Hong Kong College of Critical Care Nursing

Annual General Meeting and Symposium 2018

Utilizing Simulations to Improve Intensive Care Services

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MN, RN, ET, FHKAN(Critical Care)

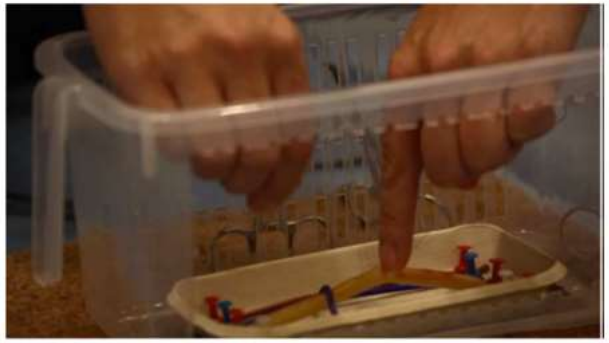
6 Oct 2018

Disclosure

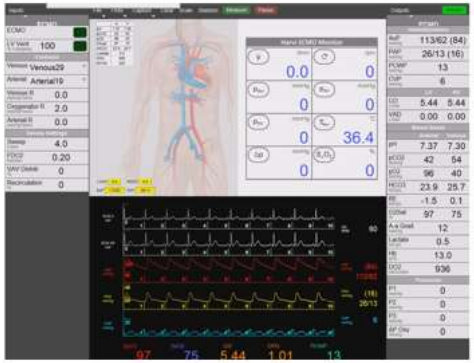
- None
- I will make reference to and present some commercial products in this presentation but I do not intend to endorse their use

SIMULATION

WHAT DOES IT MEAN TO YOU?

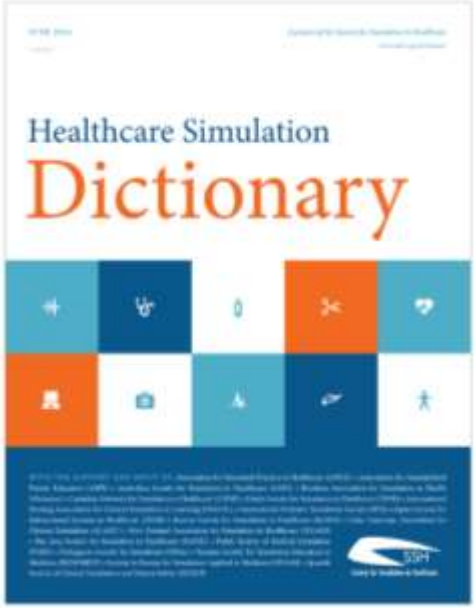


- Technology?
- Simulators? Manikin?
- Teamwork? CRM?
- Instructor?
- Debriefing?
- Money / Investment?



What is Simulation?

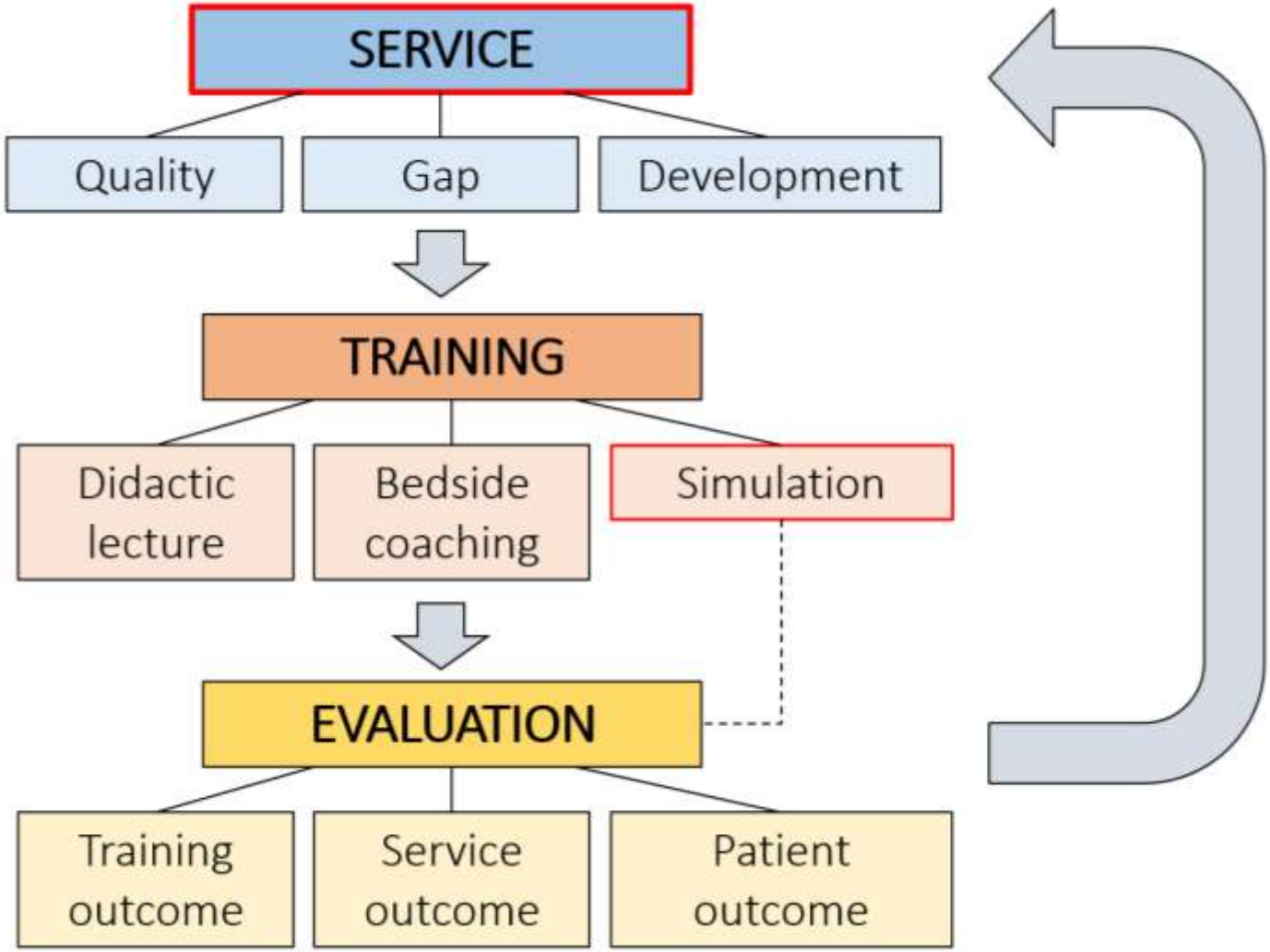
A technique that creates a situation or environment to allow persons to experience a representation of a real event for the purpose of practice, learning, evaluation, testing, or to gain understanding of systems or human actions.



