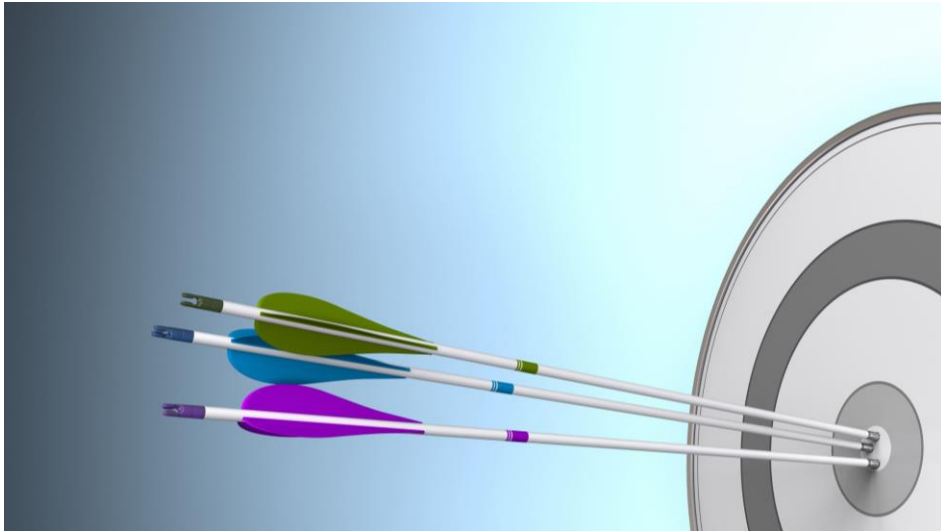


Human Factors in Critical Care: Embracing Vulnerability for High Performance



Scott Tilton

Objectives



- Discuss human factors engineering, its origins, and how it relates to healthcare
 - Understand the complexities of the healthcare setting and how the cognitive load we are exposed to can impact performance.
 - Detail how we utilized human factors engineering to improve the quality of care delivery at our institution
 - Empower you to look at your healthcare setting with a new and improved human factors lens
-



What is “Human Factors and Ergonomics”

- Evidence based discipline that studies the interaction between people and their work
- We work in complex environments and interact with a network of people, procedures, equipment
- We are imperfect, we are vulnerable, and that is ok.
- The overall goal of the human factors discipline is to make it impossible for the end user to do the wrong thing

Human Factors in Industry: Nuclear Power

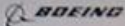


https://thealmanac.net/news/remembering-three-mile-island-the-nation-s-worst-commercial-nuclear-accident/article_f393687a-4f51-11e9-b45c-afd8eab8b9.html

Human Factors in Aviation



8.2

 **BOEING**
737 Flight Crew Operations Manual

**ENGINE FIRE
or
Engine Severe Damage or
Separation**

Condition: One or more of these occur:

- Engine fire warning
- Airframe vibrations with abnormal engine indications
- Engine separation.

- 1 Autothrottle (if engaged) Disengage
- 2 Thrust lever (affected engine) Confirm Close
- 3 Engine start lever (affected engine) Confirm CUTOFF
- 4 Engine fire switch (affected engine) Confirm Pull
To manually unlock the engine fire switch, press the override and pull.
- 5 **If** the engine fire switch or ENG OVERHEAT light is illuminated:
Engine fire switch (affected engine) Rotate to the stop and hold for 1 second

▼ Continued on next page ▼



Human Factors in Aviation: US Airways Flight 1549



“The Miracle on the Hudson”

Enabling the user to do the right thing? Past Design Flaws

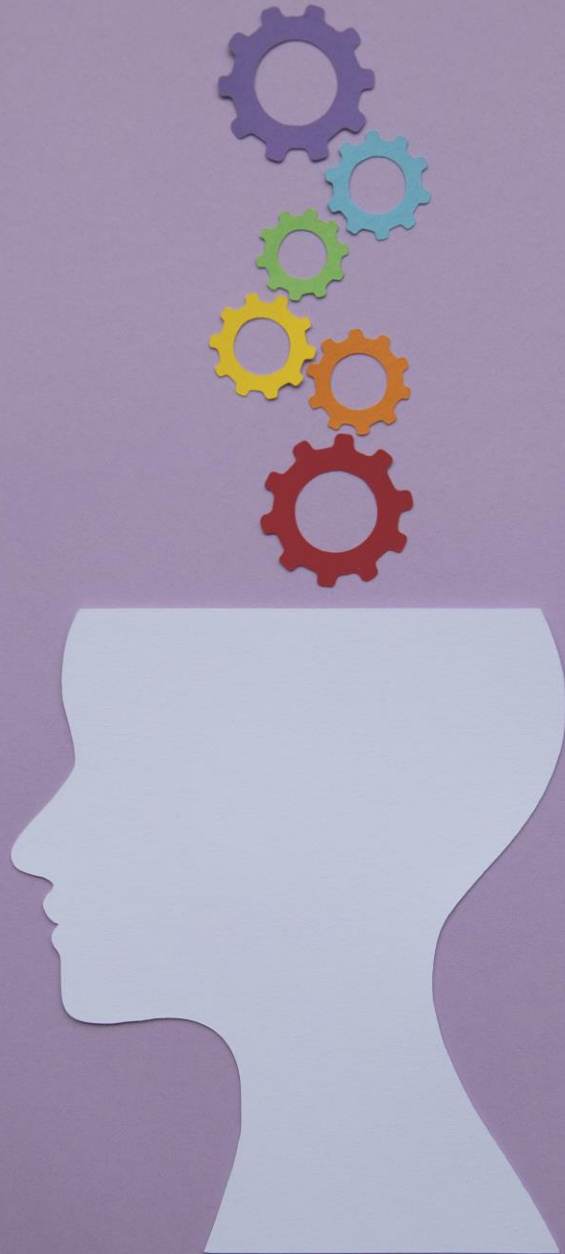


Enabling the user to do the right thing? Current Design Flaws



@katherinealee

Cognitive Psychology of Human Factors



Significant cognitive load on individuals, which predisposes them to error.

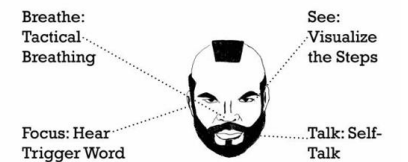
Appreciating George Miller's Law of Psychology "Rule of 7" (credit to Sydney HEMS)

Stress results
from a perceived
imbalance
between demands
of the situation and
your ability to meet
those demands



