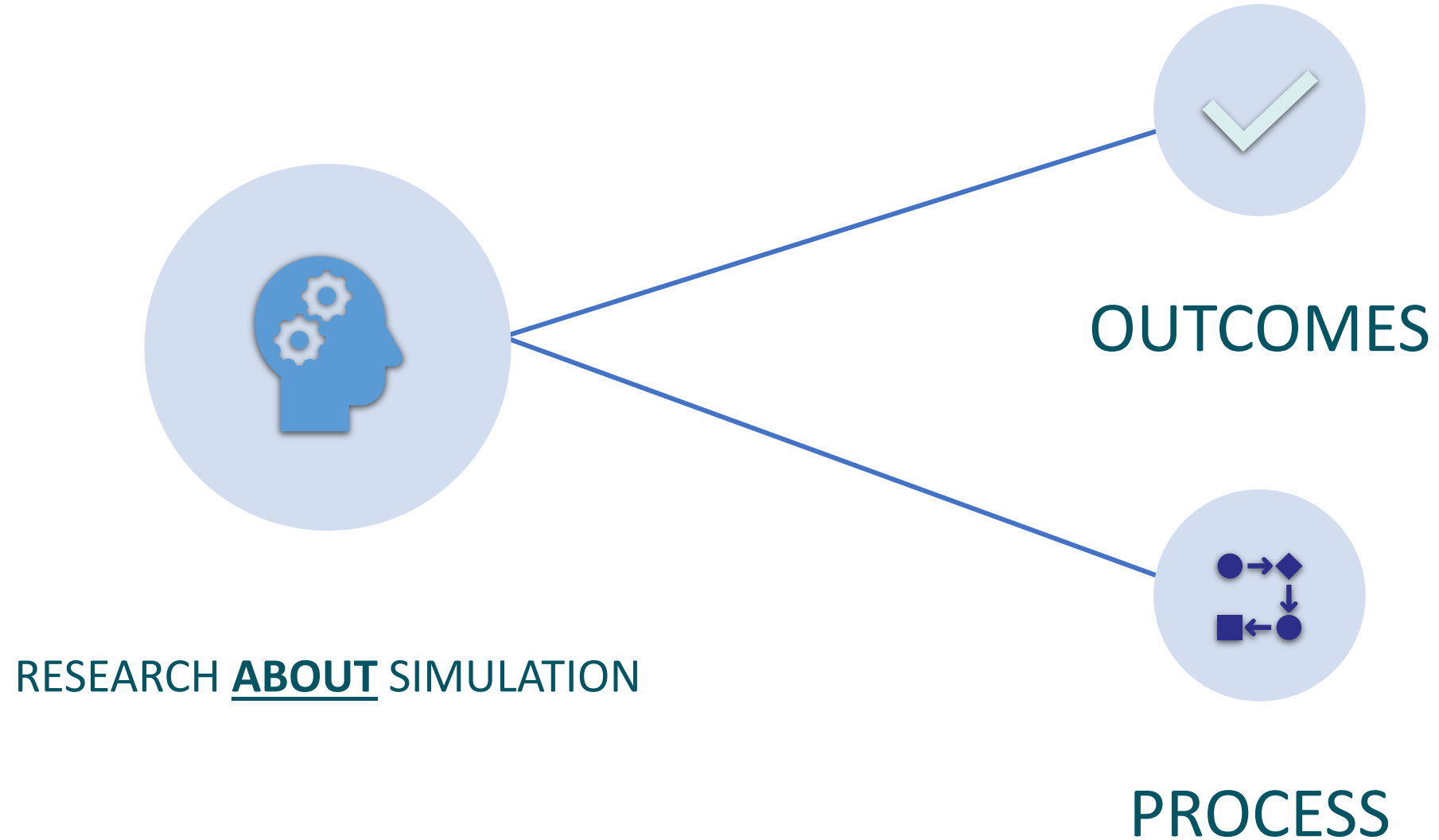


RESEARCH ABOUT SIMULATION

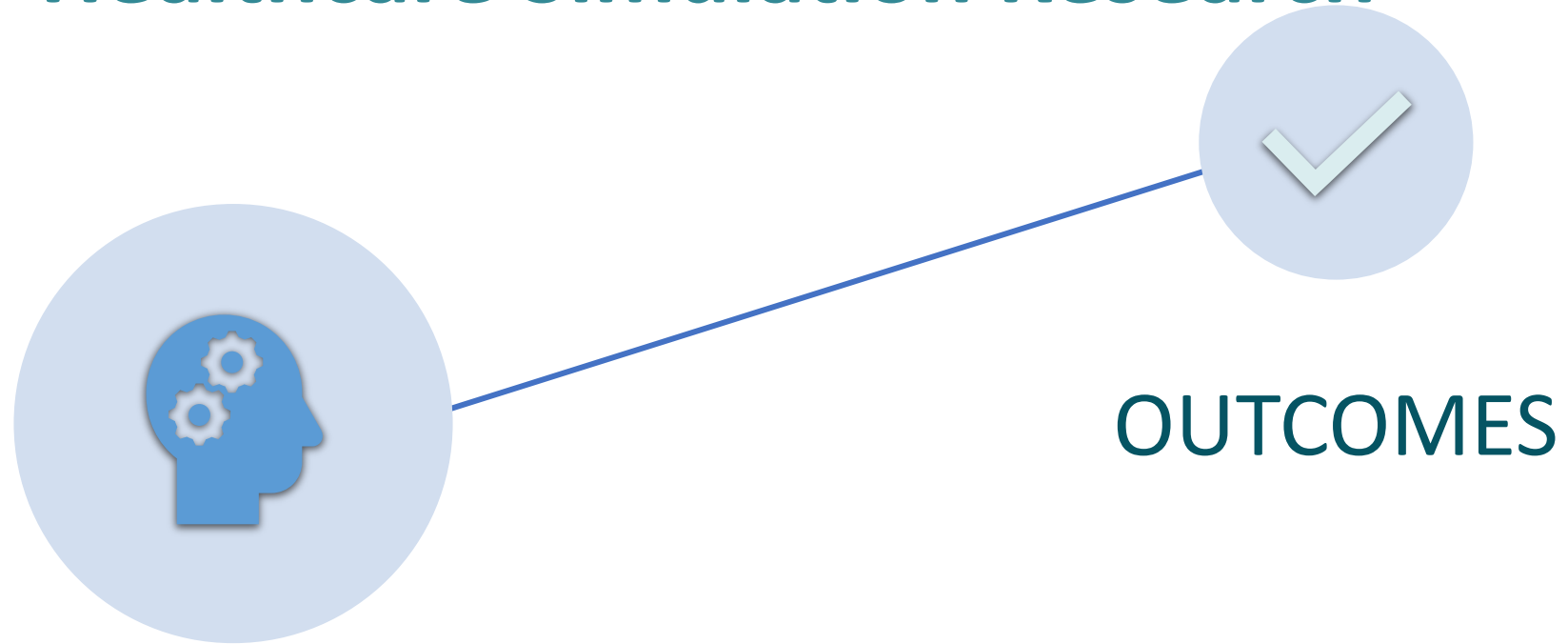


RESEARCH WITH SIMULATION

Healthcare Simulation Research



Healthcare Simulation Research





Medical Education as Translational Science

	T1	T2	T3
Improved	Knowledge, skills, attitudes	Patient care practices	Patient outcomes
Target	Individuals, teams	Individuals, teams	Individuals, teams, public health
Setting	Simulation lab	Clinic, bedside	Clinic, hospital, community

McGaghie, Medical Education 2010



Classic Simulation Study

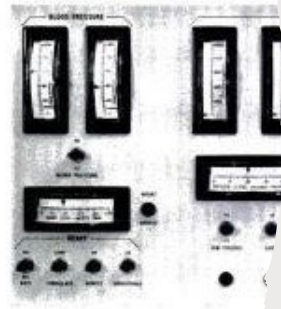
Effectiveness of a Simulator in Training Anesthesiology Residents