Healthcare Simulation Dictionary,

Society for Simulation in Healthcare, 2016

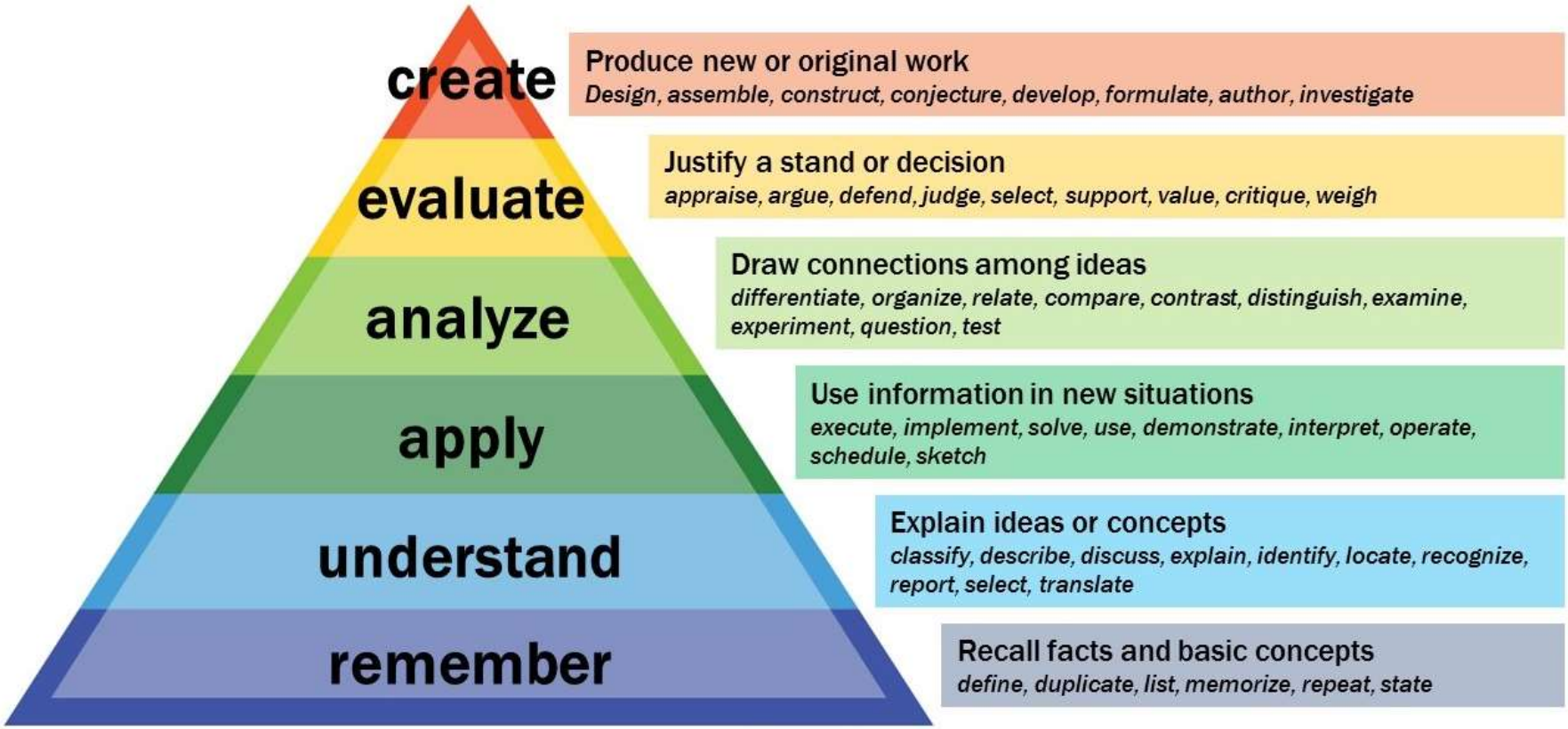
Establishing the Need for Training



Matching the Right XXX

- Skill set – Cognitive, Technical, Behavioral
- Participant level or expected competency
- Service

Bloom's Taxonomy



Dear Parent:
Your child's love of reading starts here!

Every child learns to read in a different way and at his or her own speed. Some go back and forth between reading levels and read favorite books again and again. Others read through each level in order. You can help your young reader improve and become more confident by encouraging his or her own interests and abilities. From books your child reads with you to the first books he or she reads alone, there are I Can Read Books for every stage of reading:

My First — **SHARED READING**
Basic language, word repetition, and whimsical illustrations, ideal for sharing with your emergent reader

1 — **BEGINNING READING**
Short sentences, familiar words, and simple concepts for children eager to read on their own

2 — **READING WITH HELP**
Engaging stories, longer sentences, and language play for developing readers

3 — **READING ALONE**
Complex plots, challenging vocabulary, and high-interest topics for the independent reader

4 — **ADVANCED READING**
Short paragraphs, chapters, and exciting themes for the perfect bridge to chapter books

I Can Read Books have introduced children to the joy of reading since 1957. Featuring award-winning authors and illustrators and a fabulous cast of beloved characters, I Can Read Books set the standard for beginning readers.

A lifetime of discovery begins with the magical words **"I Can Read!"**

Visit www.icanread.com for information on enriching your child's reading experience.

Relate Your Training with The Service

All competencies in other 2 levels + Speed priming

E-CPR

All basics + Manage emergencies in unfamiliar environment & with limited resources + ECMO transport (inter-hospital)

Mobile ECMO

ECMO physiology
VVECMO
VAECMO
Other configurations
ECMO initiation
Patient & circuit management
ECMO mobilization
Pharmacology
Patient monitoring during weaning
Blood sampling from circuit
Attach CRRT circuit to ECMO
ECMO emergencies & management
ECMO complications & management
ECMO transport (intra-hospital)

Basic ECMO Management

Short Term Outcome:
To Keep Students Awake!

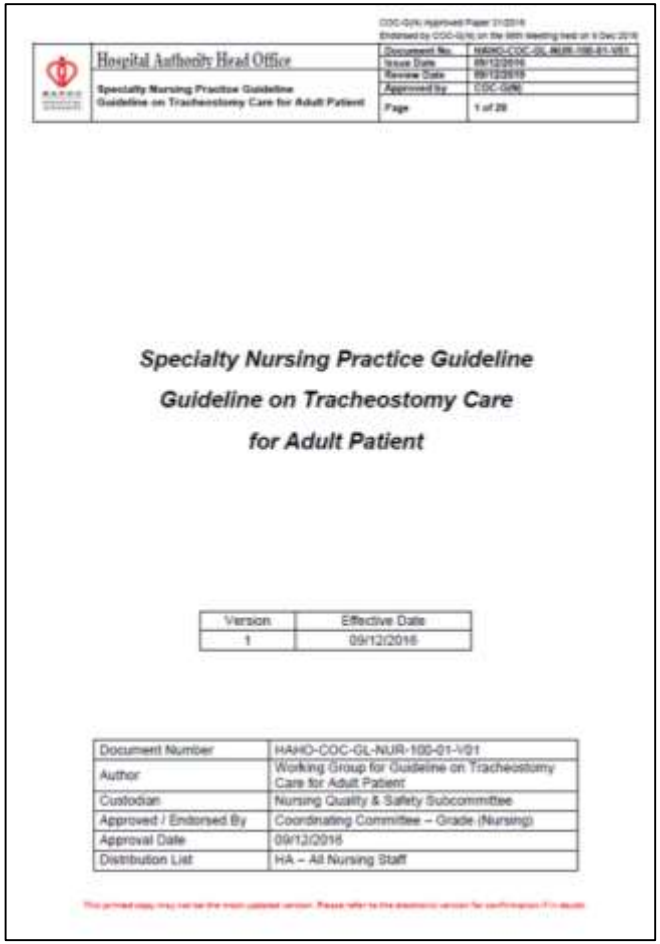
Evaluation & Outcome

But the GOOD news is that we managed to keep him alive long enough so he won't effect this months mortality targets AT ALL!

