Management of Respiratory Failure in Pulmonary Hypertension

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Disclosures

No conflicts of interest

Objectives

- Primer on Pulmonary Hypertension
- Review relevant physiology
- How big is the problem? Epidemiology and outcomes of respiratory failure in pulmonary hypertension patients
- Understand how does pulmonary hypertension affect mechanical ventilation management
- Treatment strategies including pulmonary vasodilator therapy
- Case discussions

Primer on PAH

Pulmonary arterial hypertension (PAH) is a rare condition characterized by vascular proliferation and remodeling of the medium and small pulmonary vessels, resulting in a progressive increase in pulmonary vascular resistance and ultimately right ventricular failure and death.

JACC 2013;62: D42–50

Estimates of disease burden

- PAH - Incidence ~ upper limit of about 15 / million
- 77% Females
- 50 +/- 17 years; average age of diagnosis rising
- In the 1980s – NIH registry of 184 pts showed median survival at 2.8 years
- Recent estimates show left heart disease and lung disease as the most common cause of PH across the world.
- Schistosomiasis, HIV, sickle cell disease, other hemoglobinopathies, rheumatic heart disease cause significant disease burden in the developing world

CHEST 2012; 142(2):448–456; Lancet 2016; 4 (4):306-322
Circulation. 2009;119:2250-2294

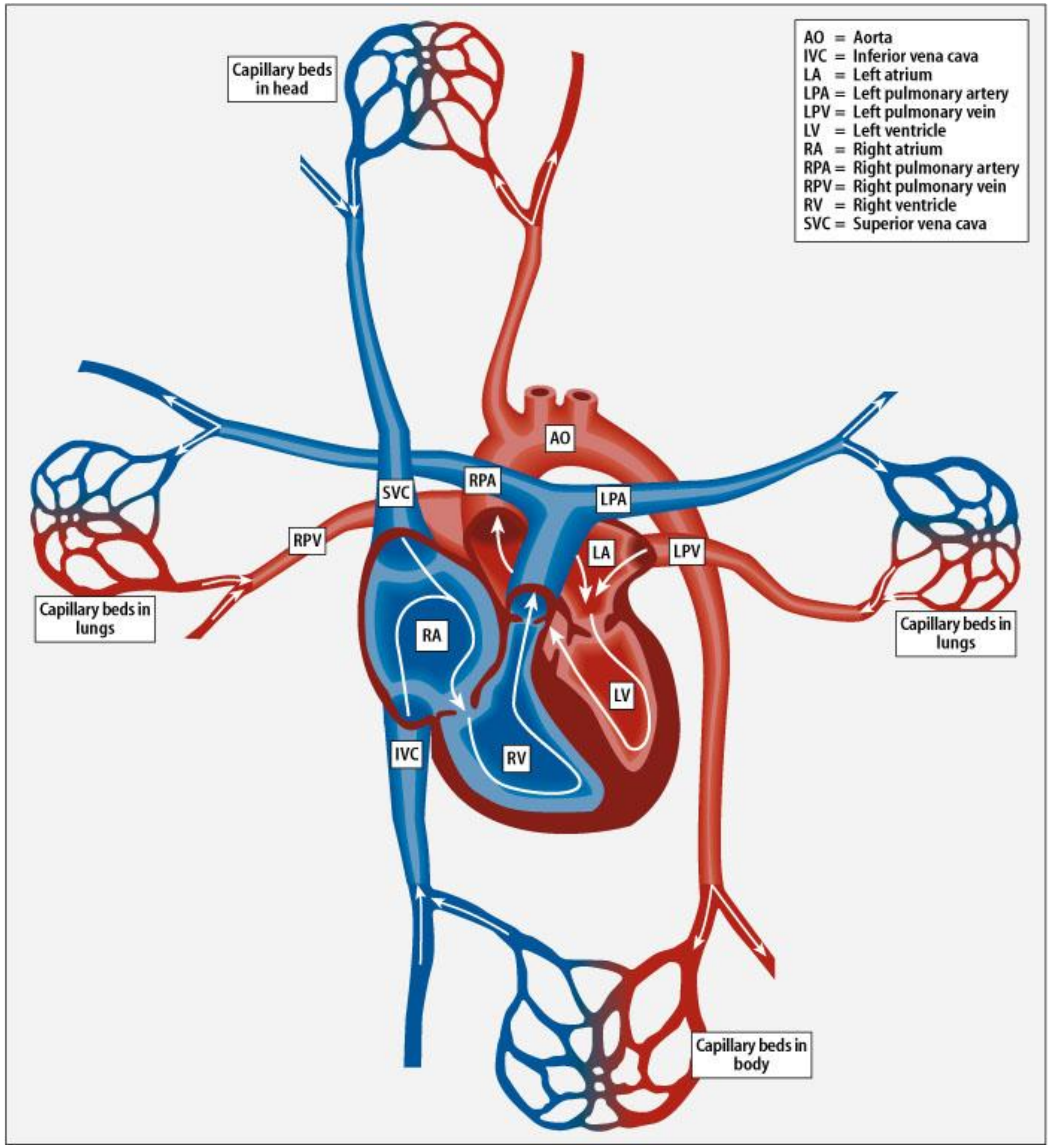
Estimates of disease burden

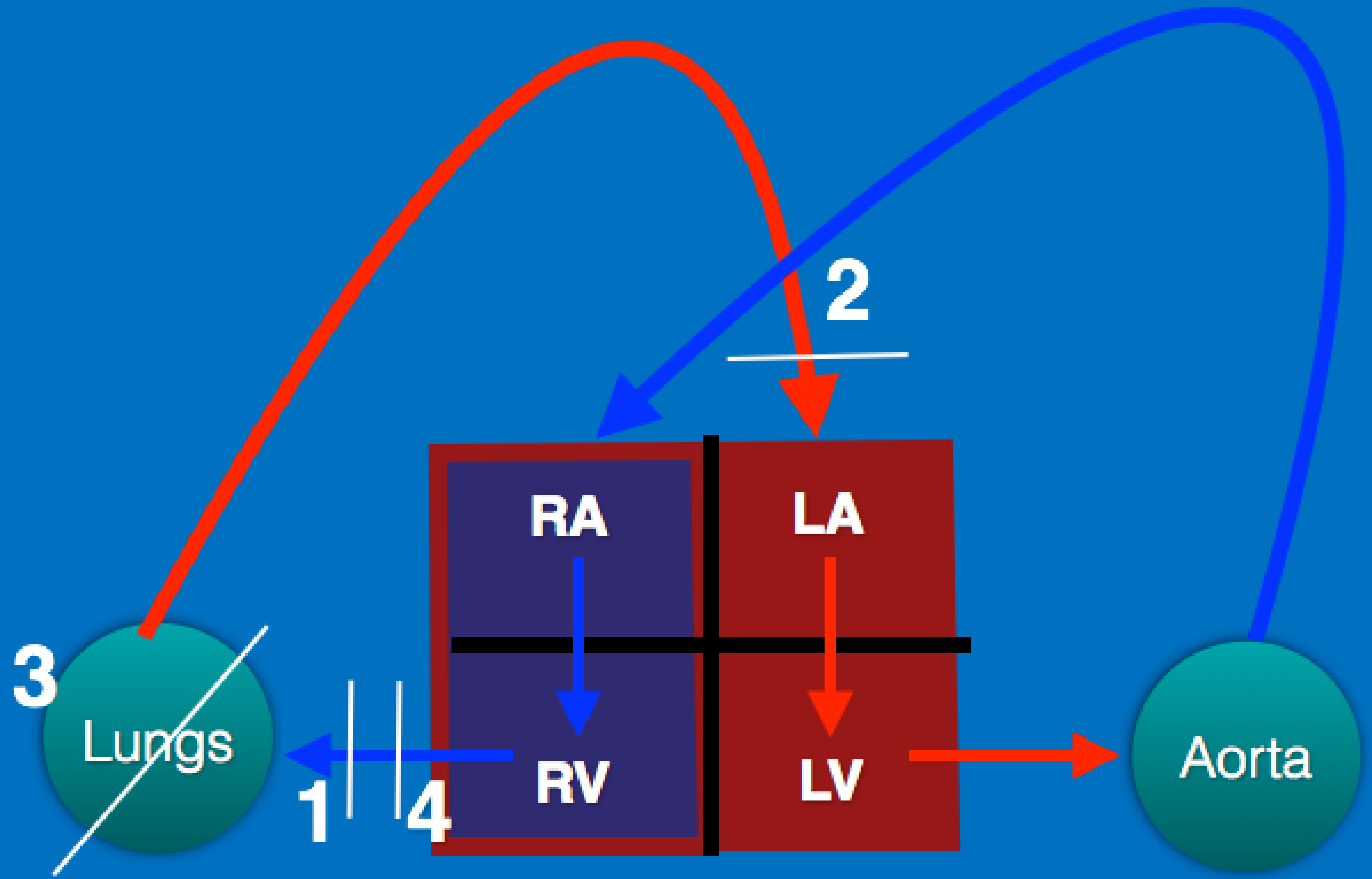
- PH –LHD in hospitalized patient population - 12.8%
- 14.5 % of hospitalized covid patients with PH and RHD
  - ICU admission and / or death – 41.7% vs 8.5% those without RHD
- 10% of all Echocardiograms done in a hospital showed evidence of PH (based on the TR jet measurement of >3m/s)
- Prevalence of 32% (meta-analysis 21 studies: 23%-42%) in CKD without dialysis. Higher on patients on HD or PD

Prevalence and significance of pulmonary hypertension among hospitalized patients with left heart disease. Respir Med. 2024 Sep 23;234:107817.
2020. Pulmonary hypertension and right ventricular involvement in hospitalised patients with COVID-19. *Heart*, *106*(17), pp.1324-1331
Unrecognized pulmonary arterial hypertension in hospitalized patients. Int J Cardiovasc Imaging. 2021 Apr;37(4):1237-1243
Prevalence of pulmonary hypertension in patients with chronic kidney disease without dialysis: a meta-analysis. Int Urol Nephrol. 2018 Aug;50(8):1497-1504

Normal Hemodynamics

- RAP 0-8 mmHg
- PAP 20/10/14 mmHg
- PAOP or PCWP 8-12
- CI 2.5-4.0 L/min/m^2
- PVR 80-120 dyne.sec/cm^5 (1-2 WU)