Abrahamson et al, Journal of Medical Education 1969

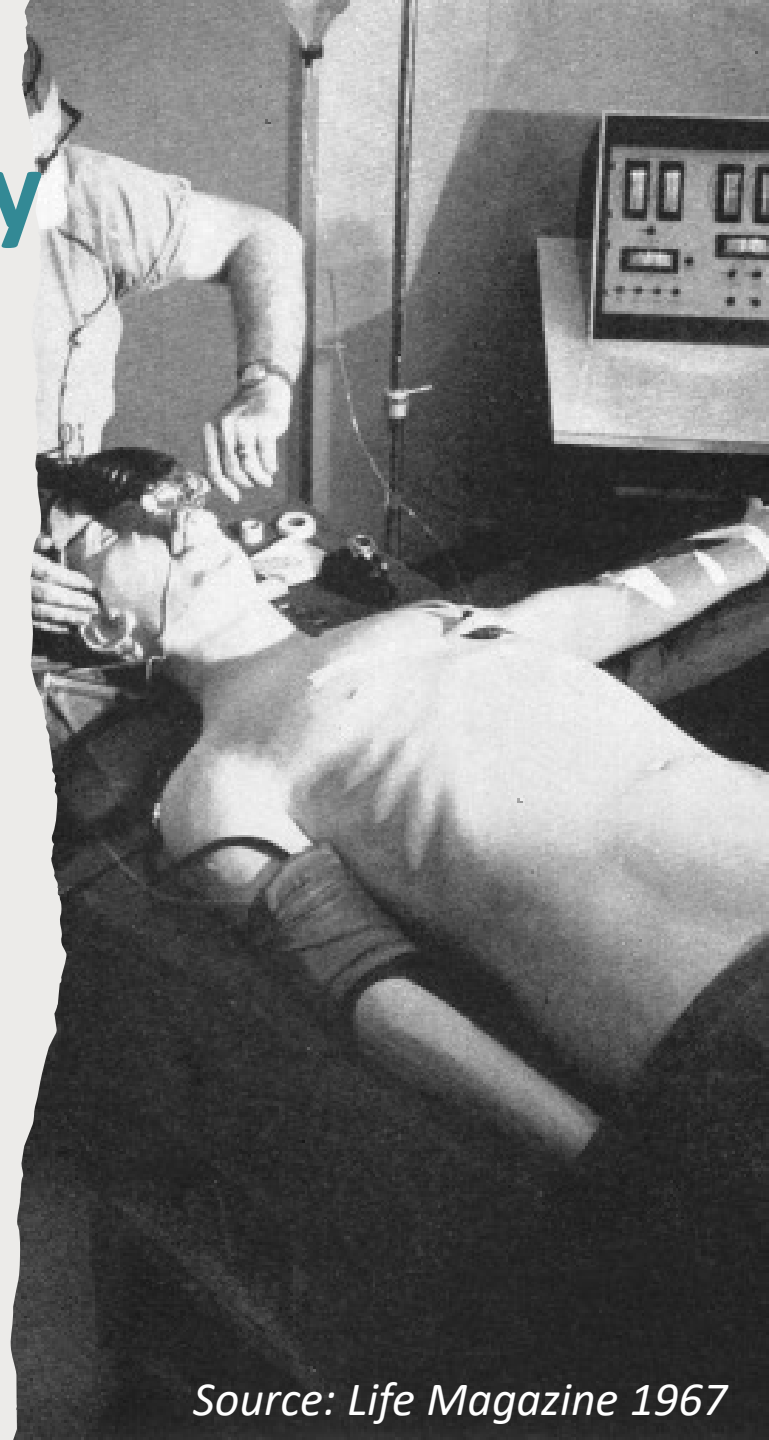
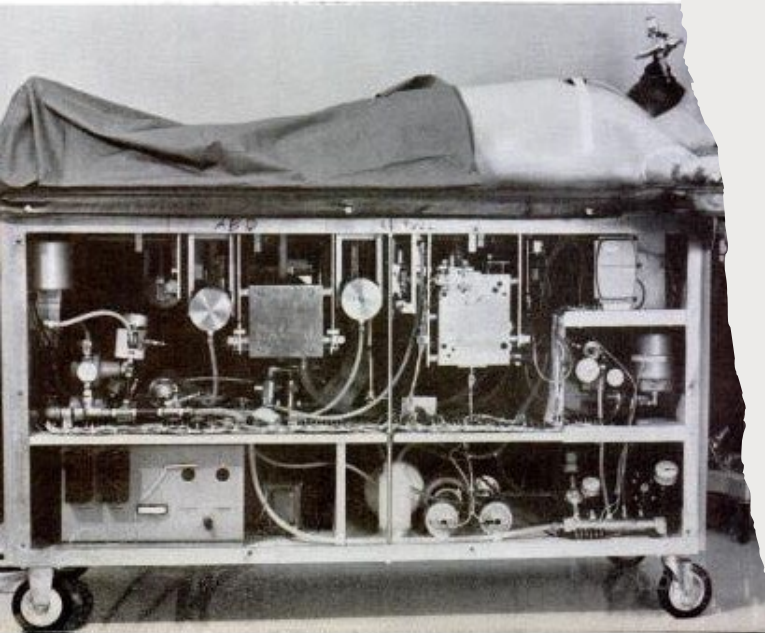
- T2 level outcome
 - Controlled trial
 - Intubations to reach competency
 - Days to reach competency

...amazingly lifelike
open and close re-
the pupils also di-
left) and contract
To the anesthesiolo-
m is a danger signal,
if the patient must
er more oxygen or
g the control panel
structor can monitor
dent's actions and
s. The side view be-
at makes the device
er of electronic gear
the operating table.
ousings immediate-
contain the control