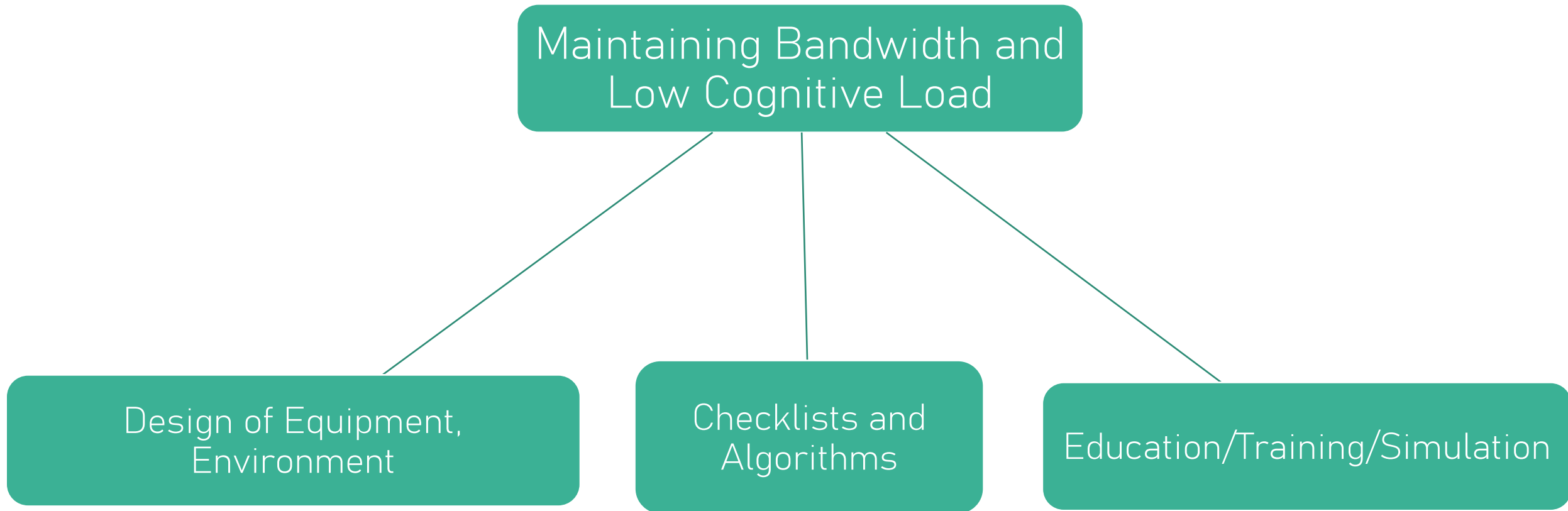
Michael Lauria
@ResusPadawan

**Beat the
Stress
Fool!**



- B** - Breathe
- T** - Talk (Self)
- S** - See (Mental Rehearsal)
- F** - Focus with Trigger Word

What does the field of human factors have to do with cognitive load?





Human Factors in Healthcare?

We are also exposed to significant stressors during critical moments

Our work is also complicated and can be influenced by numerous variables

The level of training and performance we strive for can affect our team and our patients

Healthcare today...

We are asked to take on more responsibilities to respond to system inadequacy

Regulations and requirements from c-suite do not align with patient care or your work-flow

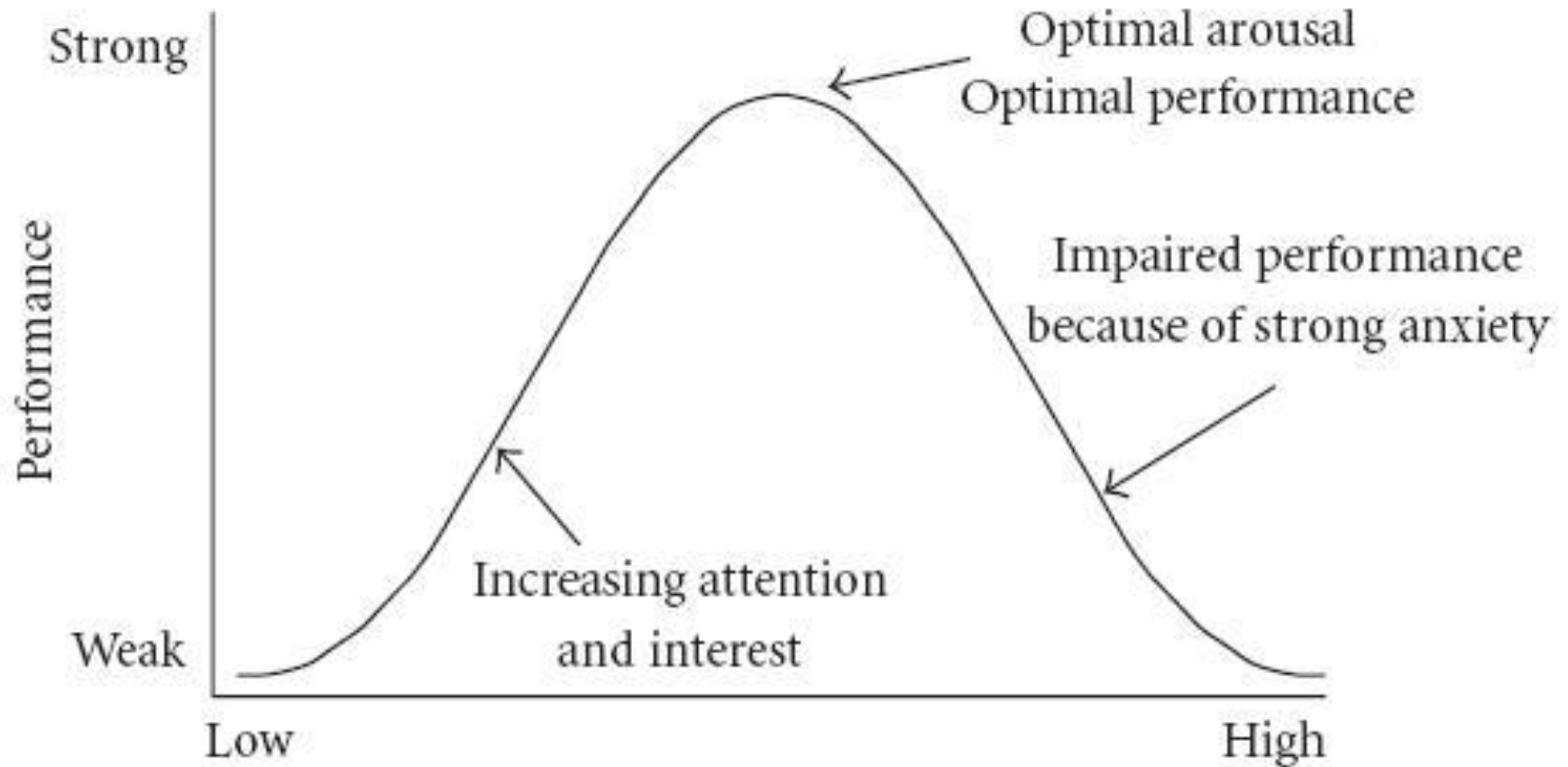
Excess cognitive load and ultimately burnout