2
3
Lungs
RA
LA
RV
LV
1
4
Aorta

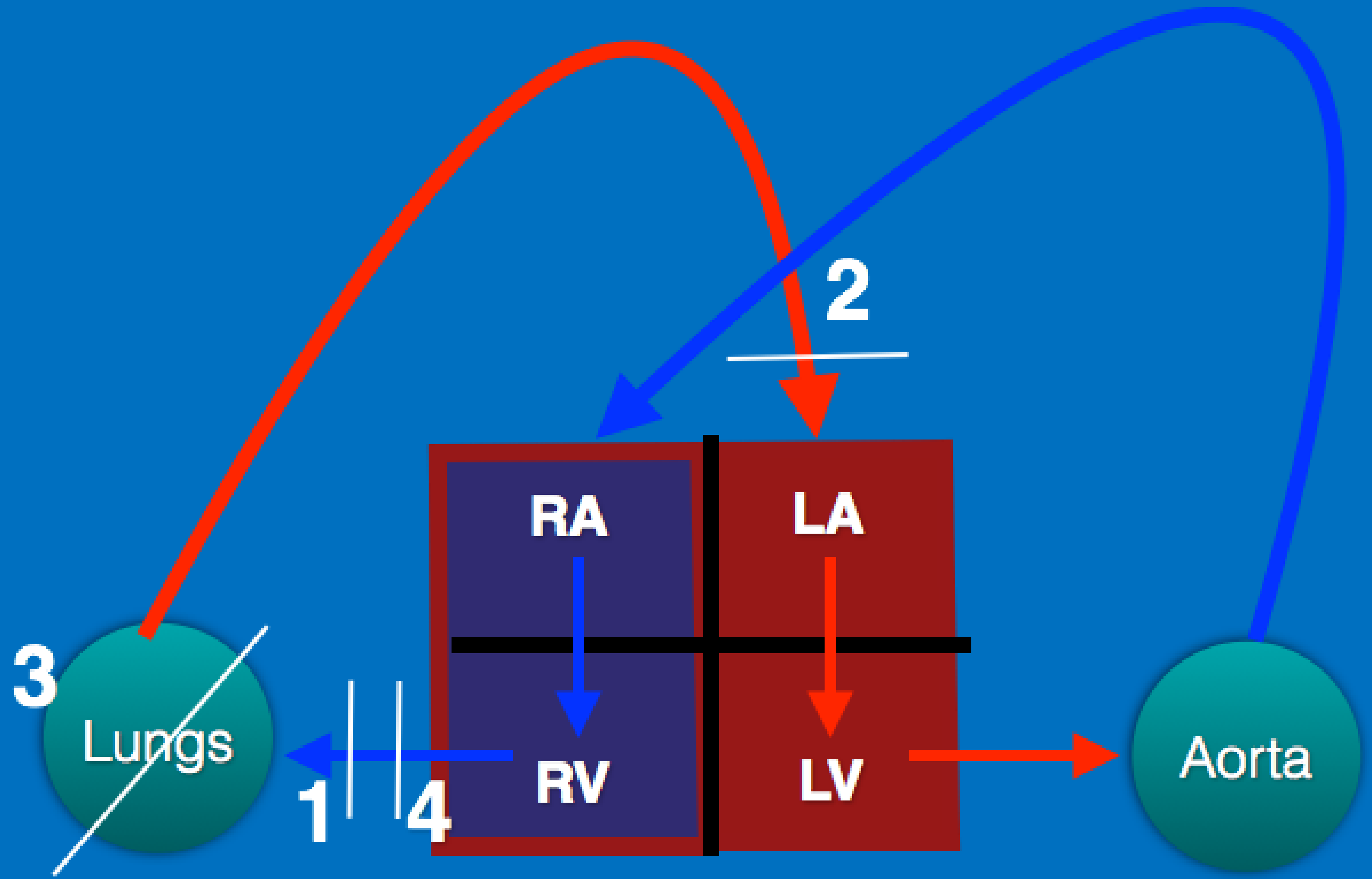
2022 ESC / ERS guidelines for PAH

TABLE 5 Haemodynamic definitions of pulmonary hypertension

Definition	Haemodynamic characteristics
PH	mPAP >20 mmHg
Pre-capillary PH	mPAP >20 mmHg PAWP ⩽15 mmHg PVR >2 WU
IpcPH	mPAP >20 mmHg PAWP >15 mmHg PVR ⩽2 WU
CpcPH	mPAP >20 mmHg PAWP >15 mmHg PVR >2 WU
Exercise PH	mPAP/CO slope between rest and exercise >3 mmHg/L/min

CO, cardiac output; CpcPH, combined post- and pre-capillary pulmonary hypertension; IpcPH, isolated post-capillary pulmonary hypertension; mPAP, mean pulmonary arterial pressure; PAWP, pulmonary arterial wedge pressure; PH, pulmonary hypertension; PVR, pulmonary vascular resistance; WU, Wood units. Some patients present with elevated mPAP (>20 mmHg) but low PVR (⩽2 WU) and low PAWP (⩽15 mmHg); this haemodynamic condition may be described by the term 'unclassified PH' (see text for further details).

European heart journal, 43(38), pp.3618-3731.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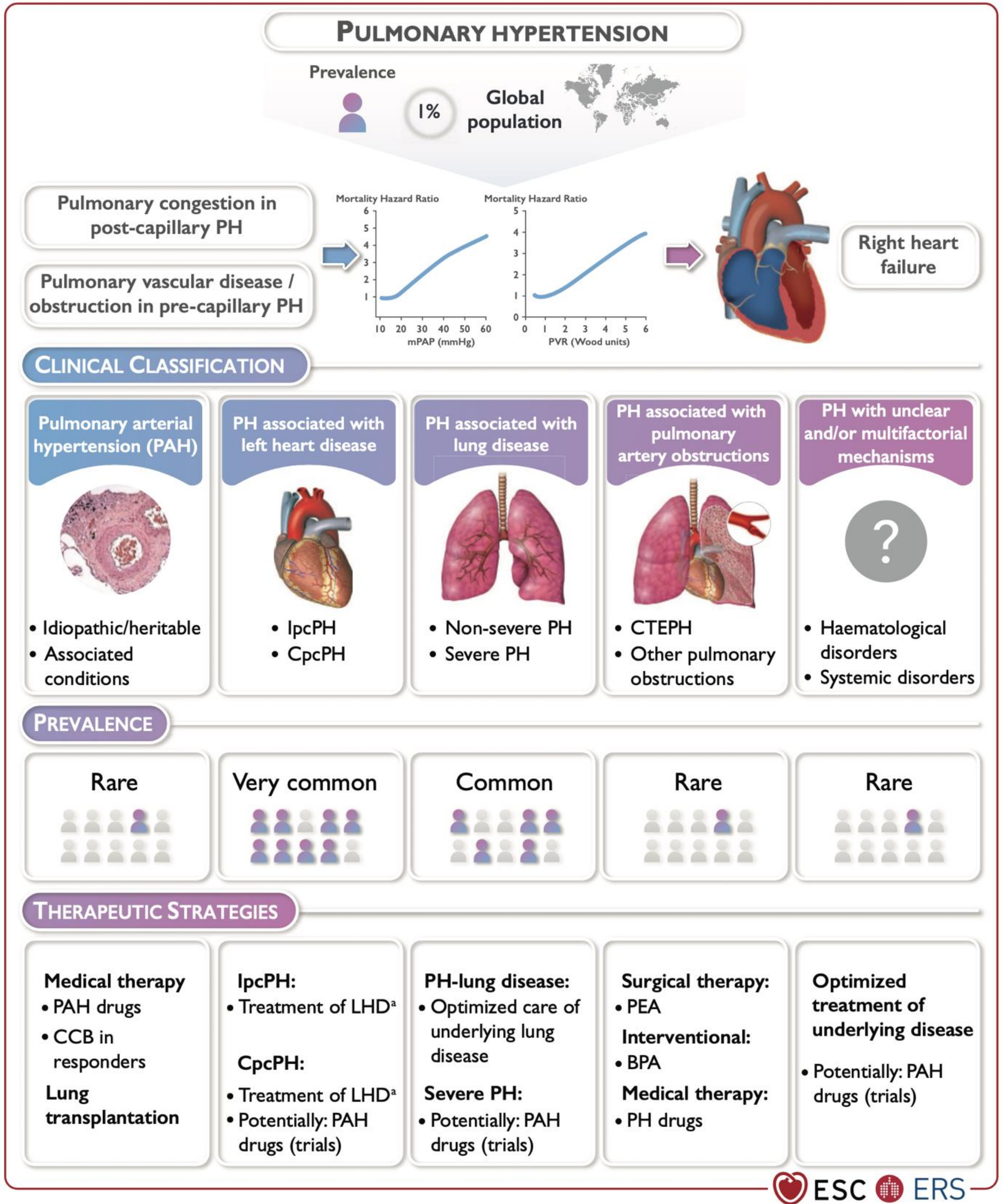


European heart journal, 43(38), pp.3618-3731.

Timeline of Drug approval for PAH treatment

FDA-approved drugs for PAH			
IV Epoprostenol - *Flolan*®	1995	IV Epoprostenol –*Veletri*®	2008
Bosentin - *Tracleer*®	2001	Tadalafil - *Adcirca*®	2009
SQ - Treprostenil - *Remodulin*®	2002	Treprostenil inhaled *Tyvaso*®	2009
Iloprost Inhaled - *Ventavis*®	2004	Riociguat - Adempas®	2013
Sildenafil - *Revatio*®	2005	Macitentan - Opsumit®	2013
IV Treprostenil - *Remodulin*®	2004	Oral Treprostenil- Orinitram®	2013
Ambrisentan - *Letairis*®	2007	Selexipag – Prostacyclin receptor agonist – Uptravi ®	2015
Treprostenil inhaled *Tyvaso*®	2021	Sotatercept – inhibits activin signaling pathway	2024

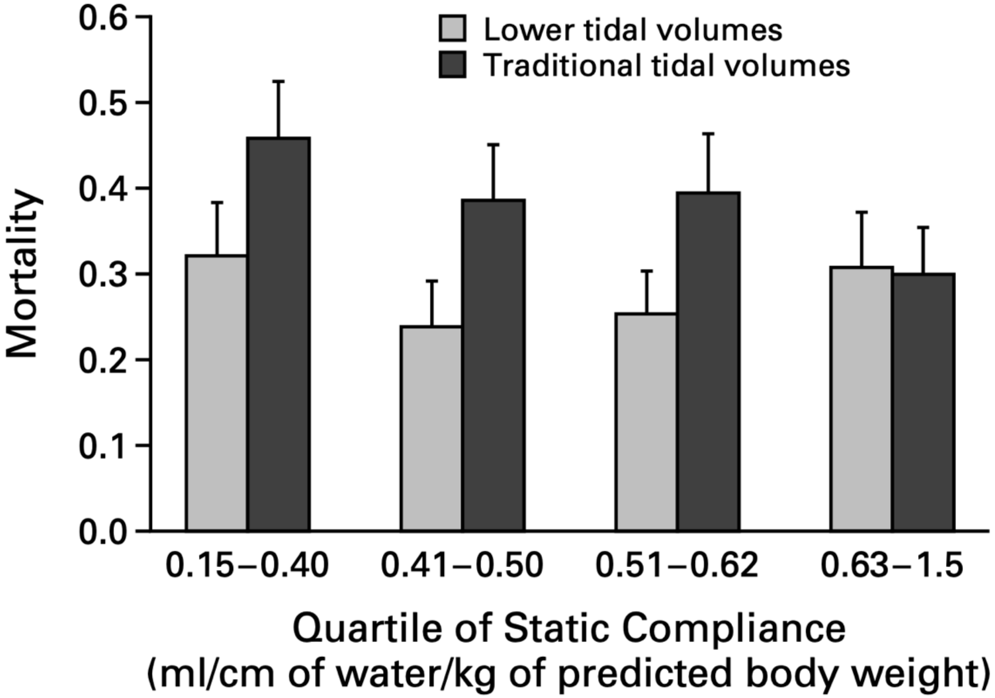
Pulmonary physiology 101 – PEEP..PEEP

- PEEP (Positive End Expiratory Pressure) – Prevents cyclic opening and closing of atelectatic alveoli and distal small airways with tidal breathing, that is known to be a basic mechanism leading to ventilator-induced lung injury
- Part of ARDS definition - – PEEP ≧5
- Does PEEP affect Mortality ?
- How to set the ideal PEEP?
  - ARDSNET table ?
  - Oxygenation goal?
  - VAE goals?