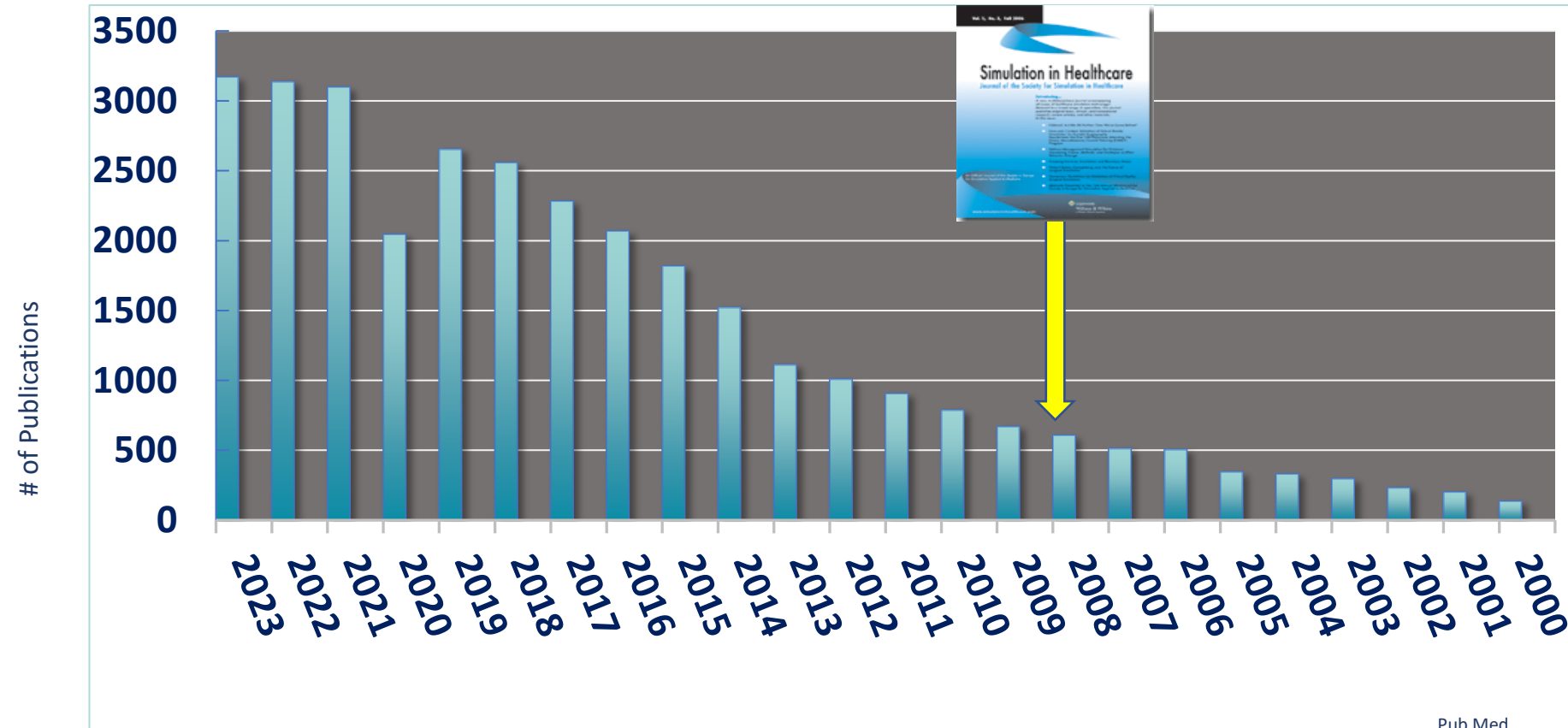
centers for the abdomen and lungs.
To duplicate actual conditions
often encountered in an operating
room, the instructor can try to con-
found the student with problems
such as coughing or spasms. He
can also suspend the proceedings
at any moment if he wants to dis-
cuss a point. Whereas with a live
patient a difficult procedure need
—and can—be done only once,
Sim makes it possible for the stu-
dent to practice a process dozen-
s of times. The inventors are al-
ready looking ahead: future Sims
will bleed, perspire, salivate and
turn blue when short of oxygen.