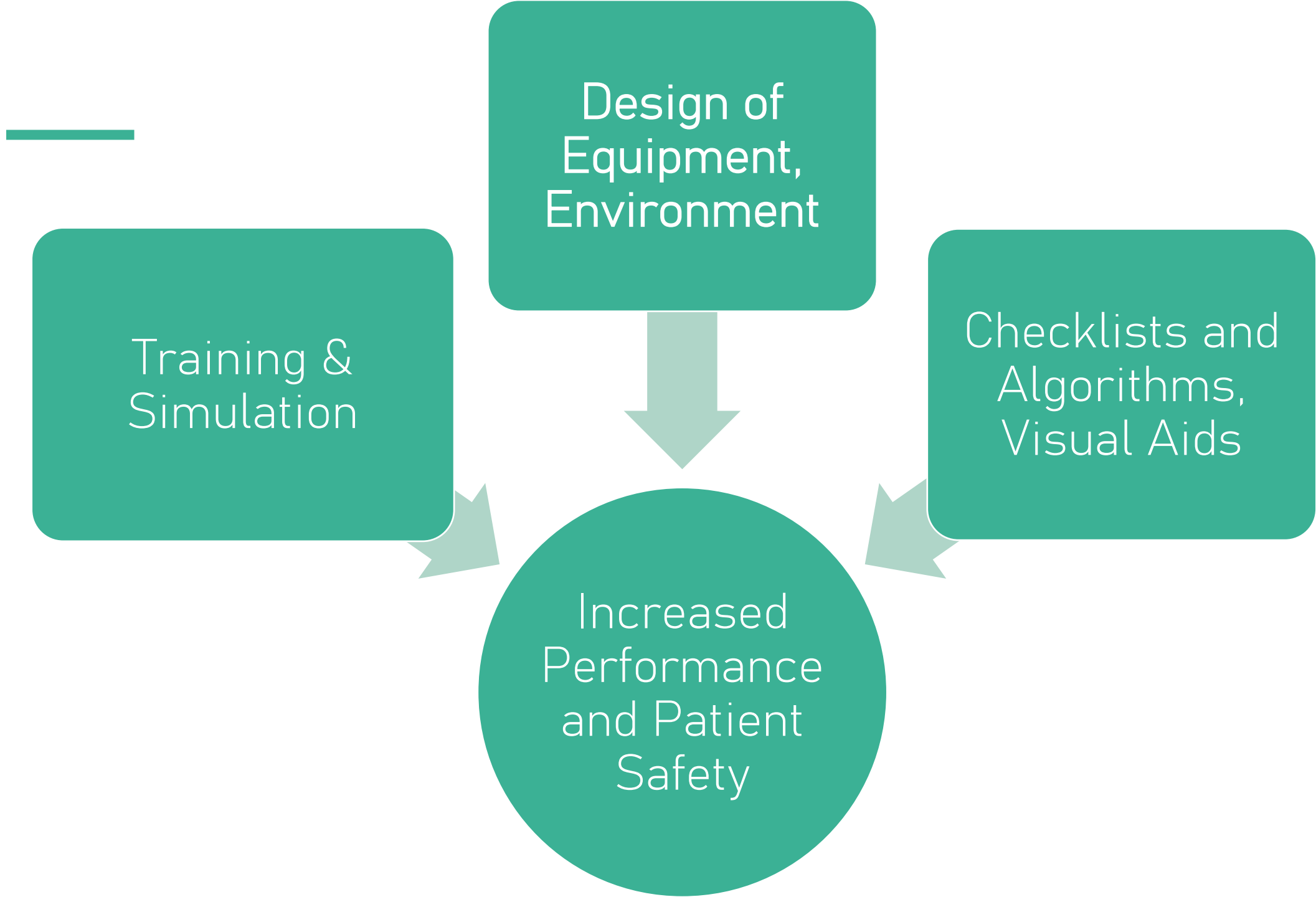
More and more experienced practitioners are leaving their settings due to chronic excess cognitive load

To Err is human?

<h2>Safety 1</h2> <p>Clinician as a Hazard</p> <p>Reactive</p>	<h2>Safety 2</h2> <p>Clinician wellbeing is solution to problem</p> <p>Proactive</p>
<ul style="list-style-type: none">• Study how things go wrong• Safety and quality is defined by absence of events• Applicable in some industries, where you can pinpoint specific cause• Reactive in nature (RCA or root cause analysis)• Blame and re-train	<ul style="list-style-type: none">• Agency for Healthcare Research and quality (AHRQ) favors• Study how things go right• Clinician wellbeing=patient safety• Human factors/ergonomics promotes clinician wellbeing through decreased stress and increasing patient safety.