Case 1: Use of Simulation as a Tool for Guideline Dissemination

Background

- In 2016, HAHO released a practice guideline on tracheostomy care for adult patients
- Our team was charged with the duty to disseminate the guideline



Hospital Authority Head Office	Document No.	HAHO-COC-GL-NUR-100-01-V01
Specialty Nursing Practice Guideline Guideline on Tracheostomy Care for Adult Patient	Issue Date	09/12/2016
	Review Date	09/12/2019
	Approved by	COC-G/N
	Page	1 of 20

Specialty Nursing Practice Guideline

Guideline on Tracheostomy Care

for Adult Patient

Version	Effective Date
1	09/12/2016

Document Number	HAHO-COC-GL-NUR-100-01-V01
Author	Working Group for Guideline on Tracheostomy Care for Adult Patient
Custodian	Nursing Quality & Safety Subcommittee
Approved / Endorsed By	Coordinating Committee – Grade (Nursing)
Approval Date	09/12/2016
Distribution List	HA – All Nursing Staff

Methods

- A 1.5-hour training session with four different types of clinical scenarios
- Covered complications and incidents that might happen in temporary or permanent tracheostomies:
  - Bleeding
  - Tube displacement
  - Tube dislodgement
  - Tube obstruction

- Participants were required to identify and solve the problems independently
- Debriefing with standardized training materials were conducted after each scenario
- The training materials were developed from the new clinical guideline

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Results

- 262 nurses participated in 34 identical sessions in January – May 2017
- Mean year of service was 3.03±0.71
- 91.0% and 62.2% had former experience in care of patients with temporary and permanent tracheostomies
- 54.2% and 36.2% had experience in managing emergencies associated with temporary and permanent tracheostomies.

Results

- 55.4% had attended classroom-based tracheostomy care training within the last six months
- 155 participants preferred simulation training to classroom-based briefing sessions
- Mean satisfaction score: 5.34±0.00 out of 6
- Mean program effectiveness in meeting training needs: 5.39±0.71 out of 6
- Degree of simulation realism: 7.88±0.71 out of 10

Results

- Self-reported confidence level before and after training: 5.16±2.12/10 versus 7.43±0.71/10 (mean difference = 2.27, $p<0.001$)
- Self-reported competence level before and after training: 5.51±2.83/10 versus 7.35±0.71/10 (mean difference = 1.84, $p<0.001$)

Discussion

- Simulation-based training can be used as a tool for guideline dissemination
- Is participant-centered
- Better designed to meet the needs of the participants based on their background, service experience and exposure
- More time can be spent in developing higher-order cognitive skills

Limitations

- Level of guideline transfer to clinical practice is uncertain
- Perceived competence and confidence levels were high at initial phase after training but skill decay over time is possible
- Training sessions may be required in the future to upkeep the clinical skills

Use of Simulation as a Tool to Induce Culture Shift

ORIGINAL RESEARCH ARTICLE Open Access

What can we learn from simulation-based training to improve skills for end-of-life care? Insights from a national project in Israel

Mayer Brezis[1*], Yael Lahat[2], Meir Frankel[2], Alan Rubinov[3], Davina Bohm[1], Matan J Cohen[1], Meni Koslowsky[4], Orit Shalomson[5], Charles L Sprung[3], Henia Perry-Mezare[2], Rina Yahalom[2] and Amitai Ziv[5]

Isr J Health Policy Res. 2017 Nov 6;6(1):48.

Abstract

Background: Simulation-based training improves residents' skills for end-of-life (EOL) care. In the field, staff providers play a significant role in handling those situations and in shaping practice by role modeling. We initiated an educational intervention to train healthcare providers for improved communication skills at EOL using simulation of sensitive encounters with patients and families.

Methods: Hospital physicians and nurses (n = 1324) attended simulation-based workshops (n = 100) in a national project to improve EOL care. We analyzed perceptions emerging from group discussions following simulations, from questionnaires before and after each workshop, and from video-recorded simulations using a validated coding system. We used the simulation setting as a novel tool for action research. We used a participatory inquiry paradigm, with repetitive cycles of exploring barriers and challenges with participants in an iterative pattern of observation, discussion and reflection – including a description of our own responses and evolution of thought as well as system effects.

Results: The themes transpiring included lack of training, knowledge and time, technology overuse, uncertainty in decision-making, poor skills for communication and teamwork. Specific scenarios demonstrated lack of experience

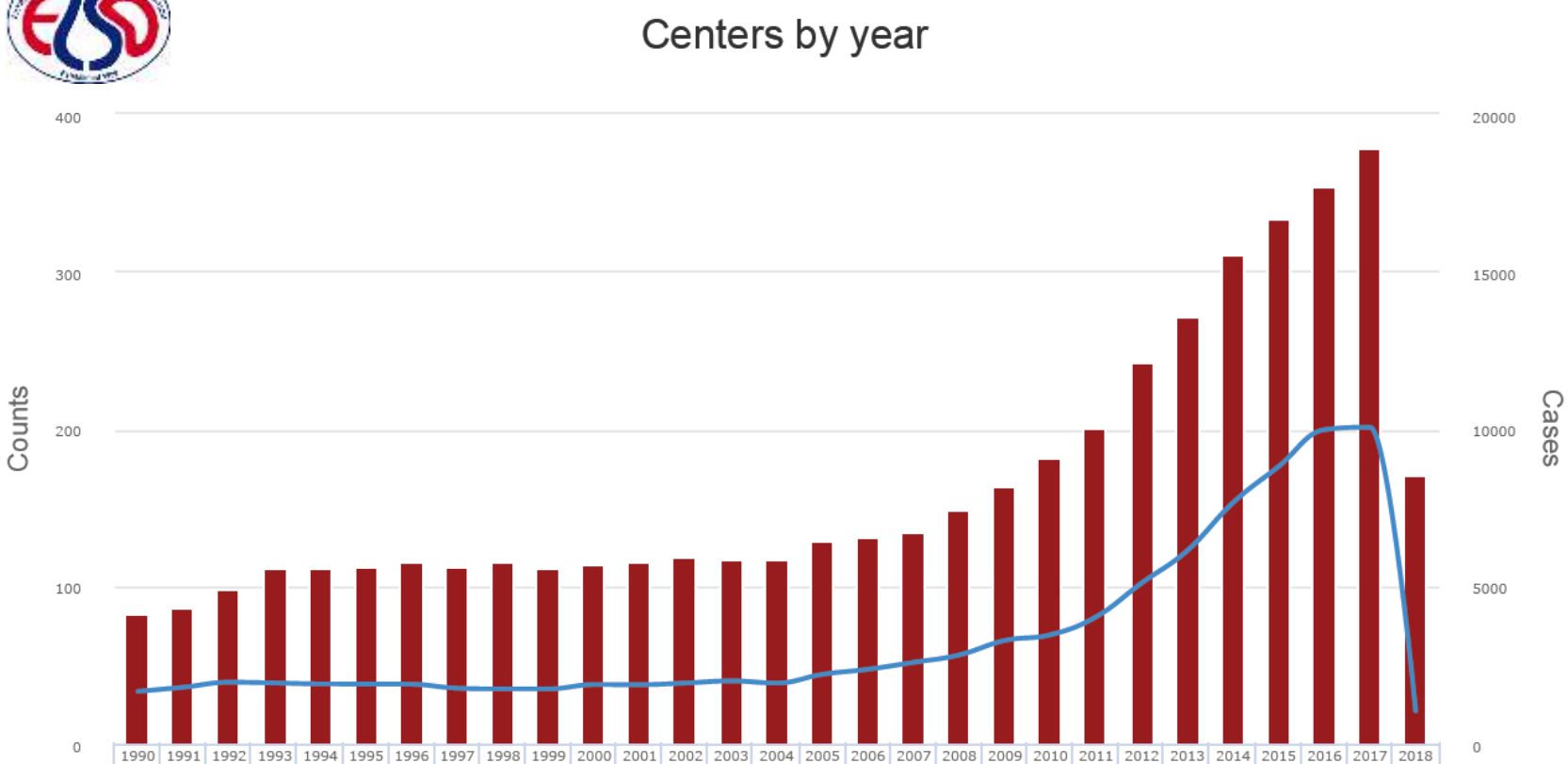
Case 2: Enhancing Individual & Team Competency Through Standardization of Practice