It can get sick on command 30 times



Search Terms + Simulation : Medical : Education ○





Foundational: *Issenberg et al, Medical Teacher 2005*

Features and Uses of High-fidelity Medical Simulations That Lead to Effective Learning: a BEME Systematic Review



- 109 articles
- 1969-2003
- 57% during 2000 to 2003

Agenda: rigorous scholarship, qualitative research,
mastery learning



Foundational: Deliberate Practice Mastery Learning *US Guided CVC Placement*

Pre-test 27-
item checklist



1 hour
didactic



3 hours
deliberate
practice



Post-test 27-
item checklist
MPS



Foundational: Deliberate Practice Mastery Learning *US Guided CVC Placement*

- **Simulation-based Mastery Learning Reduces Complications During Central Venous Catheter Insertion in a Medical Intensive Care Unit** - *Barsuk et al, Crit Care Med 2009*
- **Use of Simulation-Based Education to Reduce Catheter-Related Bloodstream Infections** - *Barsuk et al, Arch Int Med 2009*
- **Cost Savings From Reduced Catheter-Related Bloodstream Infection After Simulation-Based Education for Residents in a Medical Intensive Care Unit** - *Cohen et al, Simul Healthc 2010*

Deliberate Practice Mastery Learning

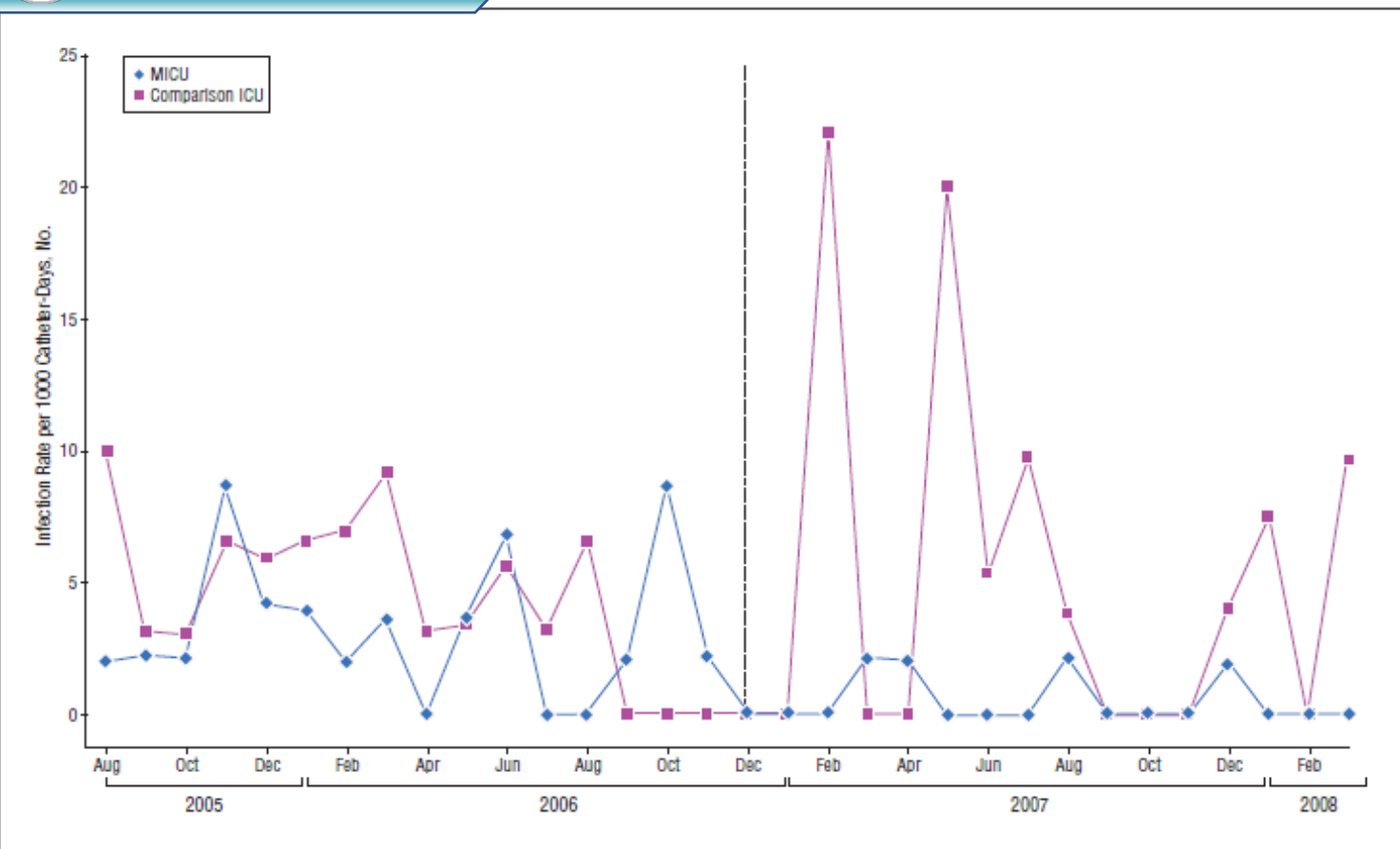


Figure 2. Monthly catheter-related bloodstream infection rates in a medical intensive care unit (MICU) and a comparison intensive care unit (ICU) before and after a simulation-based educational intervention in the MICU. The vertical line at December 2006 indicates the time that simulator-trained residents entered the MICU.