MED - SURG ICU





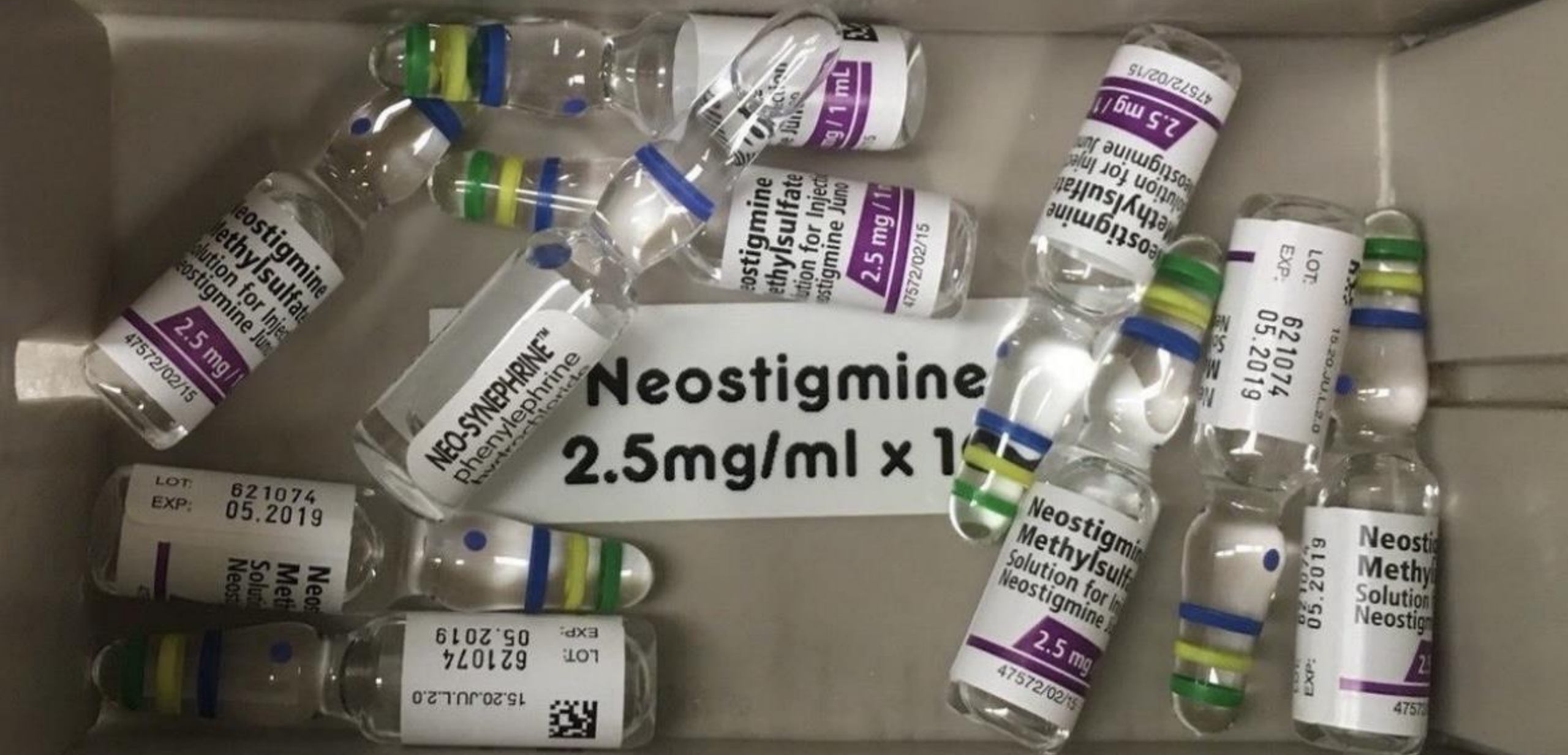
Design of
Equipment,
Environment

Training &
Simulation

Checklists and
Algorithms,
Visual Aids

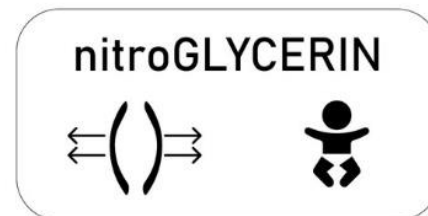
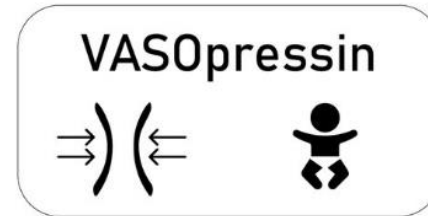
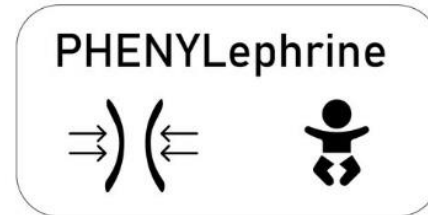
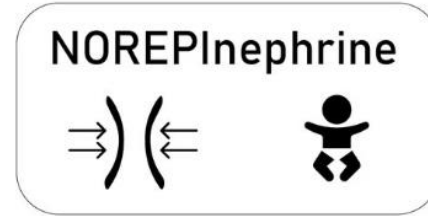
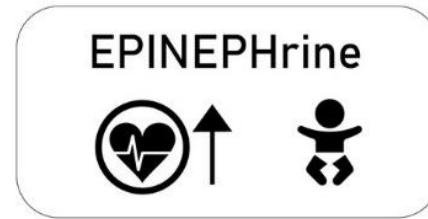
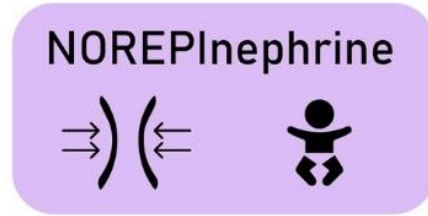
Increased
Performance
and Patient
Safety

Bad Design? @DrGetafix



Bad Design? @DrGetafix





@KenCatchpole

Lusk, C., Catchpole, K., Neyens, D. M., Goel, S., Graham, R., Elrod, N., Paintlia, A., Alfred, M., Joseph, A., Jaruzel, C., Tobin, C., Heinke, T., & Abernathy, J. H., 3rd (2022). Improving safety in the operating room: Medication icon labels increase visibility and discrimination. *Applied ergonomics*, 104, 103831. <https://doi.org/10.1016/j.apergo.2022.103831>

Bad Design?



Human Factors Design



<http://vortexapproach.org/airwaycart>

Checklists

HYPOXIA Unexplained Acute Oxygen Desaturation

Alert Team: "The patient has desaturated. Can you help me troubleshoot?"

IMMEDIATE ACTION O2 to 100% Confirm supply working

RAPID SCAN Patient  Monitor  Ventilator 

- CHECK**
- 1 PATIENT** Chest Rising? Palpable Pulse
 - 2 MONITOR** ETCO2? Vitals? Alarms? SaO2 Probe off?
 - 3 VENTILATOR** Cycling? Alarms? (Read-out)
 - 4 TRACHEAL TUBE** ? Displaced - Bronchial/Pharyngeal
? Pilot balloon inflated

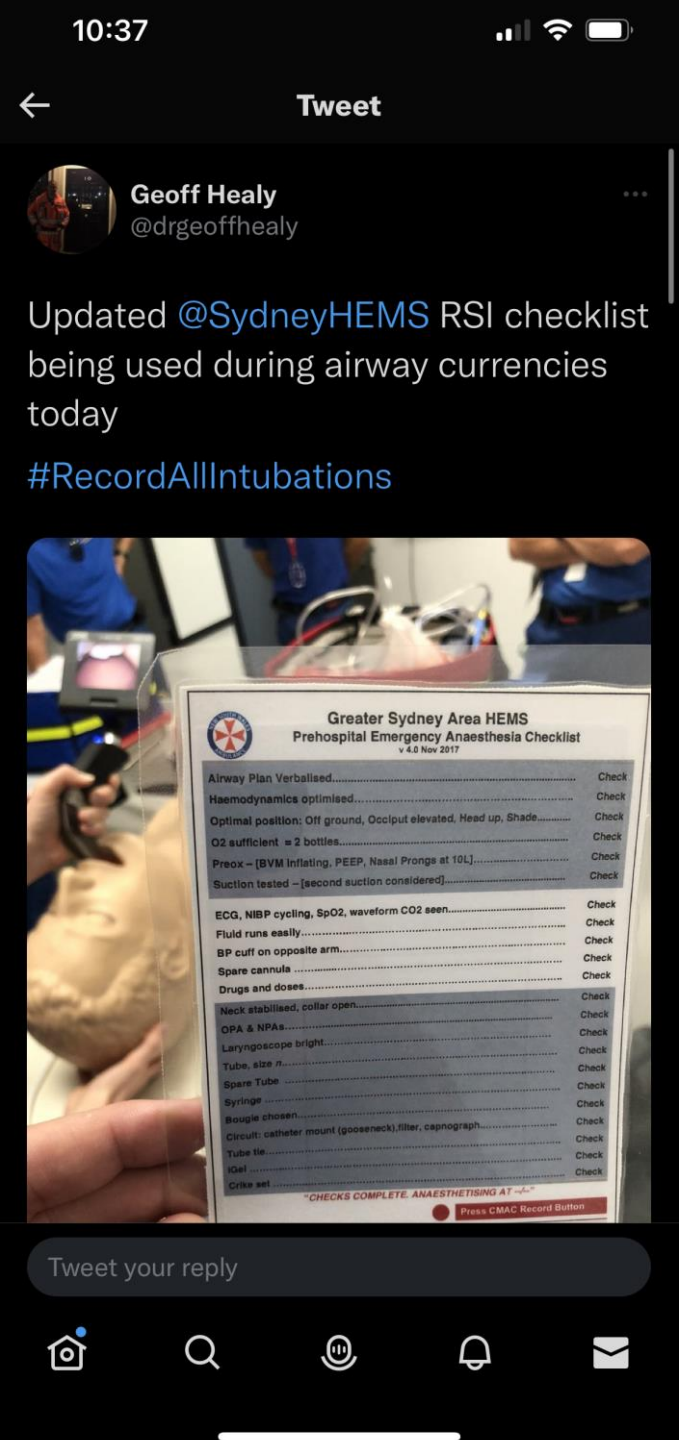
DO

HAND VENTILATE WITH BVM
 15L O2 BVM + PEEP Valve
 Remove HME Filter & gooseneck connections if no chest rise
 Pass suction catheter beyond tube tip and suction