Case 2:

Background:

- Doctors must successfully cannulate major blood vessels before ECMO initiation
- Error in any step can be fatal
- Previous training relies on practice on animal models or real patients

ECMO service is growing worldwide



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Counts	83	86	98	111	111	112	115	112	115	111	114	115	119	117	117	129	131	134	149	163	182	201	243	272	310	334	354	379	170
Cases	1644	1775	1933	1910	1879	1876	1868	1743	1720	1721	1859	1855	1908	1974	1907	2183	2346	2564	2802	3261	3443	4015	5092	6124	7644	8796	9960	10038	1025

ADULT CARDIAC

Complications of Extracorporeal Membrane Oxygenation for Treatment of Cardiogenic Shock and Cardiac Arrest: A Meta-Analysis of 1,866 Adult Patients

Richard Cheng, MD, Rory Hachamovitch, MD, Michelle Kittleson, MD, PhD, Jignesh Patel, MD, PhD, Francisco Arabia, MD, Jaime Moriguchi, MD, Fardad Esmailian, MD, and Babak Azarbal, MD

Cedars-Sinai Heart Institute, Los Angeles, California, and Department of Cardiovascular Medicine, Heart and Vascular Institute, Cleveland Clinic, Cleveland, Ohio

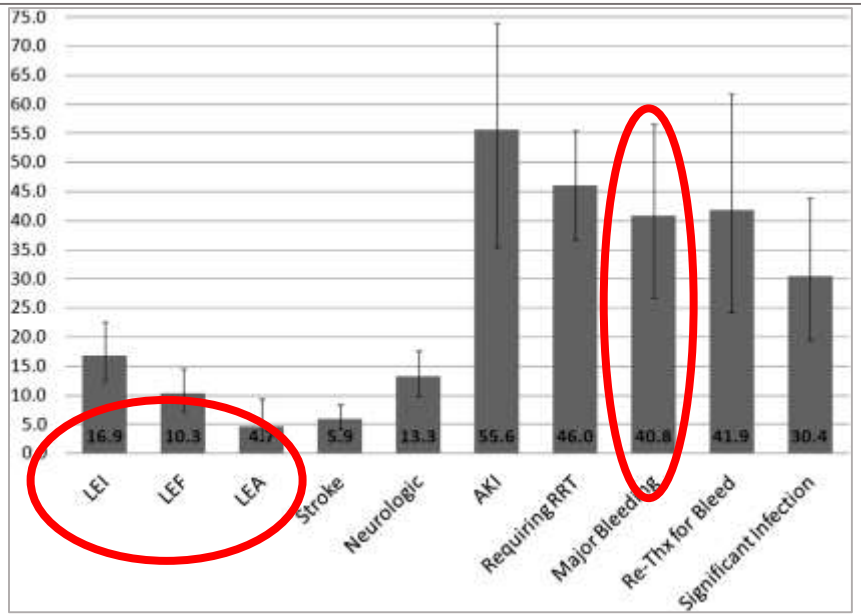
Background. Venoarterial extracorporeal membrane oxygenation (ECMO) has been used successfully for treatment of cardiogenic shock or cardiac arrest. The exact complication rate is not well understood, in part because of small study sizes. In the absence of large clinical trials, performance of pooled analysis represents the best method for ascertaining complication rates for ECMO.

Methods. A systematic PubMed search was conducted on ECMO for treatment of cardiogenic shock or cardiac arrest in adult patients only, updated to November 2012. Studies with more than 10 patients published in the year 2000 or later that reported complication rates for ECMO were included. Specific complications analyzed included lower extremity ischemia, fasciotomy or compartment syndrome, amputation, stroke, neurologic complications, acute kidney injury, renal replacement therapy, major or significant bleeding, rethoracotomy for bleeding or tamponade, and significant infection. For studies that included overlapping patients, the largest study was included and the others excluded. Cochran's Q and I-squared were calculated. A more conservative random-effects model was chosen for all analyses.

Results. Twenty studies were included in the analyses encompassing 1,866 patients. Seventeen studies reported survival to hospital discharge, with a cumulative survival rate of 534 of 1,529, and a range of 20.8% to 65.4%. Analyses encompassed 192 to 1,452 patients depending on the specific complication analyzed. The pooled estimate rates of complications with 95% confidence intervals were as follows: lower extremity ischemia, 16.9% (12.5% to 22.6%); fasciotomy or compartment syndrome, 10.3% (7.3% to 14.5%); lower extremity amputation, 4.7% (2.3% to 9.3%); stroke, 5.9% (4.2% to 8.3%); neurologic complications, 13.3% (9.9% to 17.7%); acute kidney injury, 55.6% (35.5% to 74.0%); renal replacement therapy, 46.0% (36.7% to 55.5%); major or significant bleeding, 40.8% (26.8% to 56.6%); rethoracotomy for bleeding or tamponade in postcardiotomy patients, 41.9% (24.3% to 61.8%); and significant infection, 30.4% (19.5% to 44.0%).

Conclusions. Although ECMO can improve survival of patients with advanced heart disease, there is significant associated morbidity with performance of this intervention. These findings should be incorporated in the risk-benefit analysis when initiation of ECMO for cardiogenic shock is being considered.

(Ann Thorac Surg 2014;97:610–6)



Total: 9096 cases
(2012 – 2017)

International Summary - July, 2017

ECLS Registry Report

International Summary

July, 2017

Extracorporeal Life Support Organization
2800 Plymouth Road
Building 300, Room 303
Ann Arbor, MI 48109

Adult Cardiac Runs by Diagnosis from 2012

	Total Runs	Avg Run Time	Longest Run Time	Survived	% Survived
Congenital Defect	257	141	928	99	38%
Cardiac Arrest	389	112	772	128	32%
Cardiogenic Shock	2,486	158	3,306	1,066	42%
Cardiomyopathy	416	169	1,345	215	51%
Myocarditis	147	207	1,370	88	59%
Other	5,401	150	3,066	2,305	42%

Note some runs are missing primary diagnosis

Adult Cardiac Complications from 2012

	No Reported	% Reported	Survived	% Survived
Mechanical: Oxygenator failure	330	3%	121	37%
Mechanical: Raceway rupture	2	0%	2	100%
Mechanical: Other tubing rupture	8	0%	1	13%
Mechanical: Pump malfunction	67	1%	21	31%
Mechanical: Heat exchanger malfunction	6	0%	5	83%
Mechanical: Clots: oxygenator	726	7%	302	42%
Mechanical: Clots: bridge	26	0%	13	50%
Mechanical: Clots: bladder	10	0%	6	60%
Mechanical: Clots: hemofilter	72	1%	14	19%
Mechanical: Clots: other	512	5%	220	43%
Mechanical: Air in circuit	110	1%	32	29%
Mechanical: Cracks in pigtail connectors	35	0%	11	31%
Mechanical: Cannula problems	369	4%	129	35%
Hemorrhagic: GI hemorrhage	447	5%	105	23%
Hemorrhagic: Cannulation site bleeding	1,632	16%	625	38%
Hemorrhagic: Surgical site bleeding	1,687	17%	539	32%
Hemorrhagic: Hemolysis (hgb > 50 mg/dl)	455	5%	142	31%