Nonintubated ARDS†	Intubated ARDS
$Pa_{O_2}:FI_{O_2} \leq 300$ mm Hg or $Sp_{O_2}:FI_{O_2} \leq 315$ (if $Sp_{O_2} \leq 97\%$) on HFNO with flow of ⩾30 L/min or NIV/CPAP with at least 5 cm H_2O end-expiratory pressure	Mild¶: $200 < Pa_{O_2}:FI_{O_2} \leq 300$ mm Hg or $235 < Sp_{O_2}:FI_{O_2} \leq 315$ (if $Sp_{O_2} \leq 97\%$) Moderate: $100 < Pa_{O_2}:FI_{O_2} \leq 200$ mm Hg or $148 < Sp_{O_2}:FI_{O_2} \leq 235$ (if $Sp_{O_2} \leq 97\%$) Severe: $Pa_{O_2}:FI_{O_2} \leq 100$ mm Hg or $Sp_{O_2}:FI_{O_2} \leq 148$ (if $Sp_{O_2} \leq 97\%$)

Current Opinion in Critical Care, 30(1), pp.10-19.
Am J Respir Crit Care Med Vol 209, Iss 1, pp 37–47, Jan 1, 2024

ARDSNET Trial 2000



31% Vs 39.8%

PaO_2, 55–80 mm Hg, or SpO_2, 88–95%
0.3 and 5
0.4 and 5
0.4 and 8
0.5 and 8
0.5 and 10
0.6 and 10
0.7 and 10
0.7 and 12
0.7 and 14
0.8 and 14
0.9 and 14
0.9 and 16
0.9 and 18
1.0 and 18
1.0 and 20
1.0 and 22
1.0 and 24

Oxygenation Goal

Group Receiving Traditional Tidal Volumes	Group Receiving Lower Tidal Volumes
Volume assist–control	Volume assist–control
12	6
≤50	≤30
6–35	6–35
1:1–1:3	1:1–1:3

Primary Ventilator parameters

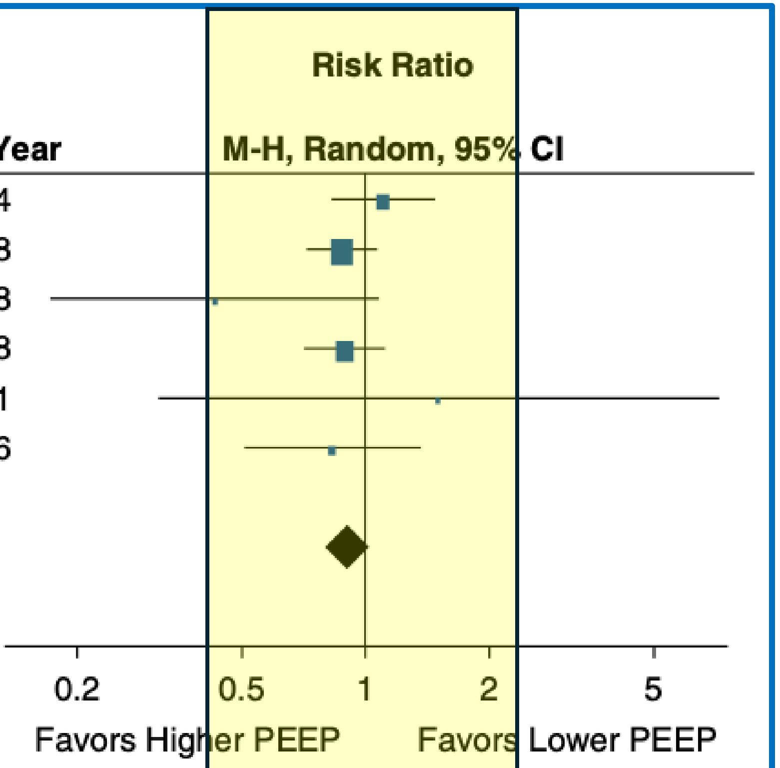
N Engl J Med. 2000 May 4;342(18):1301-8

Meta-Analysis 2004 – 2016 trials

Study or Subgroup	High Mortality Events	High Total Patients	Low Mortality Events	Low Total Patients	Weight	Risk Ratio M-H, Random, 95% CI	Year
Brower *et al.*, 2004	76	276	68	273	19.2%	1.11 [0.83, 1.46]	2004
Meade *et al.*, 2008	135	475	164	508	40.8%	0.88 [0.73, 1.06]	2008
Talmor *et al.*, 2008	5	30	12	31	1.9%	0.43 [0.17, 1.07]	2008
Mercat *et al.*, 2008	107	385	119	382	31.1%	0.89 [0.72, 1.11]	2008
Hodgson *et al.*, 2011	3	10	2	10	0.6%	1.50 [0.32, 7.14]	2011
Kacmarek *et al.*, 2016	22	99	27	101	6.4%	0.83 [0.51, 1.36]	2016
Total (95% CI)		**1275**		**1305**	**100.0%**	**0.91 [0.80, 1.03]**	
Total events	348		392				

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 5.09$, df = 5 (P = 0.41); $I^2 = 2\%$

Test for overall effect: Z = 1.46 (P = 0.14)



PEEP and the Lung

- Prevents Cyclic opening and closing of atelectatic alveoli and distal small airways
- Helps in recruitment of atelectatic lung
- Increases oxygenation
- Increases mean airway pressures
- Increases Intra thoracic pressures, Pleural pressures, Pericardial pressures – depending on lung compliance
- May cause –over distention of Normal Lung – affecting the pulmonary capillary circulation
- May compromise ventilation while balancing TVs and Plateau pressures
- Increases dead space ventilation

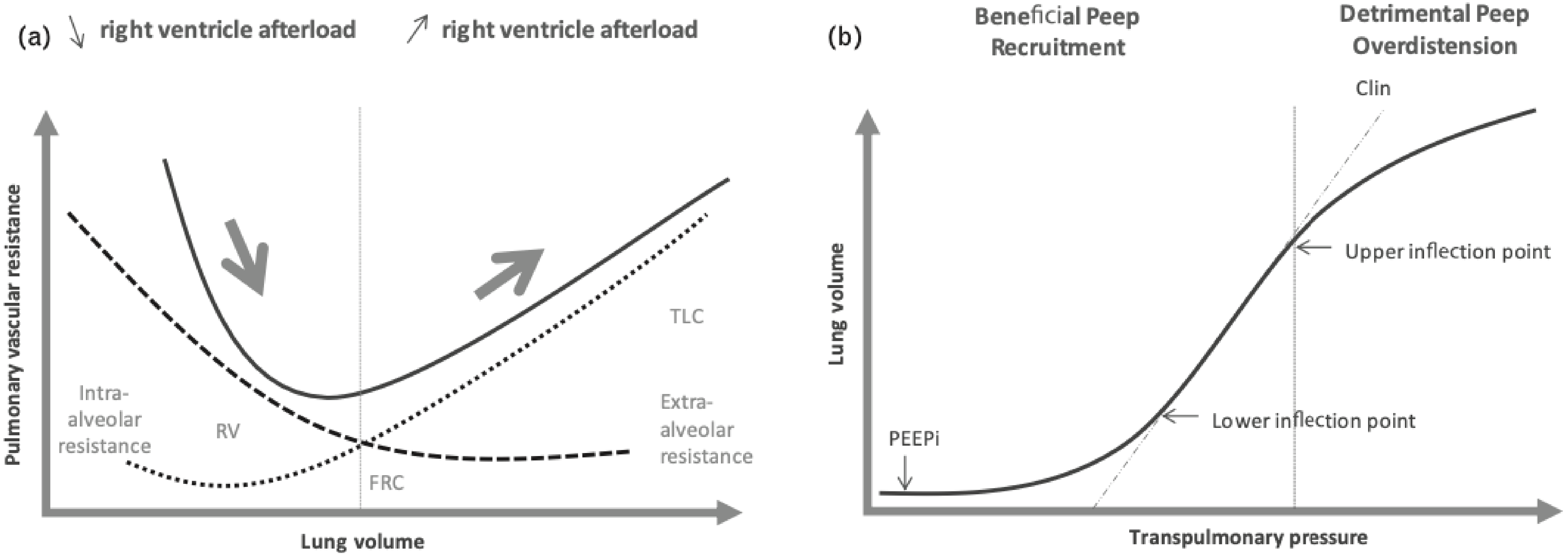
Lueckeet al. Clinical review: positive end-expiratory pressure and cardiac output. *Critical Care*, *9*, pp.1-15.
Hemodynamic effects of positive end-expiratory pressure. *Current Opinion in Critical Care*, *30*(1), pp.10-19.

PEEP and the heart

- Increasing PEEP leads to increase in pleural pressures transmitted to the vena cava; pericardium and right atrium
- May decrease venous return
- May decrease RV preload leading to decreased RV output
- May increase RV afterload progressively leading to acute RV dilation and failure
- Ventricular Interdependence leads to decreasing LV preload and decreased LV output
- Decreases LV afterload and may help LV function – specially in settings of CHF