- THINK**
- 1 ? PNEUMOTHORAX**
Clinical or US features?
 - 2 ? BRONCHOSPASM**
Carinal irritation - pull back tube
Allergic/Medication related
 - 3 ? MUCOUS PLUGGING**
Suction tube +/- saline lavage
 - 4 ? VENTILATOR/PATIENT DYS-SYNCHRONY?**
Administer paralytic +/- sedation
 - 5 ? OUTSIDE OF CHEST**
Gastric Distension?- OG/NG tube
Chest straps too tight?
 - 6 ? VENTILATOR SETTINGS + CIRCUIT**
AutoFlow? Settings? (e.g. Bariatric needs High PAW)
 ▲ PEEP / Recruitment needed for ARDS etc
 Other Mx of ARDS (Positioning/▲ I:E ratio etc)
 Consider trial of ▼ PEEP (? unilateral lung Dx/Pulm HT etc)
 Change to disposable circuit (? valve issues)

7 ? CALL DUTY RETRIEVAL CONSULTANT
 For further advice: 02 9709 6856

<https://sydneyhems.com/>



Tweet your reply



**You Don't RISE to
the Occasion
You fall to your
HIGHEST level of
PREPARATION**



A Case for Human Factors:

2020

Cross covering units with overflow

The volume of ECMO patients has increased and you are running out of machines

Two APPs on shift, it is 0500hrs



The nurse calls you to the bedside of a 55 y/o female on VV ECMO for ARDS

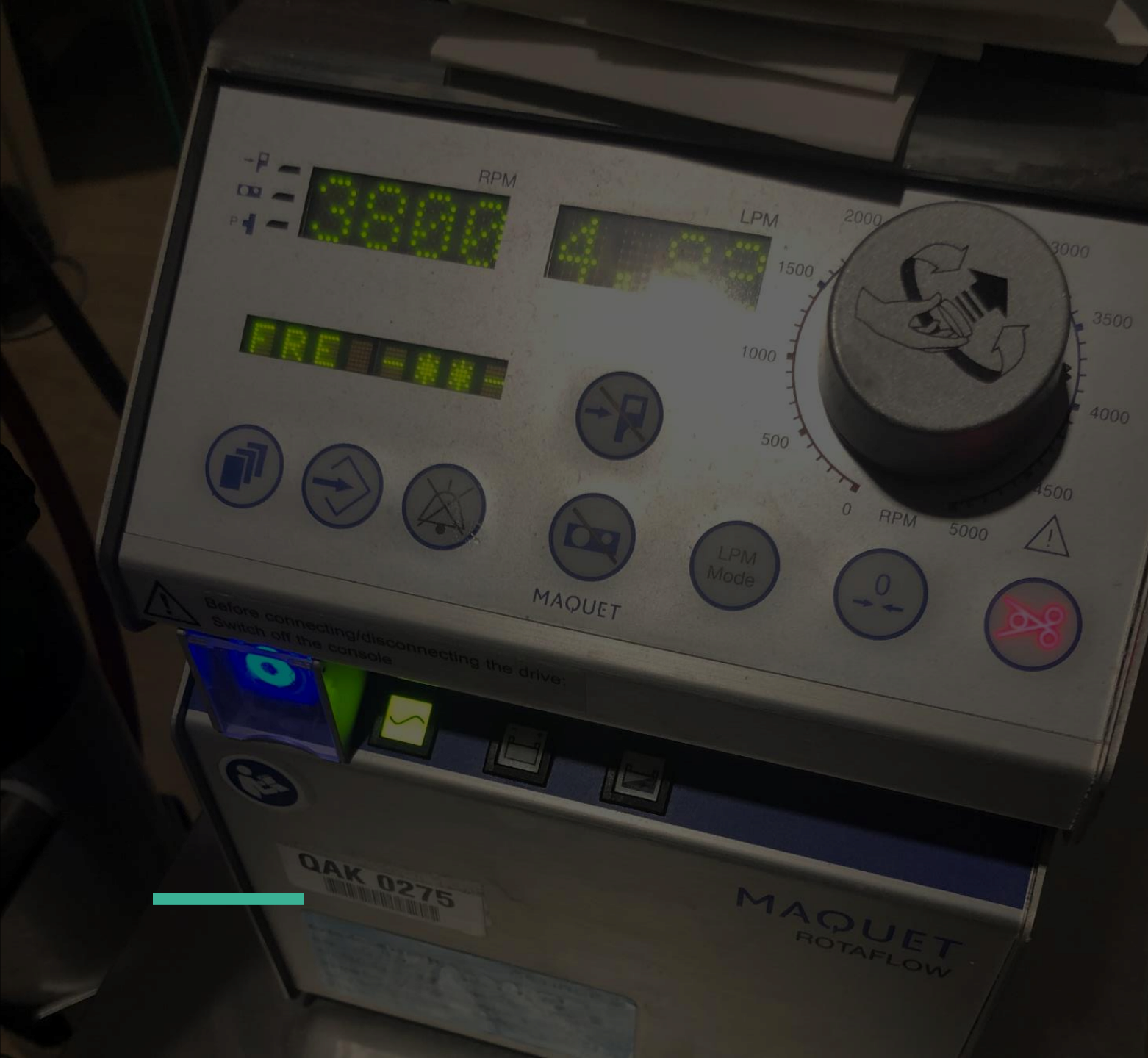
She reports acute hypotension and hypoxia with dropping ECMO flows.

ECMO and Potential Catastrophes

Oxygenator Failure

Pump Thrombosis

Cannula Dislodgement



Which complication is this?



ECMO Cart



1: Time of day

2: Environment

3: Novice staff

4: COVID era

5: Equipment barrier

6: Run resus

7: Logistics





Human Factors Design



NOTES:

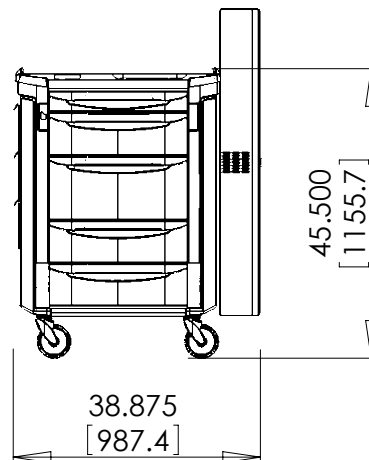
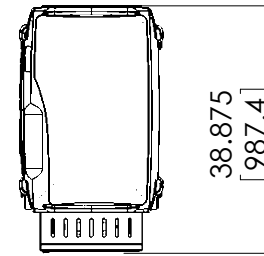
- DIMENSIONS ROUNDED TO THE NEAREST 0.1" (3 mm).
- Drawer Pulls to be Violet.