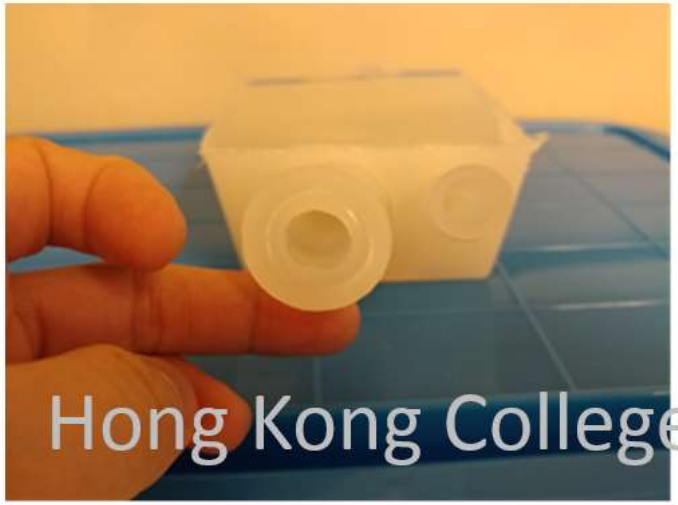
Problem in Hands

- Products in the market are expensive
- Not designed for ECMO cannulation training
- Lack of flexibility – cannot be modified to fit different training needs or different level of trainees

Methods

- An ECMO cannulation simulator system to facilitate cannulation practice and competency assessment for ECMO physicians
- Focusing on: Maneuverability, upgradability, replicability, affordability

- Silicone cannulation model which allows integration of different components to simulate different clinical problems that may encountered in cannulation



Results / Evaluation

- Over 200 physicians were trained worldwide (Hong Kong, Qatar, Japan, Singapore, Netherlands, Chile and Australia) with this system
- Mean product evaluation rating 4.53 ± 0.60 in a 5-point scale (high rate implied high realism)
- INCREASED perceived confidence level 4.3 ± 2.4 in a 10-point scale before workshop to 7.1 ± 2.1 after workshop ($p<0.01$)
- INCREASED perceived competency score 4.6 ± 2.9 in a 10-point scale before workshop to 6.8 ± 2.3 after workshop ($p<0.01$)

Modelling and Simulation for Service Improvement

Our Experience in Supermarket

- Hire more employee?
- Change work schedule?
- Add more checkout systems?

Use of Simulation in High Risk Industries

- Airline – Fleet maintenance / Replacing parts
- Maritime – Ship collisions / Routing
- Prison Population – Forecasting the no. of cells

So why not used in healthcare for system improvement?

Modelling and Simulation

- A real system is modelled to understand its behaviour
- Simulation is to test a model with different scenarios
- To understand the interdependency between human-oriented and infrastructure-oriented variables in complex systems
- Results gained provides explanation of behaviours and evaluation of strategies

Dong et al. Annals of Intensive Care 2012, 2:18

Almagooshi S. Procedia Manufacturing. 2015, 3:301.

- **Discrete event simulation**
- **Agent-based simulation**
- System dynamics
- Monte Carlo simulation
- Marko simulation

Discrete Event Simulation (DES)

- Provides a platform to perform experiments via computer modeling and test the likely effectiveness of different solutions before their implementation
- Support clinical decision making, facility planning, resource allocation, treatment evaluation, organizational redesign and information system usability tests

Agent-Based Simulation (ABS)

- Is a stochastic simulation in which the local interactions of collections of individual decision-making entities (agents), following simple rules, result in complicated and often non-obvious patterns at the aggregate level

How can Simulation Help to Improve Patient Safety?

- Manage complex problem
- Plan and validate
- Test different scenarios over time
- Efficiency and productivity experimentation at no risk to the patients
- Allow cost and resource utilization analysis

MSA! ARTICLES

Side Tracks on the Safety Express. Interruptions Lead to Errors and Unfinished... Wait, What Was I Doing?

November 29, 2012

The impact of multi-tasking and interruptions is out there!

Problem: If you're a health professional, it's hard to get through a single hour of the day without being distracted or interrupted, even when performing critical tasks. For instance, nurses administering medications and pharmacists and technicians dispensing medications are distracted and interrupted as often as **once every 2 minutes**![1-2] Physicians are interrupted, too—about once every 5 minutes in an academic emergency department (ED) setting and once every 10 minutes in a community ED setting.[3] Multi-tasking is expected from those being interrupted, and constant distractions and interruptions are generally accepted as the norm in healthcare. However, the argument that distractions and interruptions contribute to medication errors is persuasive in the literature. To cite one study, the risk of any medication error increases 12.7% with each interruption, and the risk of a harmful medication error is doubled when nurses are interrupted 4 times during a single drug administration and tripled when interrupted 6 times.[4] Thus, distractions and

BMJ Qual Saf. 2014 Nov;23(11):884-92.

OPEN ACCESS

Mitigating errors caused by interruptions during medication verification and administration: interventions in a simulated ambulatory chemotherapy setting

Varuna Prakash,[1,2] Christine Koczmara,[3] Pamela Savage,[4] Katherine Trip,[5] Janice Stewart,[6] Tara McCurdie,[2] Joseph A Cafazzo,[1,2] Patricia Trbovich[1,7]

BMJ Qual Saf. 2014 May;23(5):414-21.

SYSTEMATIC REVIEW

OPEN ACCESS

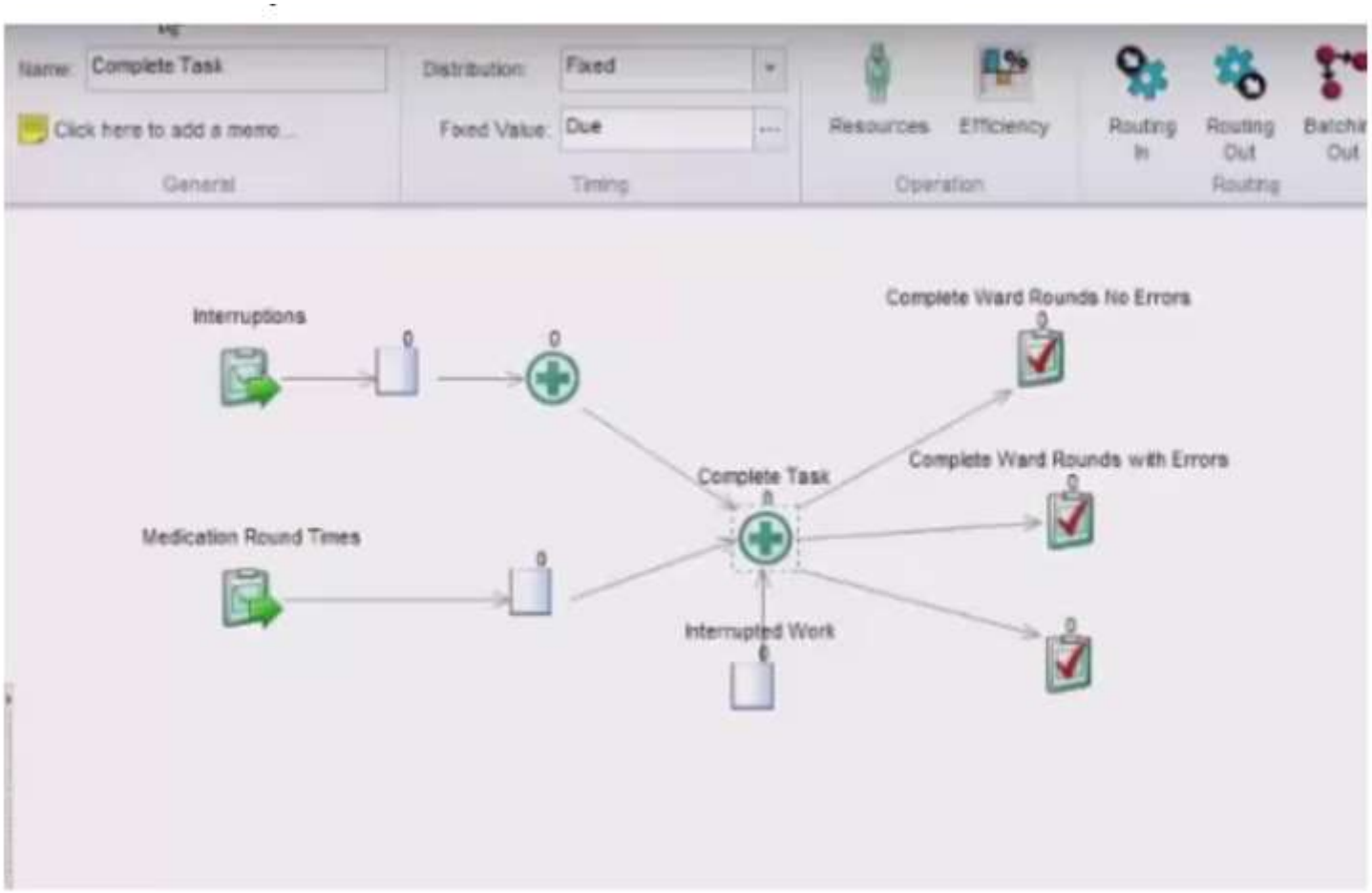
Are interventions to reduce interruptions and errors during medication administration effective?: a systematic review