Barsuk et al, Arch Int Med 2009

- T2
 - Needle passes, arterial punctures, adjustments, success rates
- T3
 - fewer CRBSI compared to SICU
- T3
 - net annual savings > \$700K
 - 7 to 1 rate of return



Foundational: Deliberate Practice Mastery Learning

ACLS, Chest 2008

Hemodialysis catheter, Am J Kidney Dis 2009

Lumbar puncture, Neurology 2012

Paracentesis, Am J Med 2013

Thoracentesis, Academ Med 2018

US guided IV placement, Am J Emerg Med 2021



Interprofessional Trauma Training

Assessing Teamwork in the Trauma Bay: Introduction of a Modified “NOTECHS” Scale for Trauma

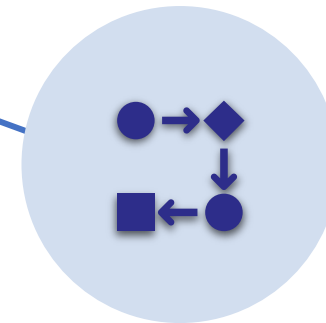
Steinemann et al, American Journal of Surgery 2012

- T1 – teamwork in simulation
- T2 – teamwork in real trauma
- T2 – task completion in real trauma

Healthcare Simulation Research



RESEARCH ABOUT SIMULATION



PROCESS



The Debriefing Process

The Effectiveness of Video-Assisted Debriefing Versus Oral Debriefing Alone at Improving Neonatal Resuscitation Performance: A Randomized Trial

Sawyer et al, Simul Healthc 2012

T1 outcome

- NRP performance & time to critical tasks



The Instructional Design Process

Emergent Themes for Instructional Design Alpha and Beta Testing During a Faculty Development Course

Lee-Jayaram et al, Simul Healthc 2019

- Grounded theory
- Themes during scenario design

SimTiki Simulation Center
 John A. Burns School of Medicine • Telehealth Research Institute
 MEB 212, 651 Ilalo Street Honolulu HI 96813
 Phone: (808) 692-1080 • Fax: (808) 692-1250

Alpha/Beta Testing
Changes with ALPHA test

Course: iSIM FunSim

Team: A

Date: 11/13/14

Location: SimTiki

Scenario Information
 Teaching or testing: _____
 Learner level: AT student
 Clinical topic: C-cells
 Assessment method: VLSI

Please list all the changes you made to your scenario after you started alpha testing and the reason why you made the changes. These include any changes made after first run of scenario up until the start of the first beta test.

- If cervical collar placed inappropriately - confederate can prompt

- Once pt ↑ → confederate prompts asthma history and worsening distress.

Orientation A
 - have student put on cervical collar and oxygen prior to scenario





Healthcare Simulation Research



RESEARCH WITH SIMULATION



Research With Simulation

Analysis of phenomena difficult for researchers to gain access firsthand

- Assess outcomes of another educational intervention
- Analyze a new environment
- Describe a situation or condition of interest
- Test a theory
- Evaluate intervention to improve patient care



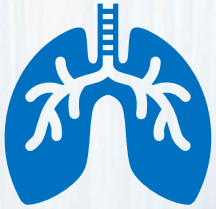
Assess Educational Intervention

Improving Anesthesiologists' Ability to Speak Up in the Operating Room: A Randomized Controlled Experiment of a Simulation-Based Intervention and a Qualitative Analysis of Hurdles and Enablers

Raemer et al, Acad Med 2016

- No difference in speaking up





Analyze New Environments

Simulation to Assess the Safety of New Healthcare Teams and New Facilities

Patterson et al, Simul Healthc 2011

- Latent safety threats and workload in new ED



Describe Situation or Condition

Information transfer in Multidisciplinary Operating Room Teams: A Simulation-based Observational Study

Cumin et al, BMJ Qual Saf 2018

- Value of pre-case briefing
- Suboptimal information sharing
- Unequal contribution