Signed Drawing Is Required To Process Order

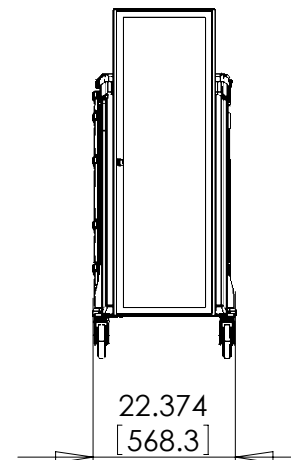
Customer Approval

Date

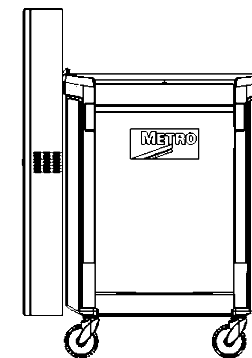
PLAN VIEW



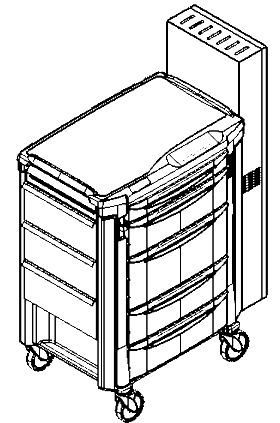
FRONT VIEW



RIGHT SIDE VIEW



REAR VIEW



ISOMETRIC VIEW (W/O BACKBOARD)



RENDERED ISOMETRIC VIEW

Human Factors Design


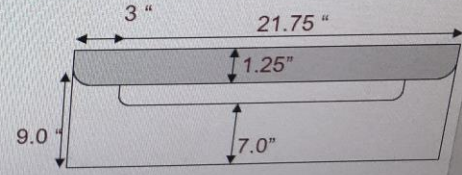
Show Review View Help Open in Desktop App Tell me what you want to do Editing Copy Link

A⁺ A⁻ B I U [Color] [Text] [List] [Align] [Indent] [Outdent] [Decrease] [Increase] [Shapes] [Image] [Table] [Text Box] [Text Box]

Drawer 6

Click to add text

Circuit Exchange Supplies		
Drawer 6 (9")	2	Large Blue Basin (14" x 14" x 5")
	2	Sterile ECMO Tray
	2	Bulb Syringe
	4	500mL IV Saline Bag
	2	Bag Decanter
	6	3/8" x 3/8" Connectors
	15-20	Tie Bands & Gun


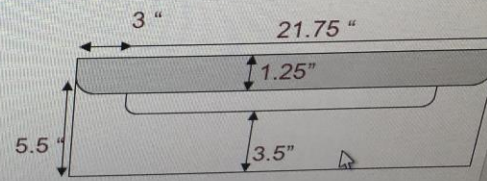
Show Review View Help Open in Desktop App Tell me what you want to do Editing Copy Link

A⁺ A⁻ B I U [Color] [Text] [List] [Align] [Indent] [Outdent] [Decrease] [Increase] [Shapes] [Image] [Table] [Text Box] [Text Box]

Drawer 2

Click to add text

Field Prep Supplies		
Drawer 2 (6")	2	3/4 Sterile Drape
	4	Towel Packs
	2	4x4 Gauze Pack
	2	Betadine Bottle
	3	Sterile Gown

3A Initiation and Circuit Exchange Supplies

RECESSED

Contents:

Large Blue Basins

Sterile ECMO Trays

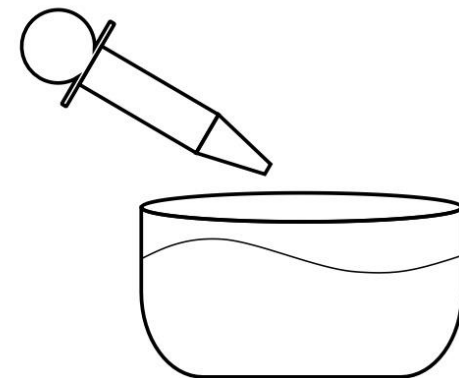
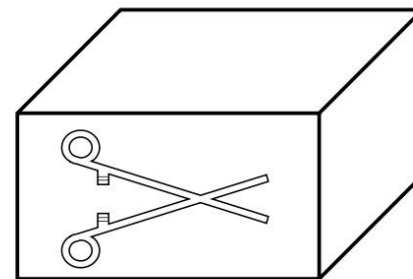
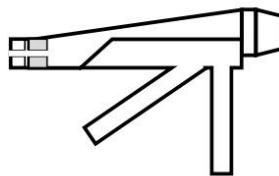
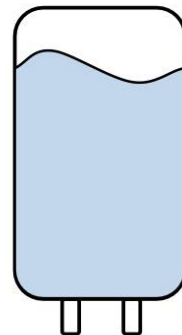
Bulb Syringes

500mL IV Saline Bags

Bag Decanter

3/8" Straight Tubing Connectors

Tie Bands & Gun



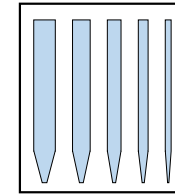
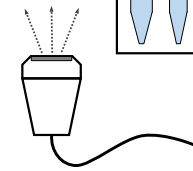
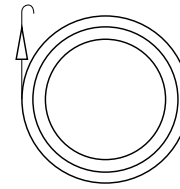
DRAWER FACE

3B Access Kits & Wires/Dilators

Contents:

- Ultrasound Gel Packet
- Ultrasound Transducer Cover
- Central Line Kit
- Pik-A & Pik-V
- Micropuncture (S-Mak) Kits
- Sorin Dilator Kit
- Amplatz Stiff (80) Wire
- Amplatz Stiff (180)Wire