Table 2 Effect of interventions on proportion of medication doses administered with error reported by studies using direct observation methods*

First author (year)	Interventions	Pre-intervention % of doses with error	Post-intervention Measurement timing†	Post-intervention % of doses with error	Statistical significance
Kliger (2012)[34]	Various‡	16.6	Immediately post	3.6	p<0.01
			12 months	2.0	p<0.01
Nguyen (2010)[36]	Signs, diversion strategies	2.0	6 months	0	–
			12 months	0	–
Kliger (2009)[33]	Various‡	14.6	6 months	8.2	p<0.05
			18 months	4.2	p<0.05

*All three studies were related to the same project, the 'Integrated Nurse Leadership Program'.
†Post-intervention measurement timing refers to how long after intervention implementation measurement occurred.
‡Multiple interventions were designed and implemented (only some of which targeted interruptions) on each ward individually and were not reported in detail in the publications.

Simulating the Impact of Interruptions in Medication Errors

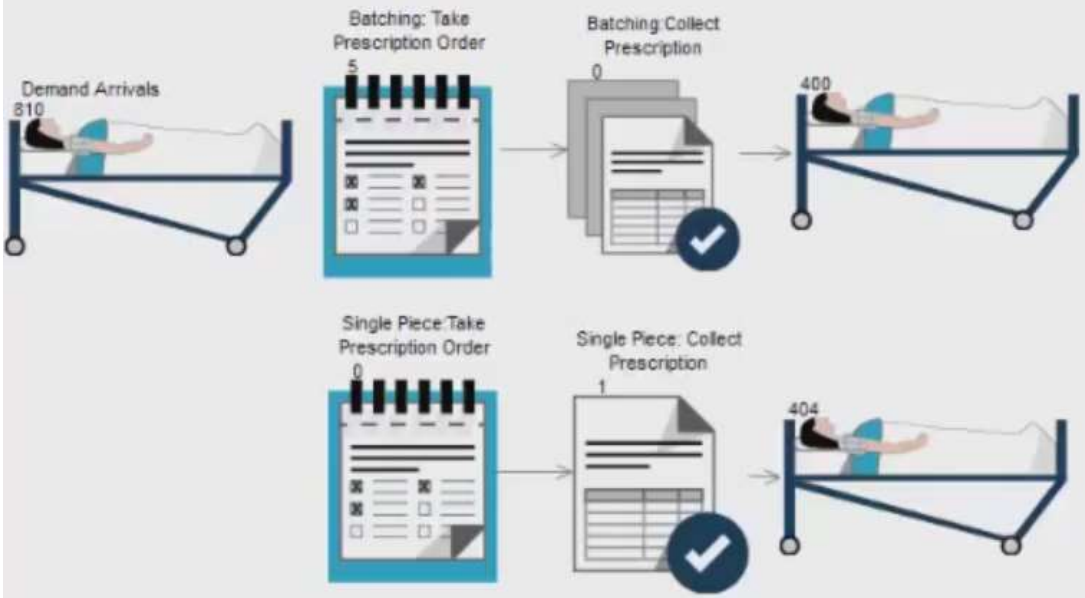


Workflow Verification

- Batching or Single Piece Flow?

This example looks at a hospital pharmacy. There are many orders placed on a daily basis, all of which need to be filled quickly and efficiently. Often, these orders are processed in batches (i.e. a pharmacy tech fills all of the Aspirin orders at the same time).

This simulation examines the impact of reducing and/or eliminating this batching of orders, so that whenever a clinician orders a medication, the prescription is filled immediately. It demonstrates that reducing/eliminating the batch size reduces the amount of time that a patient has to wait for treatment without impacting the number of orders that can be processed.



1. Click the Run button to start the simulation

The top process line collects prescription orders in batches of 5. The bottom process line collects only one prescription order at a time.

Run

2. Examine the results in the table below

Throughput is not affected at all but average time in system and average units in system are dramatically decreased by only taking one order at a time.

Results		
	Batch 6	Single Piece Flow
Throughput	400	404
Av.Units in system	5	1
Av. Time in System	134	29