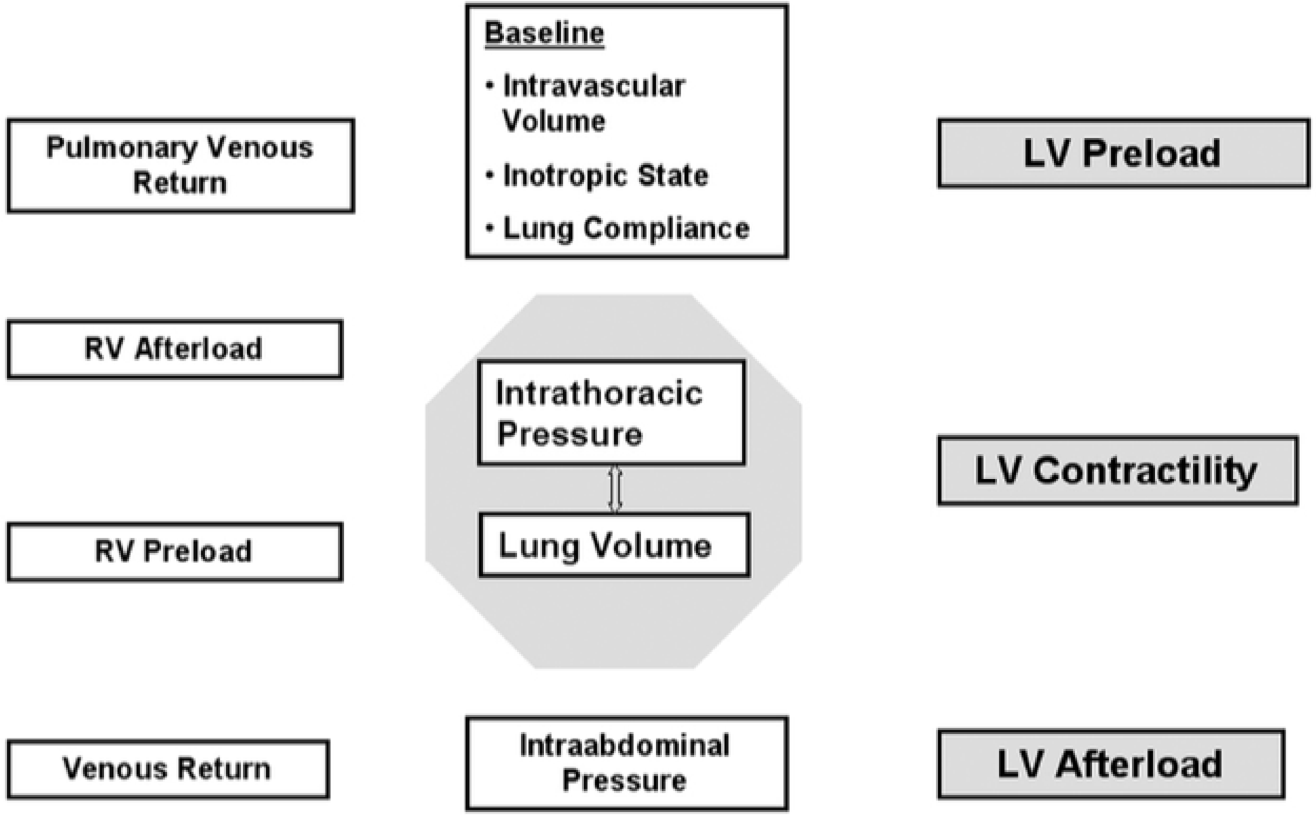
Lueckeet al. Clinical review: positive end-expiratory pressure and cardiac output. *Critical Care*, *9*, pp.1-15.
Hemodynamic effects of positive end-expiratory pressure. *Current Opinion in Critical Care*, *30*(1), pp.10-19.

PEEP - the Yin and the Yang



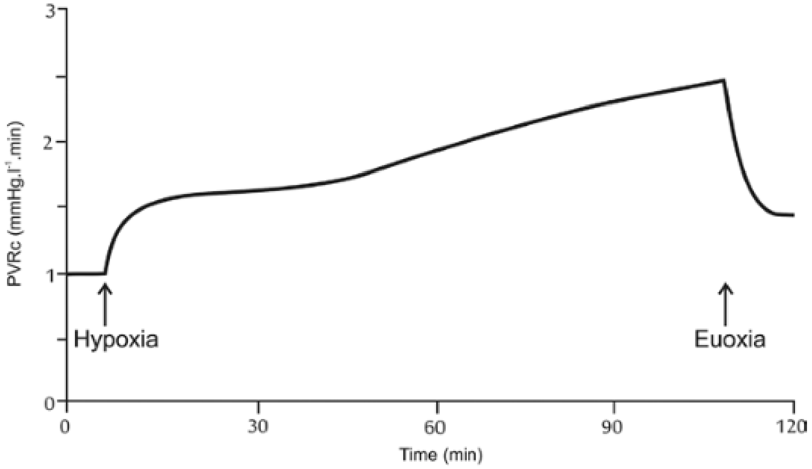
Lueckeet al. Clinical review: positive end-expiratory pressure and cardiac output. Critical Care, 9, pp.1-15.
Hemodynamic effects of positive end-expiratory pressure. Current Opinion in Critical Care, 30(1), pp.10-19.

PEEP affecting various aspects of physiology



Physiology 101

- Hypoxic Vasoconstriction
  - Active in Utero to reduce pulmonary circulation to less than 10% of cardiac output
  - Helps match regional Ventilation and Perfusion in health and disease
  - Leads to increased RV afterload and PAP
  - Heterogenous
  - Inhibited by hypothermia, enhanced by hyperthermia
  - Enhanced by vasopressors
  - Attenuated by endotoxin and drugs like CCB, PDE5 inhibitors, NO and prostacyclins

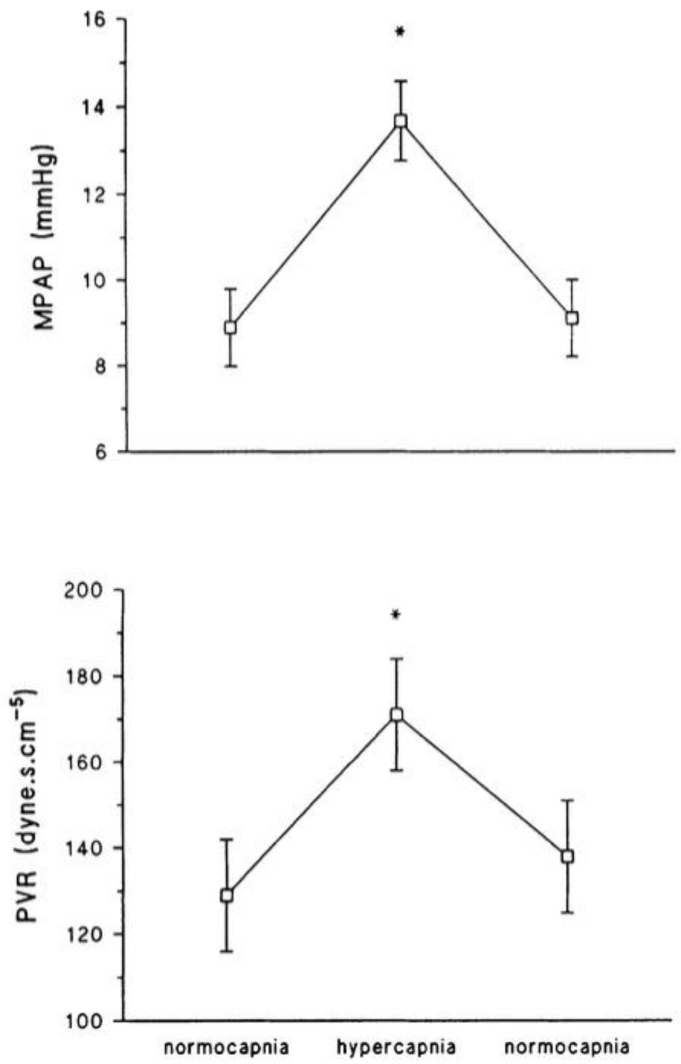


Biphasic response
12 Healthy volunteers, ETPO2 ~ 50Torr

Hypoxic pulmonary vasoconstriction: physiology and anesthetic implications. *Anesthesiology*, *122*(4), pp.932-946
Effects of hypercapnia on hemodynamic, inotropic, lusitropic, and electrophysiologic indices in humans. Chest. 1996 May;109(5):1215-21

Physiology 101

- Hypercapnia
    - Leads to pulmonary vasoconstriction
    - Increases in MPAP and PVR
    - Contrasts from systemic circulation where acidosis typically causes vasodilation

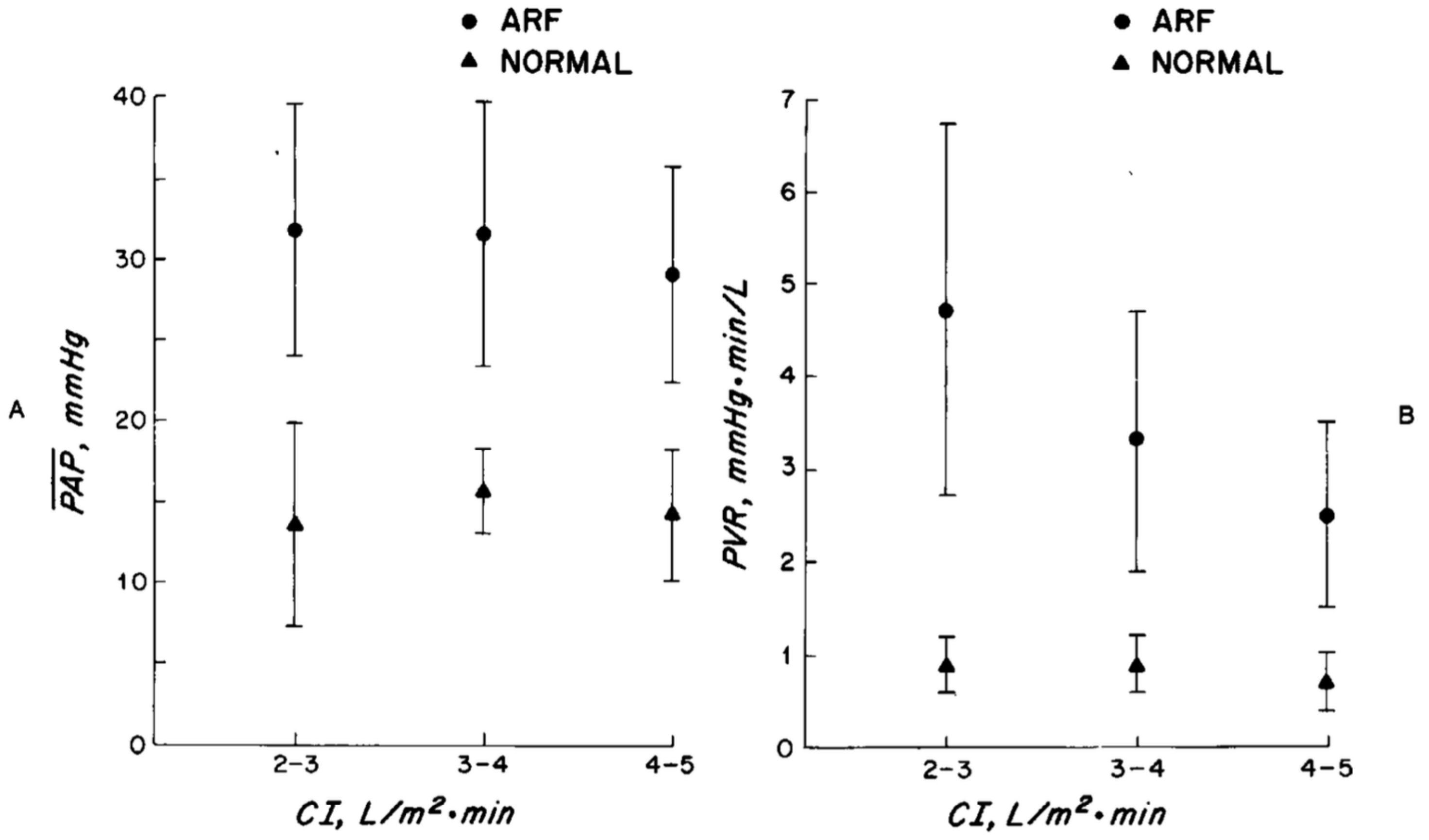


8 Healthy subjects ETCO2 7Kpa ~ 52Torr

Hypoxic pulmonary vasoconstriction: physiology and anesthetic implications. *Anesthesiology*, *122*(4), pp.932-946
Effects of hypercapnia on hemodynamic, inotropic, lusitropic, and electrophysiologic indices in humans. Chest. 1996 May;109(5):1215-21