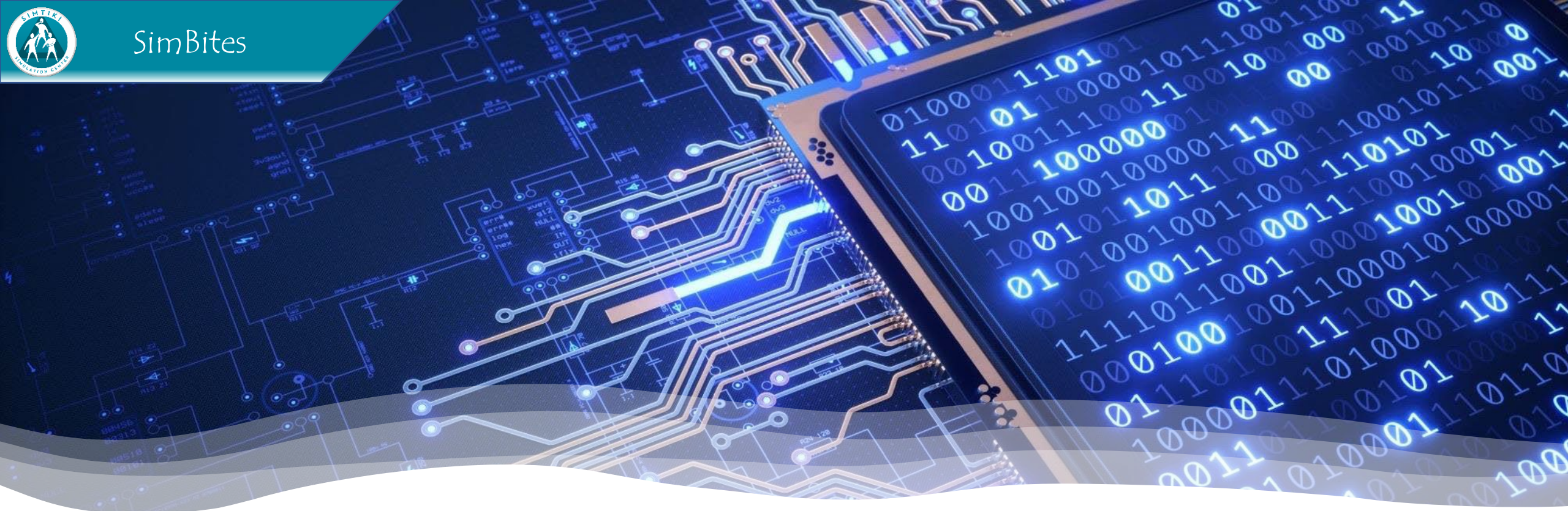


Test Theories

Impact of Sleep Deprivation on Anaesthesia Residents' Non-technical Skills: a Pilot Simulation-based Prospective Randomized Trial

Neuschwander et al, British J Anesth 2017

- NTS significantly lower for sleep-deprived



The Frontier of Healthcare Simulation Research

- Distance simulation
- Artificial intelligence
- Extended reality



Distance Simulation: Temporary or Here to Stay?

A Scoping Review of Remote Facilitation During Simulation-based Healthcare Education

Park et al, BMC Med Educ 2023

Setting an Agenda Results of a Consensus Process on Research Directions in Distance Simulation

Gross et al, Simul Healthc 2023



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Artificial Intelligence Generative Pre-Trained Transformer & The Process

- Artificial Intelligence and the Simulationists

Rodgers et al, Simul Healthc 2023

-  for Clinical Vignette Generation, Revision, and Evaluation

Benoit, medRxiv 2023



Extended Reality

- Augmented reality and immersive virtual reality
- 2006 - USD 45,000
- 2013: New generation low-priced, high-quality head-mounted VR
- 2014 - USD 1,300