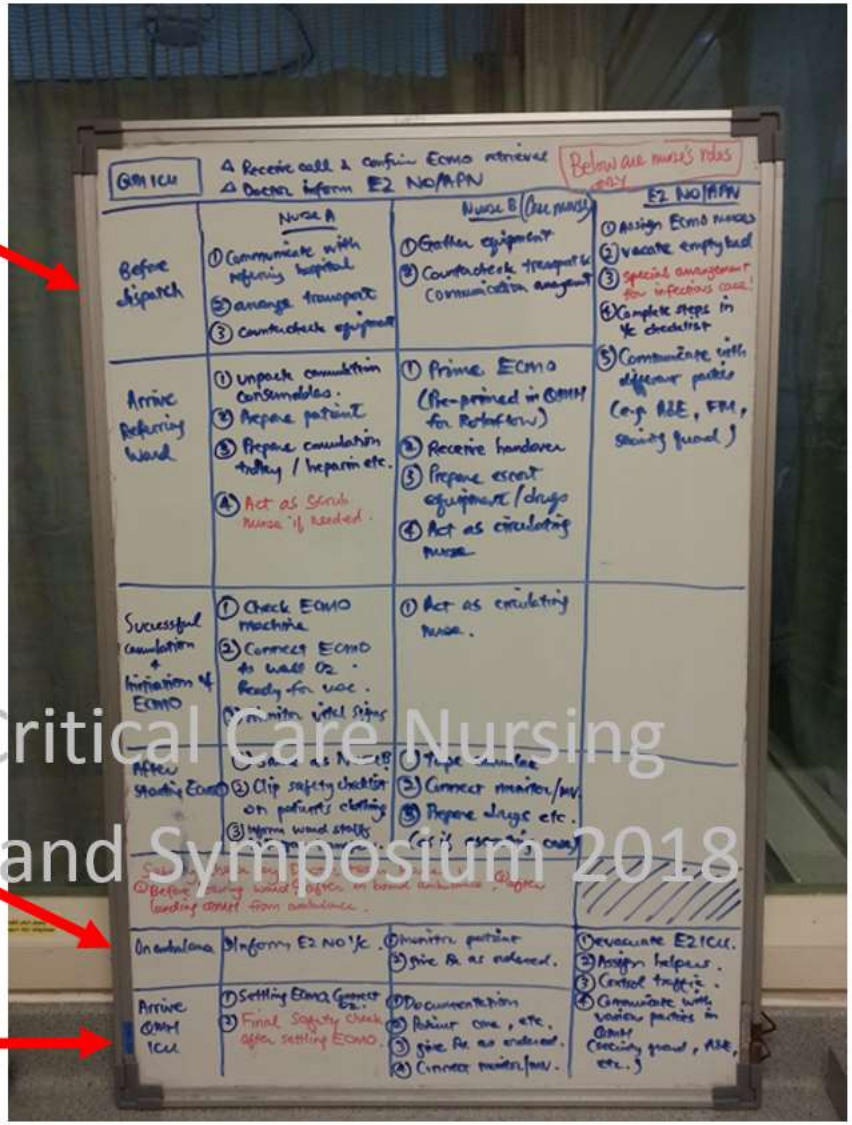
3. Experiment

Use the settings button below to experiment with different batch sizes, inter arrival rates and process timings. Then re - run the simulation in points 1 and 2 to see the impact. Use the RESET button when you want to clear the results and try another experiment.

Settings

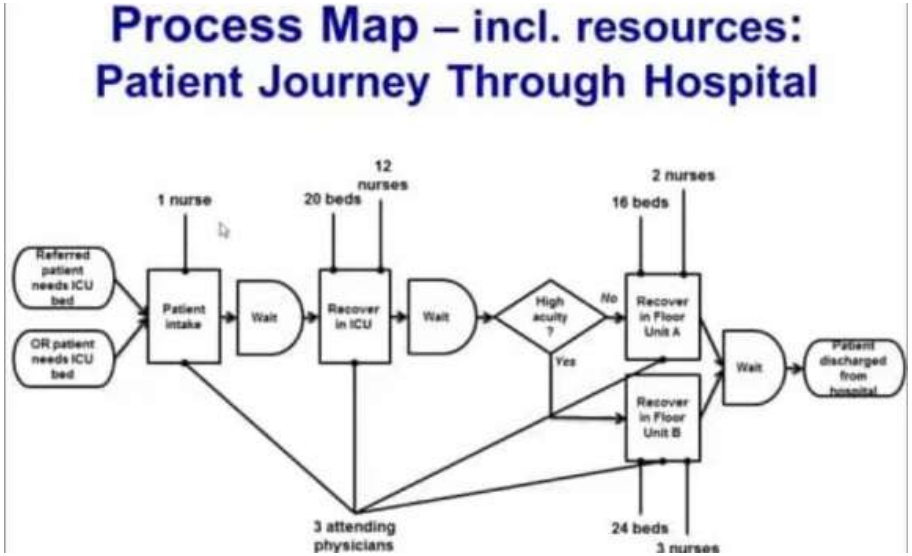
Reset

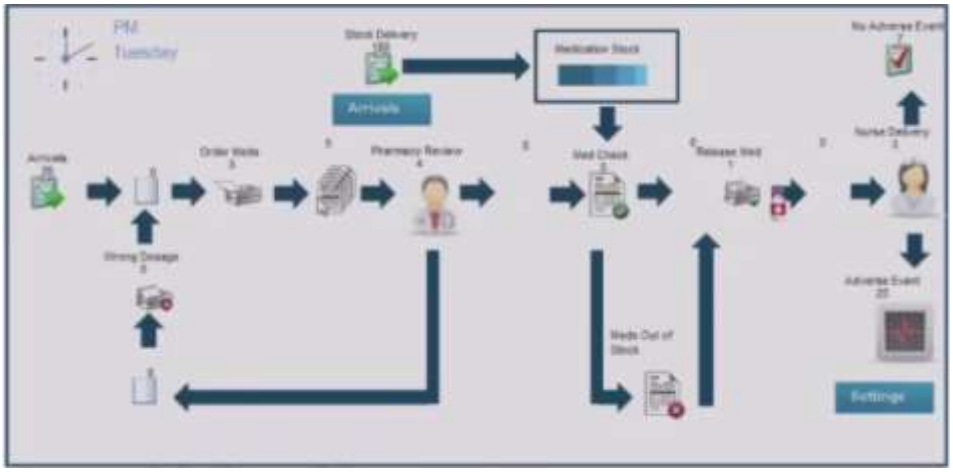
Can you find a combination that improves on single piece flow?



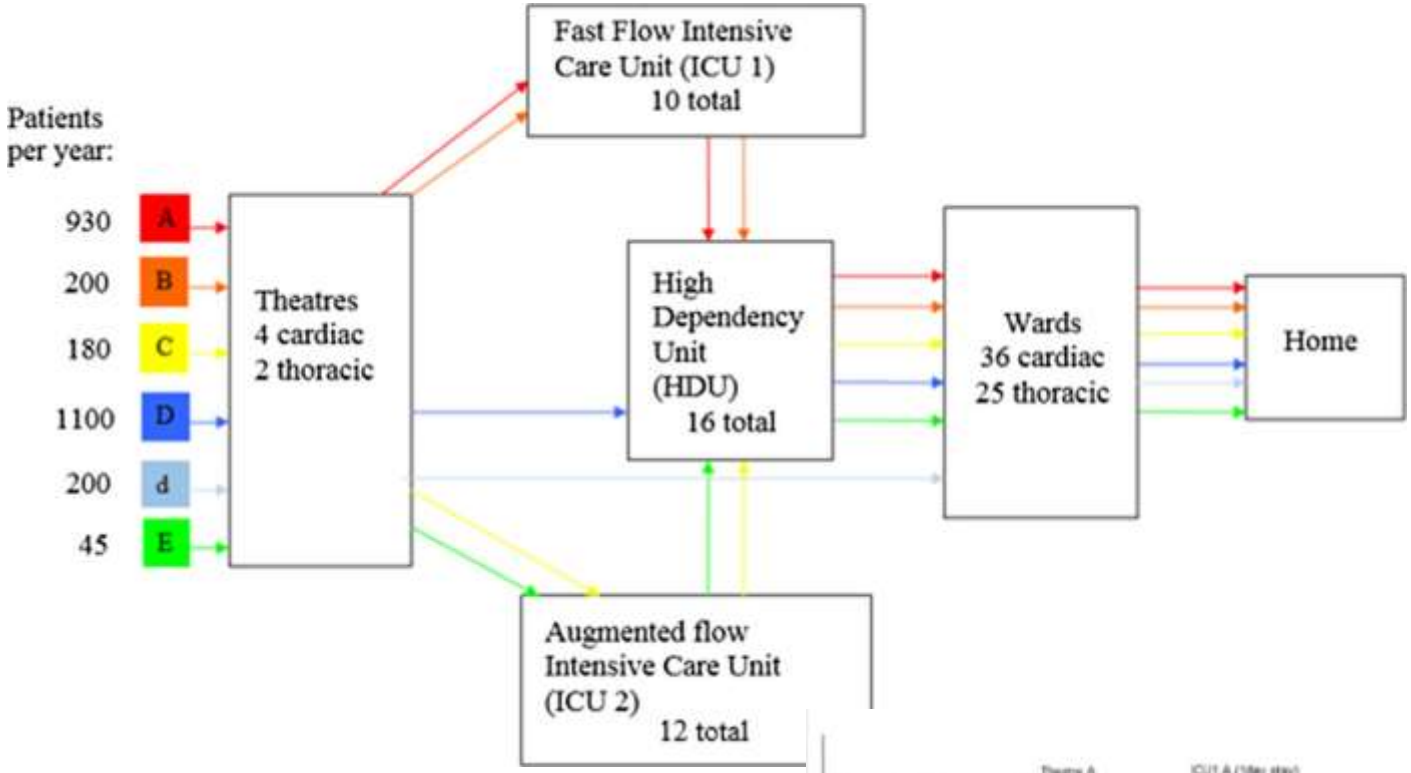
System Modelling

- Simulating a process in a virtual environment
- From Process Map to Dynamic Process Flow