Pulmonary Hypertension in Respiratory Failure

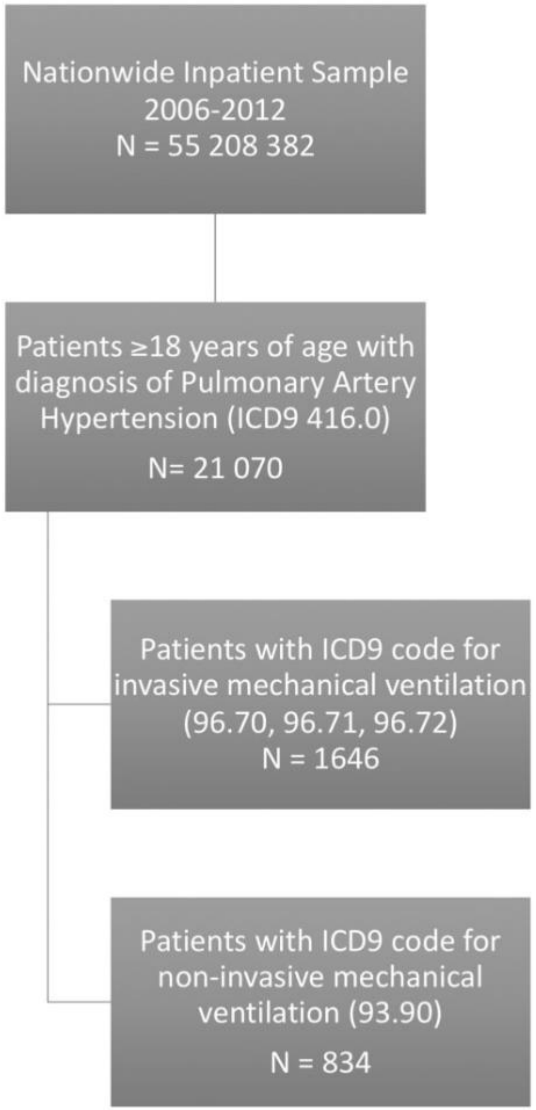
Initial Pulmonary Disease	Age* yr	No. of Patients	No. Surviving
Bacterial or fungal pneumonia	14.7±2.5	3	1
Viral pneumonia	26.6±11.7	12	1
Aspiration pneumonia	32.7±15.2	7	1
Pulmonary contusion, poisoning or amniotic-fluid embolism	26.3±9.6	8	3



Zapol et al. 1977. New England Journal of Medicine, 296(9), pp.476-480.

Mechanical Ventilation Outcomes in Patients With Pulmonary Hypertension in the United States: A National Retrospective Cohort Analysis 2006 - 2012

	Mechanical Ventilation (n = 1646)	Noninvasive Ventilation (n = 834)	*P*-Value
Age, years, mean (SD)	65.2 (16.1)	66.1 (15.1)	.68
Length of stay, in days, median (IQR)	11.9 (6.1-22.2)	6.7 (3.4-11.9)	<.001
Overall hospital mortality, n (%)	645 (39.1)	105 (12.6)	<.001
Tracheostomy rate, n (%)	199 (12.1)	0	
Home oxygen use, n (%)	73 (4.4)	122 (14.4)	<.001
Primary diagnosis mortality, n (%)			
Sepsis	107 (55.0)	13 (35.2)	.02
Respiratory failure	102 (26.8)	17 (13.5)	.01
Pneumonia	40 (42.3)	<10	< .001
Cardiac	156 (41.1)	30 (9.3)	< .001
Subgroup mortality, n (%)			
Home oxygen	26 (35.3)	13 (10.6)	< .001
Swan-Ganz catheter use	48 (45.6)	<10 (14.7)	.002
Systemic sclerosis	17 (51.9)	0	
Human immunodeficiency virus	11 (64.1)	0	
RA + SLE	15 (55.5)	<10 (16.1)	.01
Female sex, n (%)	1032 (62.6)	526 (63.2)	.76



Rush et al. 2017 Journal of Intensive Care Medicine, 32(10), pp.588-592

Characteristics and Outcomes of Critically Ill Patients With Pulmonary Hypertension Who Undergo Endotracheal Intubation and Mechanical Ventilation
10-year data from Mayo Clinic 2007-2017

- 81 patients
- Group 1,3,4 included; but no significant differences in mortality between groups
- Admission diagnosis – Right heart failure, Sepsis, respiratory failure
- 30 Day Mortality – 32.1%; 1 year mortality – 48.2%
- Only 1 of 6 patients intubated post cardiac arrest survived
- All patients intubated electively for procedures survived
- Of those who were normotensive prior to intubation; 40% needed pressors post intubation
- Baseline RVSP, pre-intubation hypoxia, Hypercapnia and Acidosis independently associated with mortality

Journal of Intensive Care Medicine, 38(12), pp.1174-1182.

Initiation of mechanical ventilation

- "Intubation and invasive mechanical ventilation should be avoided whenever possible in patients with advanced RV failure because of a high risk of further hemodynamic deterioration and death"

  - Acute reduction in venous return upon the initiation of positive pressure ventilation
  - Negative inotropic effects of respiratory acidosis and administered drugs
  - Increase in RV afterload caused by hypoxemia, acidosis and increased intrathoracic pressure
  - Acute ablation of endogenous catecholamines
  - Drop in RV coronary perfusion if the RV pressures approaches systemic pressures (or other way around if the systemic pressures drop)
    - Maintain adequate RV coronary perfusion pressure (systemic DBP – RV diastolic pressure)
  - Sudden increase in RV preload when laying the patient flat or Trendelenburg

Eur Heart J. 2022 Oct 11;43(38):3618-3731
Current Cardiology Reports, 26(8), pp.815-820.

Help me! - Pitfalls during intubation

- Difficult balance – avoid intubation - if at all possible, but also do NOT wait till the last minute with an impeding cardiac arrest

- Long term prognosis – are we being realistic here? What are the goals of therapy?

- High flow. / NIV support – helps restore oxygenation and normocapnia prior to intubation.
    - Watch those volumes on NIV

- Normalize acid-base balance PH if possible – Renal replacement therapy / bicarb gtt

- RV contractility support – dobutamine / Epi (milrinone less preferred due to more hypotension and longer time to onset of effect)

- Vasopressor support – Vasopressin / Norepi / Epi. (avoid phenylephrine due to potent pulm vasoconstrictor effect)

Current Cardiology Reports, 26(8), pp.815-820.

Hold your nerve!

- Pulmonary vasodilators? – if you have the time in close consultation with a PH expert
  - Can worsen condition in group 2 PH (post cap PH)
  - Can worsen VQ matching in group 3 PH (primary lung disease). Causes increased shunting by attenuating hypoxic pulmonary vasoconstriction
  - Group 1 PAH may benefit from systemic pulmonary vasodilators
  - Inhaled prostacyclin may help with group 3 PH or in ARDS patients by improving VQ matching

- Invasive hemodynamic monitoring
  - Maintain adequate systemic BP
  - Monitor – RAP, PAPi, CI
    - Worry if RAP > 15; CI < 2; PAPi trending down

PAPi – Pulmonary Artery Pulsatility Index
sPAP-dPAP / RAP

- POC Echo
  - Assess RV size / function / ventricular septum position
  - IVC collapsibility for volume status
  - Estimate CO

Current Cardiology Reports, 26(8), pp.815-820.

Almost there!

- Best person in the room intubates

- What drugs do you use?
  - Small doses of short acting opiates / benzodiazepines along with Etomidate. Avoid Ketamine as it increases PVR acutely
  - Avoid propofol
  - RSI - paralytics - Succinyl Choline vs Rocuronium

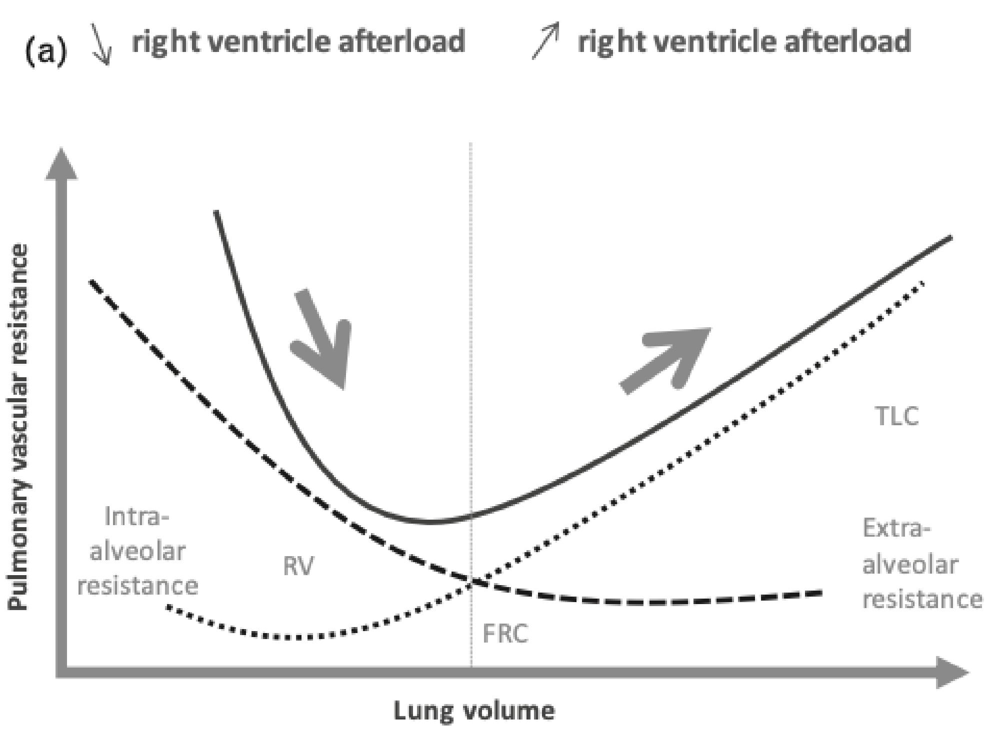
- DL vs Video Laryngoscopy vs Awake Fiberoptic bronchoscopy

- Immediate settings post intubation –
  - Find ideal PEEP – need for adequate lung recruitment, but avoid overdistension
  - Adequate ventilation – always match effort and rate from prior to intubation
  - Adequate oxygenation – preferentially increase fiO2 vs PEEP if needed

Current Cardiology Reports, 26(8), pp.815-820
Evaluation and management of pulmonary hypertension in noncardiac surgery: a scientific statement from the American Heart Association. *Circulation*, *147*(17), pp.1317-1343

To PEEP or not to PEEP

- Its not all about oxygenation
- Ideal PEEP to allow recruitment, but not over distend normal lung



Optimizing RV function on mechanical ventilation

Specific drug use depends on the cause of PAH

Systemic treatments

Sildenafil
IV prostacyclin
Group 1, 4, PH

Inhaled treatments

Inhaled NO
Inhaled prostacyclin
Group 3 PH
ARDS

Management strategies for patients with pulmonary hypertension in the intensive care unit. *Critical care medicine*, *35*(9), pp.2037-2050