RECESSED



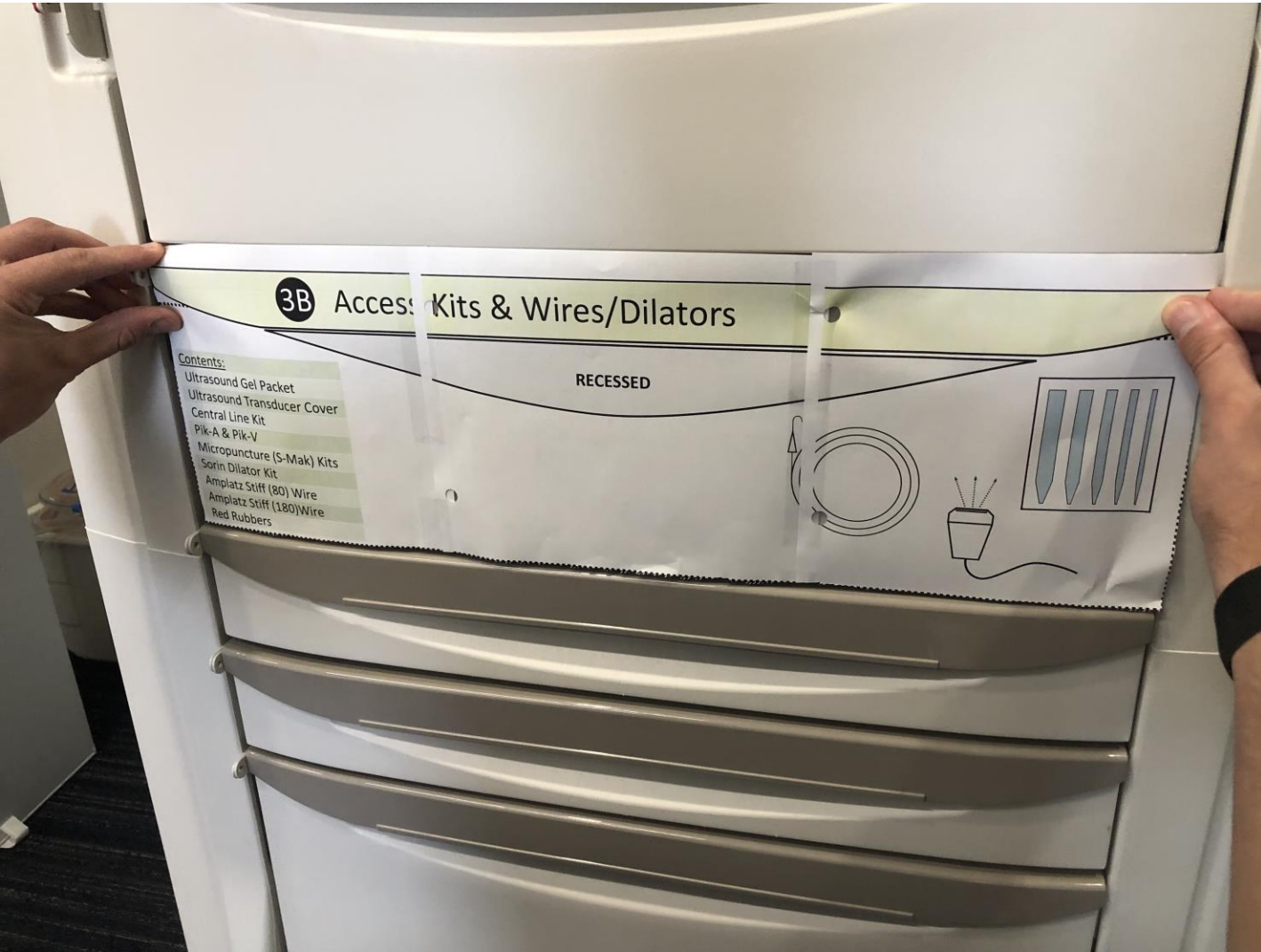
Drawer 3 B

Drawer 3B (6")

Access / Cannulation

- 2 Ultrasound Gel Packet
- 2 Ultrasound Transducer Cover
- 2 Central Line Kit
- 2 Pik-A
- 2 Pik-V
- 2 Micropuncture (S-Mak) Kits
- 2 Sorin Dilator Kit
- 3 Amplatz Stiff (80) Wire
- 3 Amplatz Stiff (180)Wire
- 2 Red Rubbers





Flexline
»» FOR EMERGENCY OR SPECIALIST USE ONLY ««

• Break Tag
• Move Lever
Along Path



E
C
M
O

E
C
M
O

1 First Stop — PPE



Contents:
White Gloves
Masks
Caps / Hats
Goggles
Blanket/Chux

2A Field Prep Supplies

Contents:

¾ Sterile Drapes
Towel Packs
4x4 Gauze Pack
Betadine Bottles
Sterile Gowns



3B Access Kits & Wires/Dilators

Contents:

Ultrasound Gel Packet
Ultrasound Transducer Cover
Central Line Kit
Pik-A & Pik-V
Micropuncture (S-Mak) Kits
Sorin Dilator Kit
Amplatz Stiff (80) Wire
Amplatz Stiff (180) Wire
Red Rubbers



4 Circuit Accessories & SFA Catheters

Contents:

3/8" - 6' Tubing Packs
Swivel Brackets
Y-connectors
8' Catheter Extension
M-M Luer Adapter



5 Return (Outflow/Arterial) Cannulas

Contents:

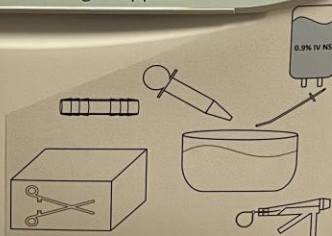
1.5, 1.7, 2.9 Fr Gauge MLL
3.6, 3.8, 2.6 Fr Edwards OptiSite
2.2 Fr Edwards Aorta (central)



3A Initiation and Circuit Exchange Supplies

Contents:

Large Blue Basins
Sterile ECMO Trays
Bulb Syringes
500mL IV Saline Bags
Bag Decanter
3/8" Straight Tubing Connectors
Tie Bands & Gun

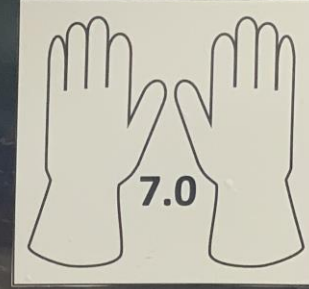
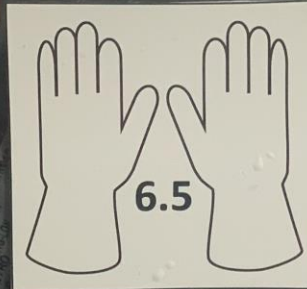


Contents:
25 Fr Biomedicus
22 Fr Edwards Qu
28 Fr Edwards Qu
28/37 Fr Edwards

2B Sterile Gloves

Contents:

Sterile Gloves (6.5)
Sterile Gloves (7.0)



2B Sterile Gloves

Contents:

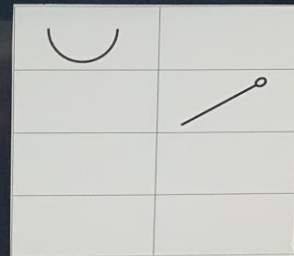
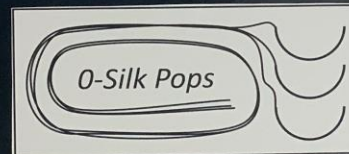
Sterile Gloves (7.5)
Sterile Gloves (8.0)



7 Site Securement

Contents:

0-Sof silk Sutures (GS-65-M)
Devon Pack (Needle Count Kit)



Checklists

EMERGENCY ACTION CARD

rev: 12 Mar 202

VV, VA - ECMO INITIATION

IMMEDIATE ACTION:

ALL-STOP... Time Out & Role Delineation

- 1) Primary/Covering APP (RESUSCITATION and Circuit SPECIALIST)
- 2) Charge RN
- 3) Free RN
- 4) APP PROCEDURALIST (1st assist)
- 5) MD CANNULATOR

Covering APP (Resuscitation & Circuit SPECIALIST)

- THINK** → Has PERFUSION, ICU ATTENDING, CARDIAC SURGERY +/- LUNG RESCUE been notified
- CHECK** → Ongoing resuscitation needs, has arterial and central access?
- DO** → Order BLOOD PRODUCTS, INOTROPES, +/- VASOPRESSORS
→ Prep NEW CIRCUIT---Handoff LINES to PROCEDURALIST--- Initiate SUPPORT

Charge RN

- DO** → Identify/assign ROLES, Call PERFUSION, CT ATTENDING/FELLOW +/- LUNG RESCUE, prep sterile table
- CHECK** → ECMO Cart and ECMO Circuit retrieved, table available, room is prepared
- THINK** → Is there enough staff to support initiation? OR staff needed (OR CHARGE # 215-662-.....)?