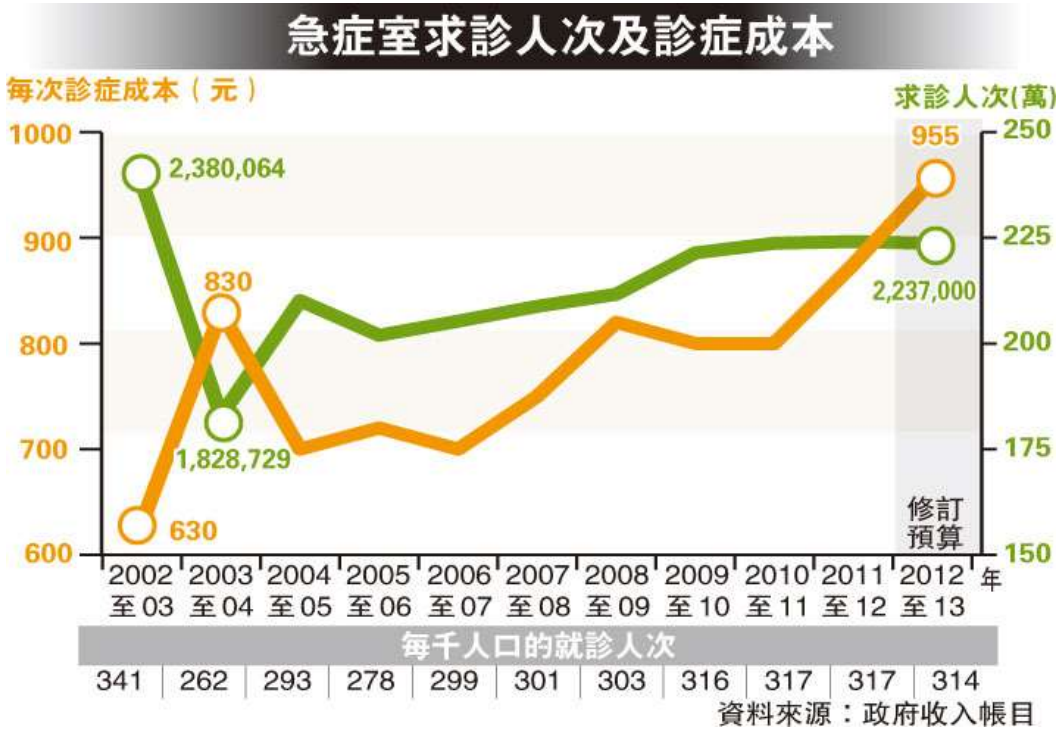




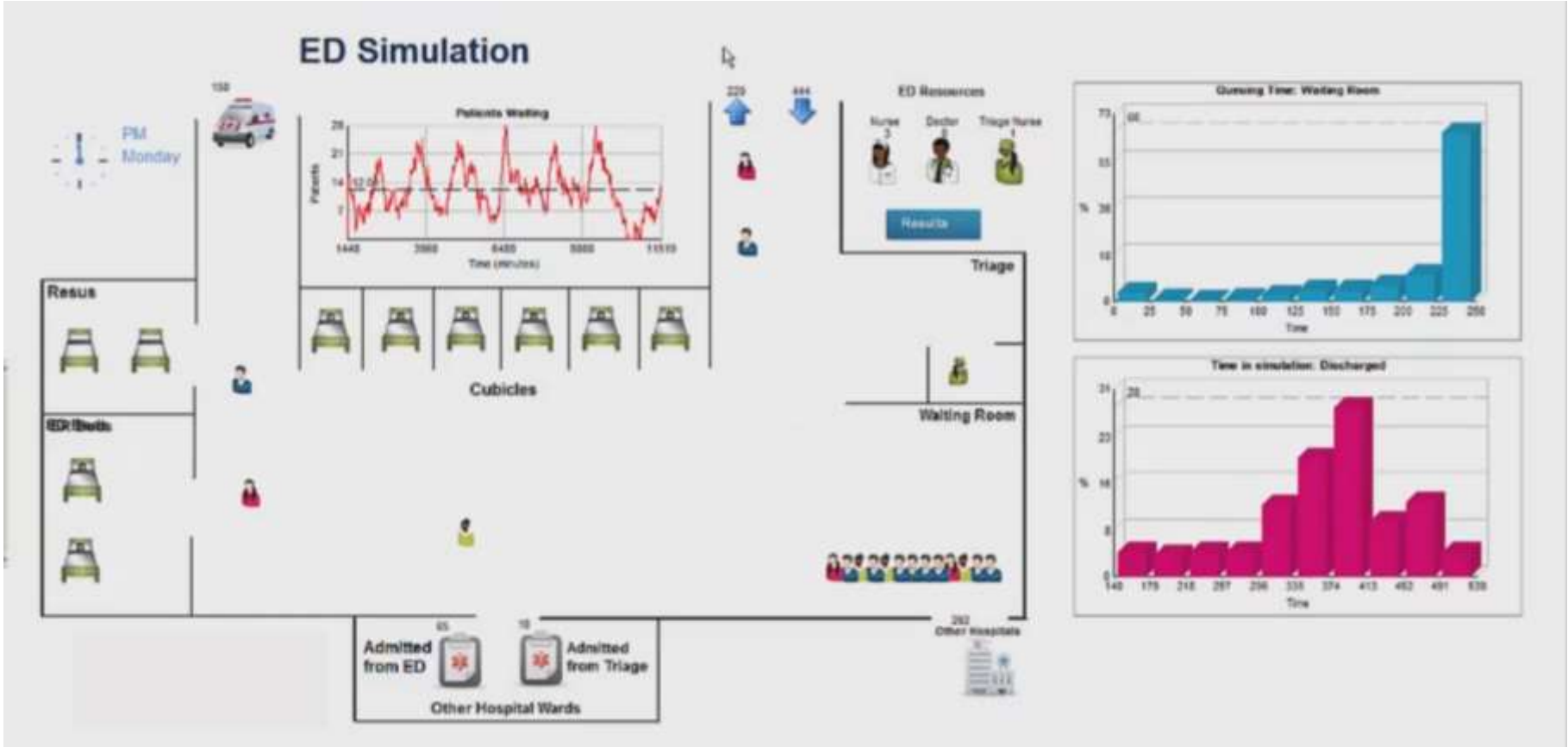
Source: http://clinicalmicrosystem.org/knowledge-center/videos/


Fast Flow Intensive Care Unit (ICU 1) 10 total
Patients per year:
930
200
180
1100
200
45
A
B
C
D
d
E
Theatres 4 cardiac 2 thoracic
High Dependency Unit (HDU) 16 total
Wards 36 cardiac 25 thoracic
Home
Augmented flow Intensive Care Unit (ICU 2) 12 total

Our Patients' Experience in Hospital



Enhancing ED Patient Flow through Simulation



Take Home Message

- The use of simulation is ever expanding
- Establishing links between simulation and patient care service is important
- Investment is ‘painful’ but can be rewarding

Thank you for your time