Inhaled Prostacyclin vs Inhaled Nitric Oxide

- Benefits:
  - Improves oxygenation – PaO2
  - Improves P/F ratio
  - Improves mPAP and CO. Helps reduce PVR and RV afterload
  - Better VQ matching

- Risks:
  - Hypotension – generally not clinically significant
  - Rebound hypoxia and worsening PAP
  - Bleeding risk

Inhaled prostacyclins for acute respiratory distress syndrome: a systematic review and meta-analysis. Critical Care Explorations, 5(6), p.e0931
Inhaled epoprostenol vs inhaled nitric oxide for refractory hypoxemia in critically ill patients. *Journal of Critical Care*, *28*(5), pp.844-848

Inhaled Prostacyclin vs Inhaled Nitric Oxide

Inhaled NO

Dose range for iNO - 1 to 80 ppm

- Colorless / Odorless gas
- Selective pulmonary vasodilator
- Delivered to ventilated areas of the lung
- Increase Oxygenation
- Inhibits PLT aggregation
- Decreased PVR
- Watch for rebound PH
- Methemoglobinemia
- Minimal bleeding risk

Inhaled Epoprostenol

Dose range for iEPO is 0.01 to 0.05 μg/kg/min

- Naturally occurring prostaglandin
- Potent pulmonary vasodilator
- Delivered to ventilated areas of the lung
- Increased Oxygenation
- Inhibits PLT aggregation
- Decreased PVR
- Rebound PH if stopped
- Systemic hypotension / tachycardia
- Minimal Bleeding risk

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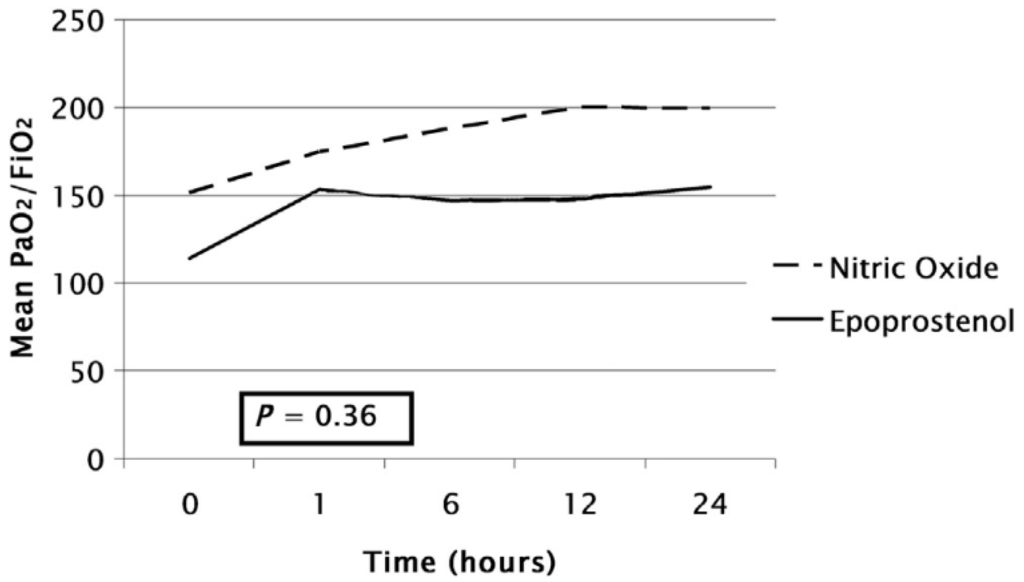
Inhaled epoprostenol vs inhaled nitric oxide for refractory hypoxemia in critically ill patients. *Journal of Critical Care*, *28*(5), pp.844-848

Inhaled Prostacyclin vs Inhaled Nitric Oxide

- No difference in oxygenation
- No difference in mortality or LOS
- iNO 4.5X more expensive



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Case - 1

- 68 year old with long standing scleroderma and worsening shortness of breath presented to the ER after collapsing at home – revived and transferred to the ICU
  - Still in shock, Multiple pressors, 80% fiO2
  - Echo with severe RV dilation, septal shift and pulmonary hypertension; hyperdynamic small LV
  - CTA with large PA, basilar aspiration PNA, no PE
- Oxygenation strategy – PEEP / no PEEP / how much?
- Ventilation strategy
- Hemodynamic strategy

Case - 2

- 55-year-old disabled construction worker, BMI 55, heavy smoker, COPD with FEV1 ~ 70%, combined obstructive and restrictive physiology on PFTs. Has not been using his cpap. Gained 20 Lb with edema in both LE in last 2 months. Progressively worse dyspnea with acute onset of cough, wheezing last 1 week
- Presenting ABG 7.25/60/40. PO2 55. sats 88% RA - > needs 2 L o2
- Gets some Narco due to back pain on the floor in addition to his home trazodone and Flexeril. Found difficult to arouse in the morning. BP 100/60; HR 100; ABG 7.15/85/45. PO2 75 on O2 at 6 L per min - to keep sats >90%
- Placed on Bipap 50%; 1 hour later ABG 7.12/82/45; PO2 75; still difficult to arouse
- Emergently intubated – becomes hypotensive – in the ICU now
- POC echo – LV hypertrophy, RV dilated with volume overloaded signs, RVSP 60
- Next steps?
- Oxygenation / Ventilation / Hemodynamic strategy ??

Case-3

- 36-year-old female presented with severe dyspnea of acute onset when she woke up this morning
- On contraceptive pills as her only medications
- CTA with sub-massive Saddle PE
- Getting increasingly dyspneic and now needing high flow.
  - BP 110 /90; HR 125; RR 35; Sats 92% on 50% high flow fio2
- What do you do?
  - Intubate; if so what drugs?
  - Stay put

Case-4

- 55-year-old alcoholic with COPD and aspiration PNA on vent support
- Has profound hypoxia – 80% fio2, xray with bilateral infiltrates, P/F ratio - 80, (severe ARDS); PEEP 15, sats 88%
- In shock - max dose 5 pressors
- Echo with severely dilated Right ventricle with severely reduced function
- Oxygenation strategy
- Ventilation strategy
- Hemodynamic strategy

Summary

- Pulmonary hypertension can be part of multiple diseases
- Always sort out underlying physiology - pre-capillary vs post capillary or combined pre and post capillary
- Recognize if and how it is impacting patient care and prognosis
- Almost always PH associated with a disease portends a worse prognosis
- BE scared of a failing RV when trying to intubate someone!
- Modulate PEEP - its not only about oxygenation and ARDSNET
- Optimizing right heart function should be a key goal in treated patients with pulmonary hypertension with respiratory failure

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Stay curious and keep exploring

Uhuru Peak, top of Africa

South Kaibab trail, Grand Canyon

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Accelerating Professional Growth Through the Use of Emotional Intelligence

Rachel Stangland, MSN, RN, CNOR
Manager Surgical Services, Patient Care Services Education, Magnet Program
Schneck Medical Center
Seymour, IN

Learning Objectives

- Learners will be able to describe the link between emotional intelligence and professionalism.
- Learners will understand the biological underpinnings of emotions.
- Learners will be able to describe the impact of emotions on the practice of healthcare professionals.
- Learners will be able to apply emotional intelligence skills to professional interactions.

Professionalism – Merriam Webster

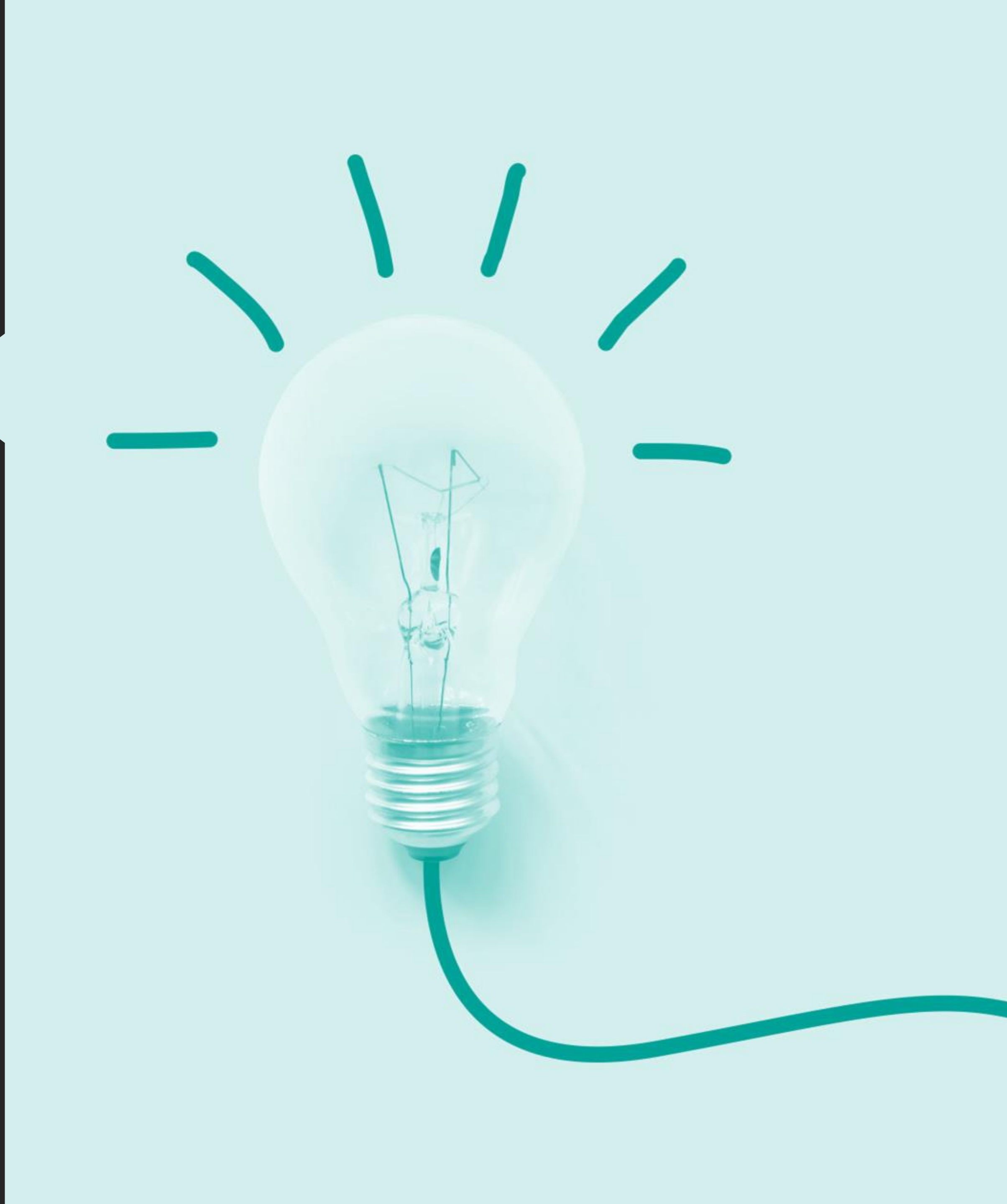
- **professionalism**
- noun
- pro·fes·sion·al·ism prə-ˈfesh-nə-ˌli-zəm -ˈfe-shə-nə-ˌli-
- **1:** the conduct, aims, or qualities that characterize or mark a profession or a professional person

Emotional Intelligence -

- **emotional intelligence**
- noun
- **:** the ability to recognize, understand, and deal skillfully with one's own emotions and the emotions of others (as by regulating one's emotions or by showing empathy and good judgment in social interactions)
- Merriam Webster

Emotional Intelligence -

- Bradbury & Greaves’ Definition: your ability to recognize and understand emotions in yourself and others, and your ability to use this awareness to manage your behavior and relationships



AARC (2021) Statement of Ethics

In the conduct of professional activities, the Respiratory Therapist shall be bound by the following ethical and professional principles. Respiratory Therapists shall:

- Demonstrate behavior that reflects integrity, supports objectivity, and fosters trust in the profession and its professionals.
- Provide care without discrimination on any bases, with respect for the rights and dignity of all individuals
- Work to achieve and maintain respectful, functional, beneficial relationships, and communication with all health professions.