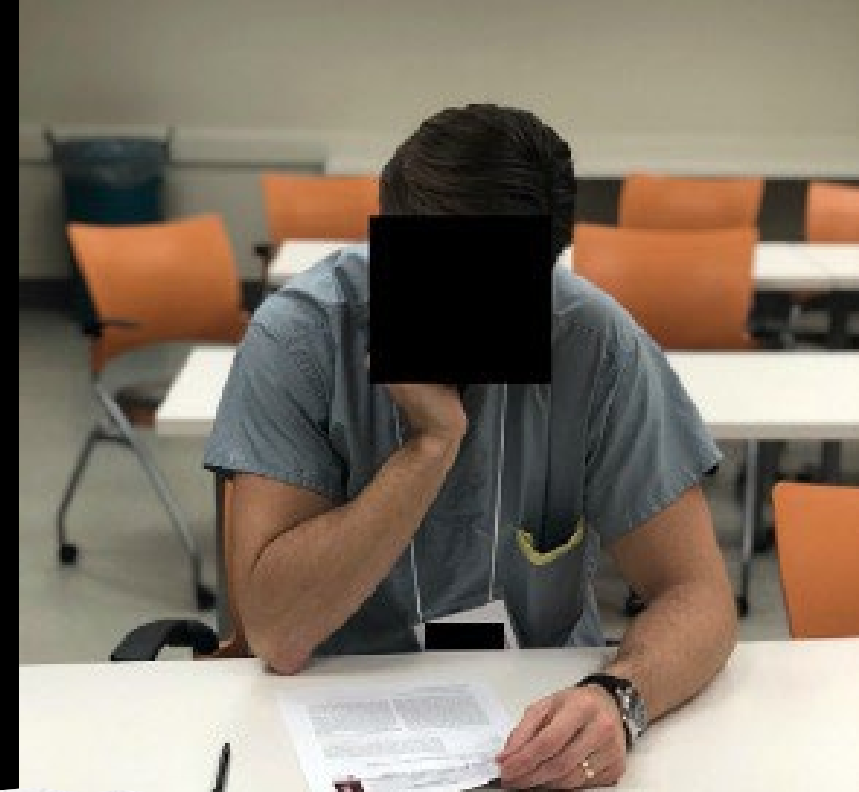


Immersive VR

Virtual Reality Head-Mounted Displays in Medical Education A Systematic Review

Tursø-Finnich et al 2023 SIH

- 41 articles, 2017-2020
- Improved surgical procedures learning outcomes
- Agenda: technical parameters, transfer, retention, economic analysis



Immersive VR

Improved Complex Skill Acquisition by Immersive Virtual Reality Training A Randomized Controlled Trial

Lohre et al, J Bone Joint Surg Am 2020

- Faster procedure time and superior surgical instrument handling



Augmented Reality

Effectiveness of Using Augmented Reality for Training in the Medical Professions: Meta-analysis

Baashar et al, JMIR Serious Games 2022

- 2013-2021
- 13 studies – 8 between 2019-2021
- Improved satisfaction, confidence, time
- No change in knowledge, skill

Augmented Reality

Feasibility of an Augmented Reality Cardiopulmonary Resuscitation Training System for Health Care Providers

Balian et al, Heliyon 2019

- Chest compression rate, depth, recoil
- Participants satisfaction high



Challenges & Considerations

- Content - software
- Hardware
- Social justice
- Equitable access to education
- Efficiency
- Psychological safety

Current Research Priorities in Healthcare Simulation

Results of a Delphi Survey

Anton et al, Simul Healthc 2022

Top 10 Prioritized Research Questions



#1: What healthcare system level simulation-based interventions result in the greatest impact on system efficiency, patient safety, and patient outcomes?



Example of #1: In healthcare practitioners, what simulation-based design of patient safety interventions, compared with traditional patient safety interventions, improves healthcare processes and patient outcomes?

Current Research Priorities in Healthcare Simulation

Results of a Delphi Survey

Anton et al, Simul Healthc 2022

Top 10 Prioritized Research Questions



#2: What is the return on investment (ROI; financial, social, health outcome)/cost effectiveness of different modalities of simulation-based training and assessment, and what research methods are optimal to assess this?



Example of #2: What is the cost-effectiveness of simulation training, as compared with other methods of training, on a variety of outcomes relating to patients (eg, length of hospital stay, success of treatment, etc), staff (eg, team efficiency, work absences), and services (eg, referral and transfer rates/times)?

Current Research Priorities in Healthcare Simulation

Results of a Delphi Survey

Anton et al, Simul Healthc 2022

Top 10 Prioritized Research Questions



#3: Is there a dose-response relationship between simulation training and impact on care processes and patient outcomes?



Example of #3: For healthcare providers delivering complex care in teams, does low-dose, high-frequency simulation-based training in situ compared with standard mandatory annual education, improve the process of care and patient outcome?



Current Research Priorities in Healthcare Simulation⁺

Results of a Delphi Survey^o

Anton et al, Simul Healthc 2022

Top 10 Prioritized Research Questions



And many more





Third SSH Research Summit

- 16 guidelines addressing key questions
 - 4 moderate evidence
 - 8 very low certainty evidence
 - 4 expert consensus
- 11 peer-reviewed systematic literature reviews
- *Simul Healthc 2024, Vol 19, No 1; IMSH Research Summit Supplement*

In Summary



Research in healthcare simulation has been advancing rapidly over the last 20 years



More focus is needed on evaluating T3+ outcomes



Issues of justice and equity given simulation education costs should be weighed



Processes of simulation-based healthcare education still require further assessment, especially with newer technologies



Discussion