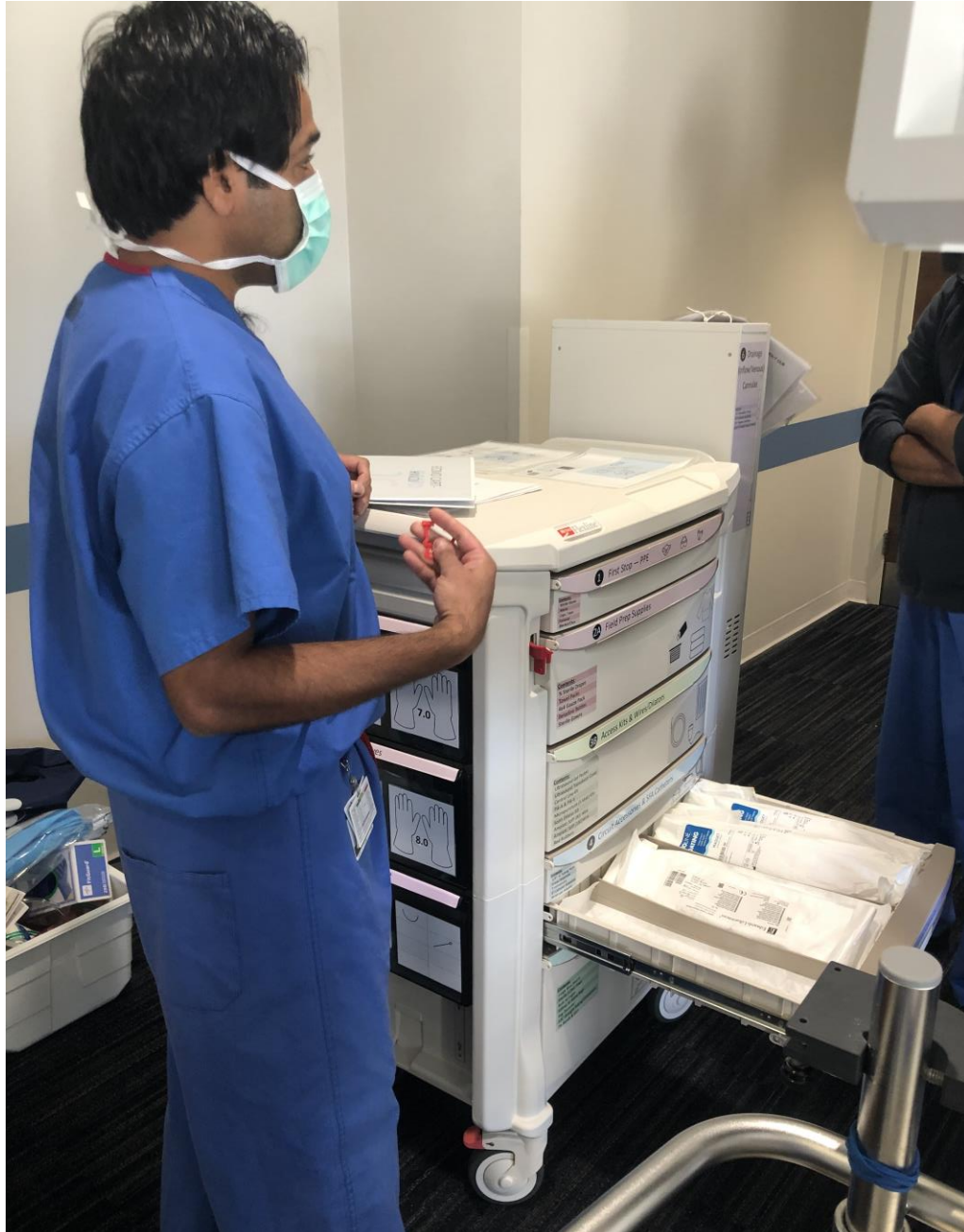
Free RN

- DO** → Retrieve ECMO Cart (hallway), ECMO Circuit (supply room). Plug in, help prepare room, assist Primary RN

APP PROCEDURALIST

- CHECK** → ECMO Circuit is bedside
- DO** → Retrieve Cannula Bag, prep sterile field and sterile table
→ Perform role as 1st Assist: Hold wires, receive LINES, and assist "wet to wet" connections


Simulation



Proof of Concept



Conclusion

- Extremely important not to underestimate cognitive load and how it affects personal and team performance in healthcare
- Quality improvement in healthcare is changing with a focus on being proactive rather than reactive. The person is not the problem. Let's adapt the environment to the user instead of adapting the user to the environment.
- Lessons learned from other industries include adapting the design, checklists, visual aids, and simulation
- Human factors integration is necessary for the healthcare setting as its goal is to improve personal performance, team performance, and patient safety (let's make it impossible to do the wrong thing)

References

Brady, Chris. (2021, March 20). *Change to QRH Engine Fire Drills*. The Boeing 737 Technical Site. <http://www.b737.org.uk/newqrhefnnp.htm>

Chrimes, N., Bradley, W. P. L., Gatward, J. J., & Weatherall, A. D. (2019). Human factors and the 'next generation' airway trolley. *Anaesthesia*, 74(4), 427–433. <https://doi.org/10.1111/anae.14543>

Funk, H. (2020, June 11). Remembering Three Mile Island: '*The nation's worst commercial nuclear accident*'. The almanac. https://thealmanac.net/news/remembering-three-mile-island-the-nation-s-worst-commercial-nuclear-accident/article_f393687a-4f51-11e9-b45c-afded8eab8b9.html

Greater Sydney Area HEMS Helicopter Emergency Service. 2023, April 9. *Hypoxia EAC*. <https://sydneyhems.com/resources/emergency-action-card/hypoxia-eac/>

Kelly, F. E., Frerk, C., Bailey, C. R., Cook, T. M., Ferguson, K., Flin, R., Fong, K., Groom, P., John, C., Lang, A. R., Meek, T., Miller, K. L., Richmond, L., Sevdalis, N., & Stacey, M. R. (2023). Implementing human factors in anaesthesia: guidance for clinicians, departments and hospitals: Guidelines from the Difficult Airway Society and the Association of Anaesthetists: Guidelines from the Difficult Airway Society and the Association of Anaesthetists. *Anaesthesia*, 78(4), 458–478. <https://doi.org/10.1111/anae.15941>

Lauria, M. J., Gallo, I. A., Rush, S., Brooks, J., Spiegel, R., & Weingart, S. D. (2017). Psychological skills to improve emergency care providers' performance under stress. *Annals of emergency medicine*, 70(6), 884–890.

References

Lorenzi, C., & Duffy, C. C. (2021). Incorporating Human Factors in Perioperative Nursing to Reduce Errors. *AORN Journal*, 114(4), 380–386. <https://doi.org/10.1002/aorn.13516>

Lusk, C., Catchpole, K., Neyens, D. M., Goel, S., Graham, R., Elrod, N., Paintlia, A., Alfred, M., Joseph, A., Jaruzel, C., Tobin, C., Heinke, T., & Abernathy, J. H., 3rd (2022). Improving safety in the operating room: Medication icon labels increase visibility and discrimination. *Applied ergonomics*, 104, 103831. <https://doi.org/10.1016/j.apergo.2022.103831>

Marshall S. D. (2023). Human error doesn't exist in isolation: it's now time for a deeper understanding of human factors in anaesthesia. *Anaesthesia*, 78(4), 407–410. <https://doi.org/10.1111/anae.15978>

Privitera, M. R. (2022). Promoting Clinician Well-Being and Patient Safety Using Human Factors Science: Reducing Unnecessary Occupational Stress. *Health*, 14(12), 1334–1356

The Vortex Approach. (2023, April 9). *Vortex Rescue Airway Cart, Clinical Integration*. <http://vortexapproach.org/airwaycart>

The Startup. (2020, Oct 26). *The Flying Fortress Fatal Flaw*. <https://medium.com/swlh/the-flying-fortress-fatal-flaw-694523359eb>

Weinger, M. B., & Slagle, J. (2001). Human factors research in anesthesia patient safety. *Proceedings. AMIA Symposium*, 756–760.