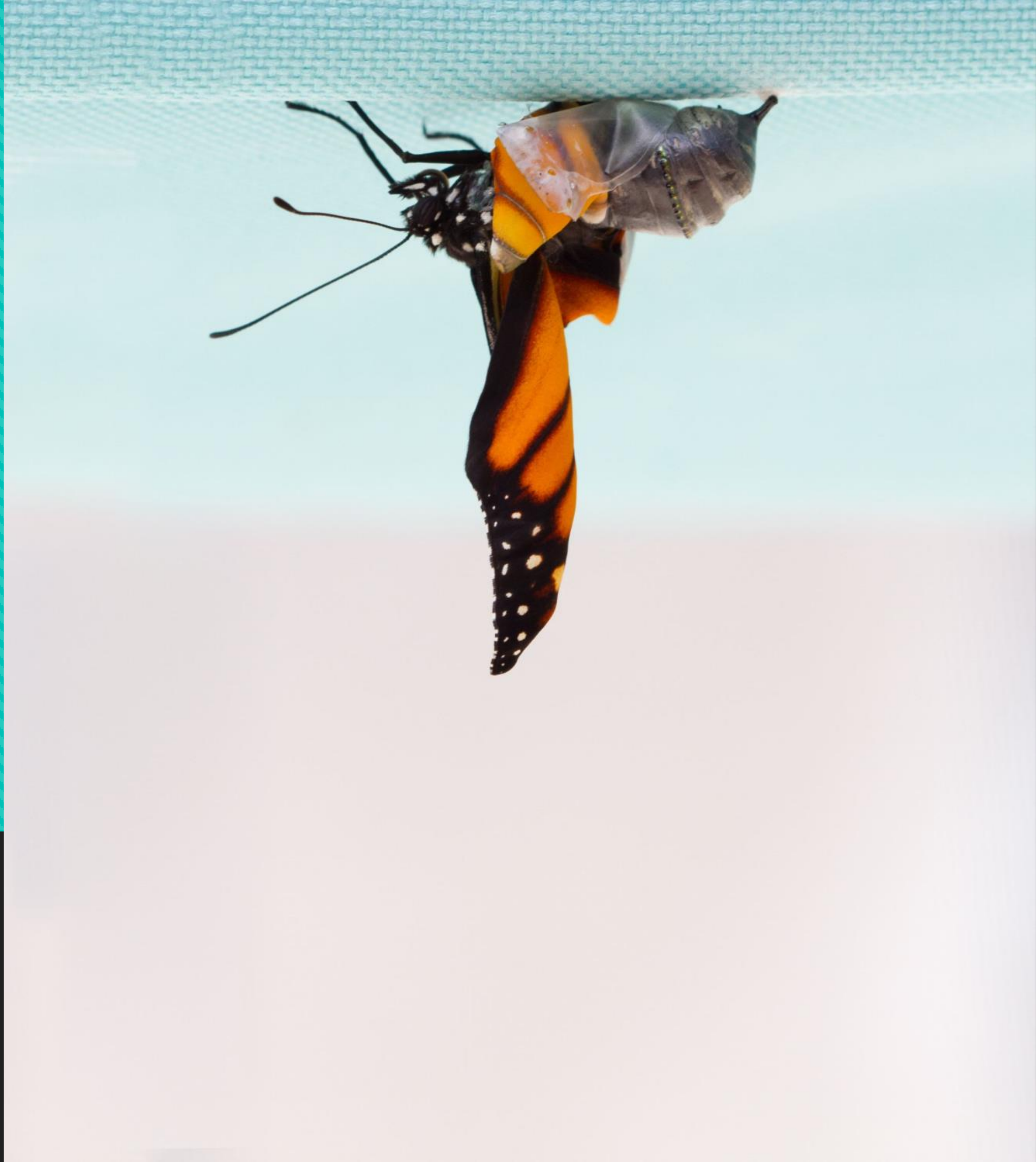
Emotional Intelligence Impact

- Only 36% of people tested were able to identify their emotions as they happen
- EQ was more important than skills like time management, decision-making, and communication in predicting success in the workplace
- (Bradbury & Greaves, 2009)

Emotional Intelligence Impact

- EQ accounts for 58% of performance in all job types
- 90% of high performers are also high in EQ
- People with high EQ make on average $29,000 more per year
- (Bradbury & Greaves, 2009)

The Biology of Emotions



The Role of the Limbic System

- Amygdala - emotional responses including feelings of fear, anger, and anxiety
- Cingulate Gyrus – helps to form and regulate emotions and behavior
- Subconscious process

(Torrico & Abdijadid, 2024)

The Role of the Limbic System

Trigger

Emotional Activation in the Limbic System

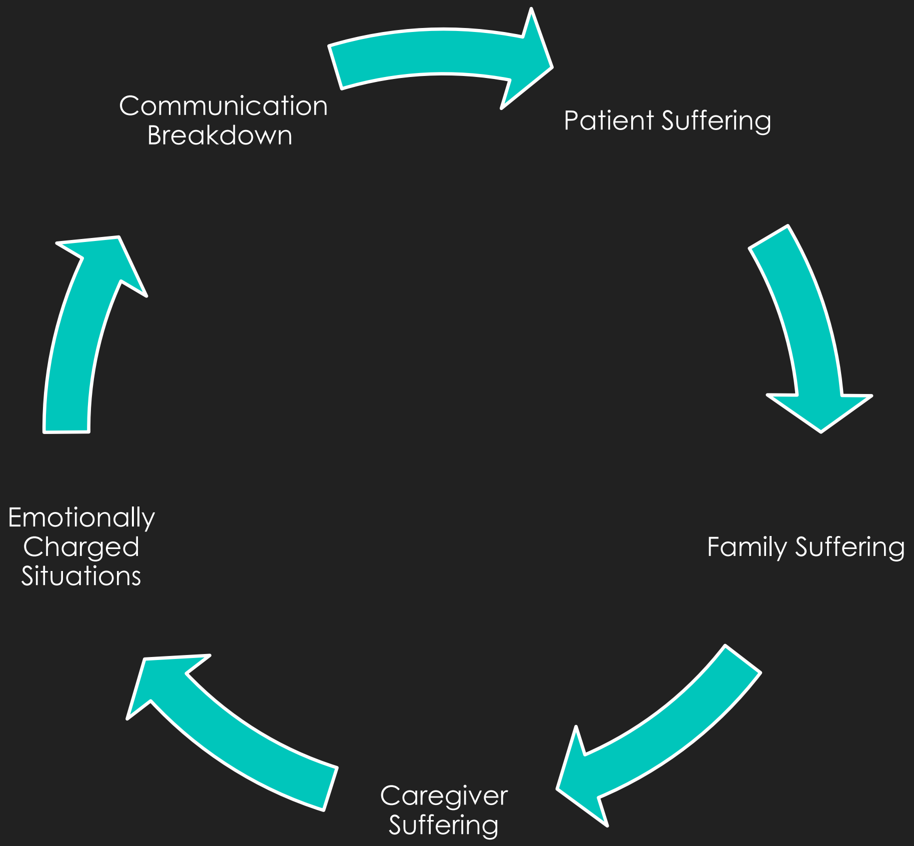
Behavioral Reaction

Emotional Garbage Trucks

The Role of Emotions in Healthcare

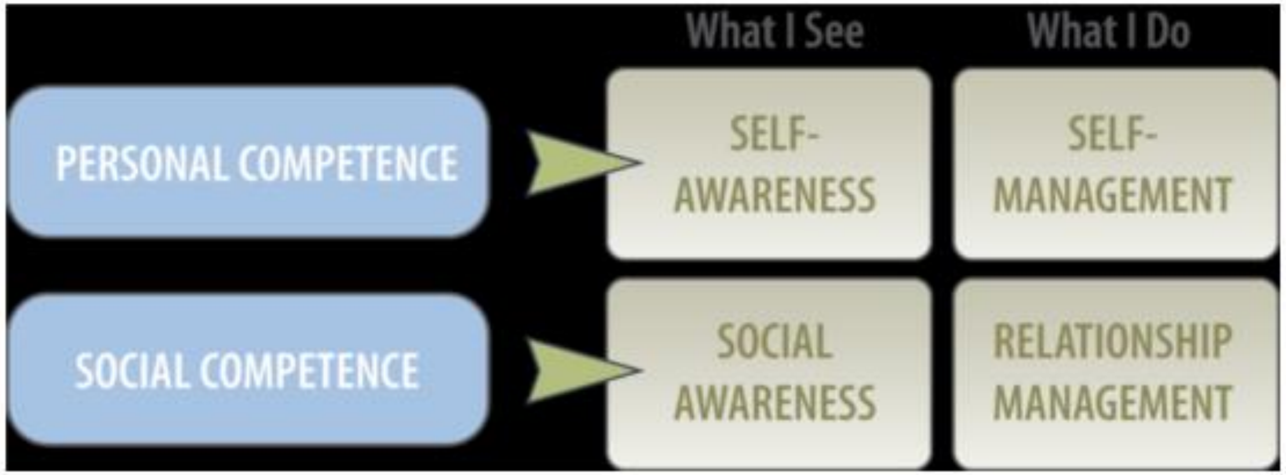
- Fragmented systems
- Illness-focused Model
- Staffing Crisis
- Fatigue
- Burnout
- Communication Barriers

Suffering


Communication Breakdown
Patient Suffering
Family Suffering
Caregiver Suffering
Emotionally Charged Situations

Emotional Intelligence Models

- Bradbury and Greaves (2009)



EQ is Made up of Four Core Skills

Emotional Intelligence Models

Goleman (1995)

Self Awareness	Emotional Self Awareness
Self Management	Emotional Balance Adaptability Achieve Positivity
Social Awareness	Empathy Organizational Awareness
Relationship Management	Influence Coach Conflict Management Inspire Teamwork

Emotional Intelligence Myths

- Some people are just naturally better at this than others…
- Emotional intelligence is something you are born with not something that you learn…
- My natural communication style is to be blunt… I can't change that.
- Other people need to be more sensitive to my viewpoint…
- If I feel a certain way about a situation, others must feel the same way…

Scenario 1- Emotional Garbage Truck Response

- I had a disagreement with my spouse last night. I come to work in a bad mood. I realize that I don't feel right, but I am not consciously aware of the emotions that I am feeling. What I am feeling is misunderstood, hurt, and frustrated. Because I don't consciously recognize these feelings, I don't process them effectively. Nancy approaches me to ask for help with a difficult patient.
- I respond by snapping at her. Nancy is now hurt, because she does not understand what she did to deserve that response from me.

Scenario 1 – Emotionally Intelligent Response

- I had a disagreement with my spouse last night. I come to work in a bad mood. I realize that I don’t feel right. I stop to process what I am feeling and realize that I am feeling misunderstood, hurt, and frustrated. Nancy approaches me to ask for help with a difficult patient.
- I respond by saying I am struggling with some strong feelings from a bad experience in my personal life. I will be happy to help you, but I need a few minutes to collect my thoughts before we assist this patient.

Scenario 2 – Emotional Garbage Truck Response

- I call a physician to discuss orders for a patient's ventilator settings. The physician responds rudely that I should know the answer and then proceeds to lecture me about not calling them after 10pm.
- I start physically shaking and respond by hanging up the phone.

Scenario 2 – Emotionally Intelligent Response

- I call a physician to discuss orders for a patient's ventilator settings. The physician responds rudely that I should know the answer and then proceeds to lecture me about not calling them after 10pm.
- I can feel myself physically shaking. I know that is a personal sign I am experiencing the emotion anger. I take a few deep breaths and respond by explaining that I understand their frustration. However, we need to address the ventilator setting concerns, in order to, safely care for this patient.

Help, I'm drowning in emotions…

Emotional Intelligence Rescue Strategies

Get to Know Yourself

Why do I respond the way that I respond?

What are common emotional triggers for me?

How does my body respond physically to emotions?

Get to Know Yourself

Keep it neutral

Journal

What do I value most?

Learn to Manage Your Behavior

THINK SITUATIONS THROUGH BEFORE RESPONDING

SEEK ADVICE FROM A TRUSTED SOURCE

FIND AN ACCOUNTABILITY PARTNER

Learn to Manage Your Behavior

Plan ahead for people or situations that trigger your emotions.

Take time to process your thoughts and feelings.

Have a plan in place for how you will react when you become triggered.

Get to Know Others

- Take a genuine interest in getting to know others
- Pay attention to body language and interactions
- Listen to understand not to respond
- Be open to other perspectives

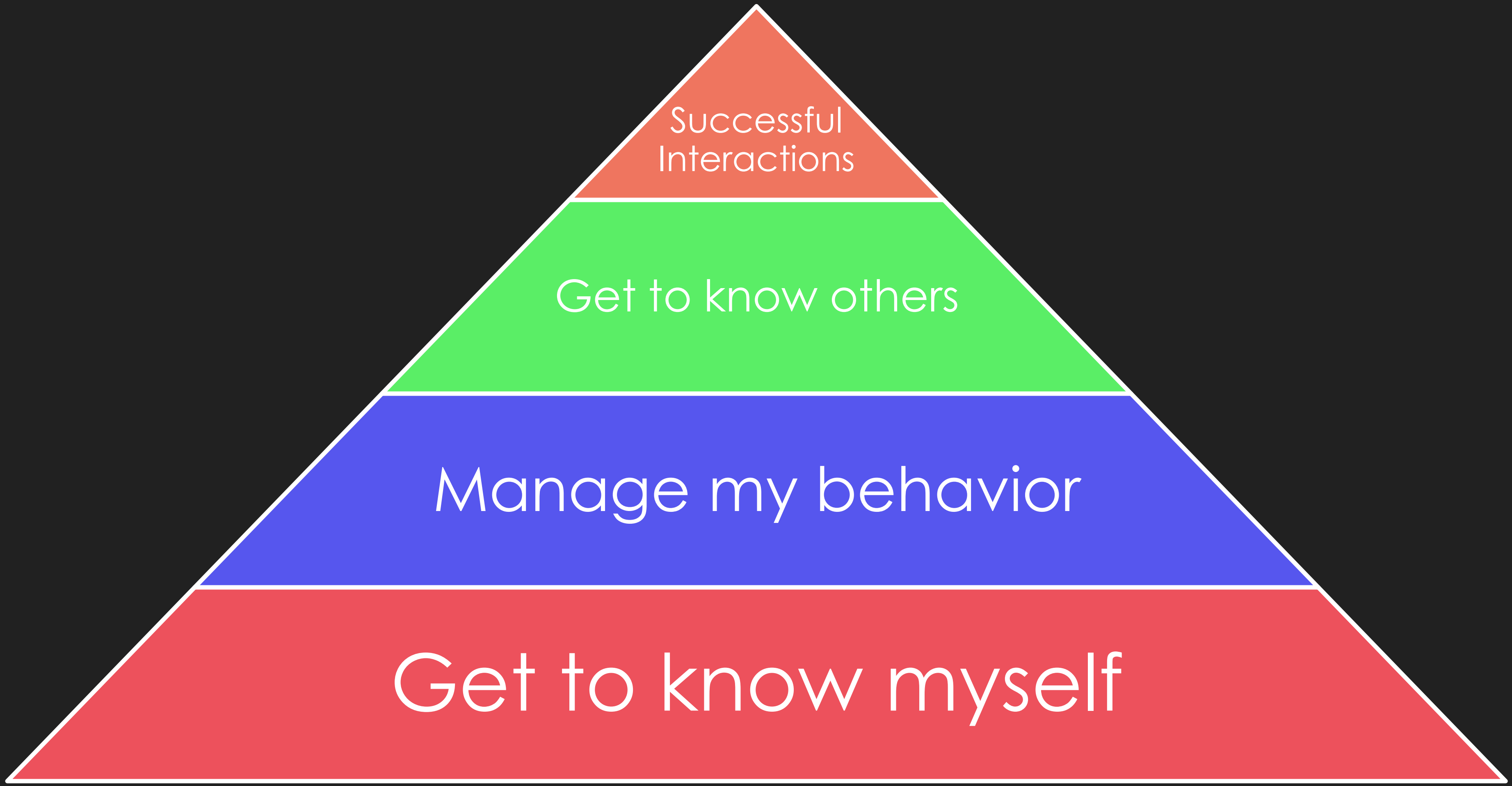
Put it All Together

- Treat others with respect
- Confront difficult situations
- Show you care for others in tangible ways

Put it All Together

- Be fair and consistent
- When things get heated – practice the pause
- What impact do you want to make?

Build on Your Success



Closing Remarks

"All sentient beings possess awareness, but among them human beings possess great intelligence. Subject to a constant stream of positive and negative thoughts and emotions, what distinguishes us as humans is that we are capable of positive change."

– the Dalai Lama

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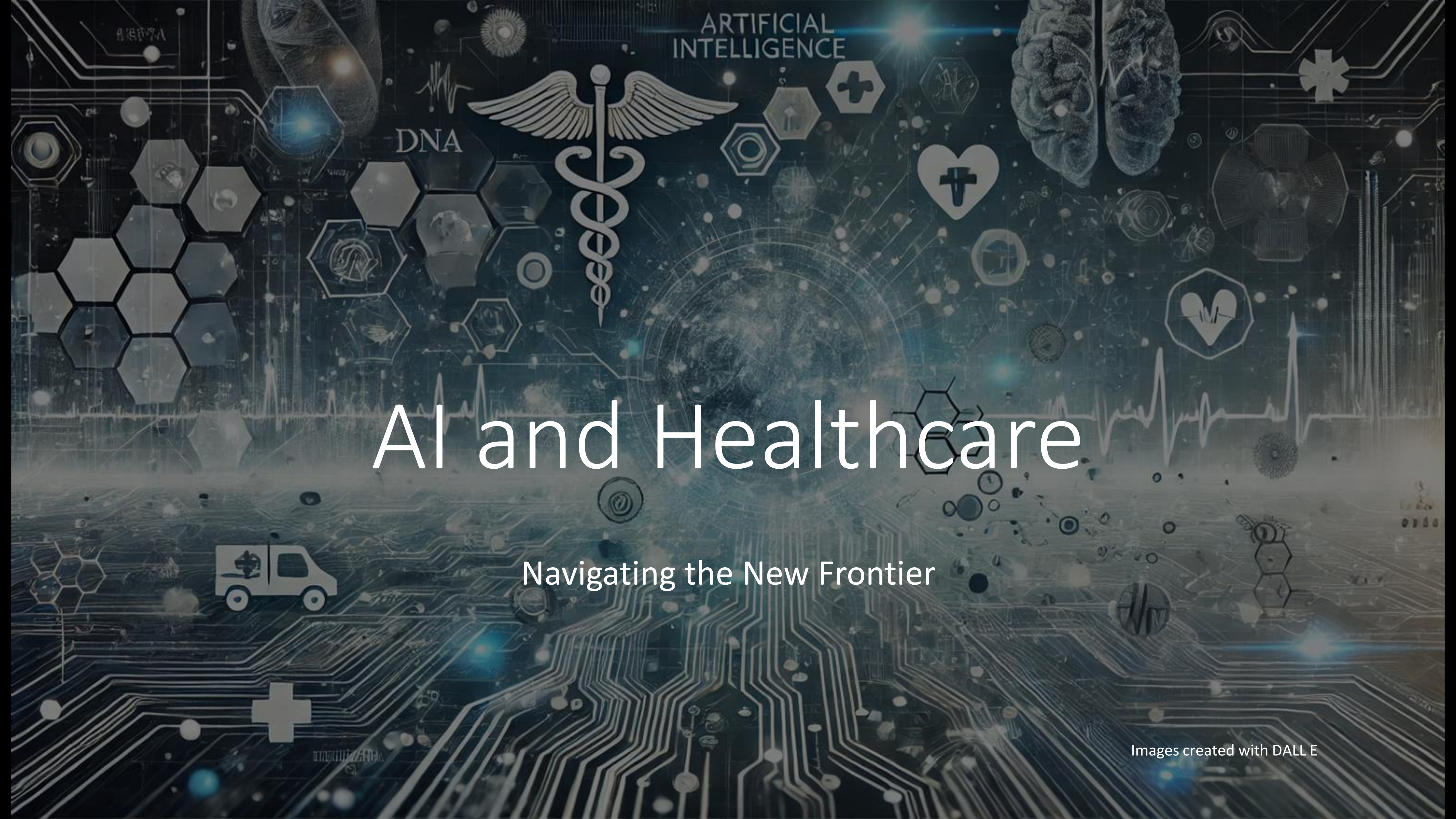
Questions?



AI and Healthcare

Navigating the New Frontier

Images created with DALL E

Learning Objectives

- **Define Common AI Terms**
- **Explain AI's impact on the economy**
- **Discuss AI's impact on society**
- **Current and Future AI Application in Health Care Research**
- **Demonstrate Generative AI**profession.

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Defining Artificial Intelligence

An umbrella term for any machine that can replace some aspect of human intelligence. AI systems learn independently by analyzing data over time, creating intelligent machines, and developing algorithms

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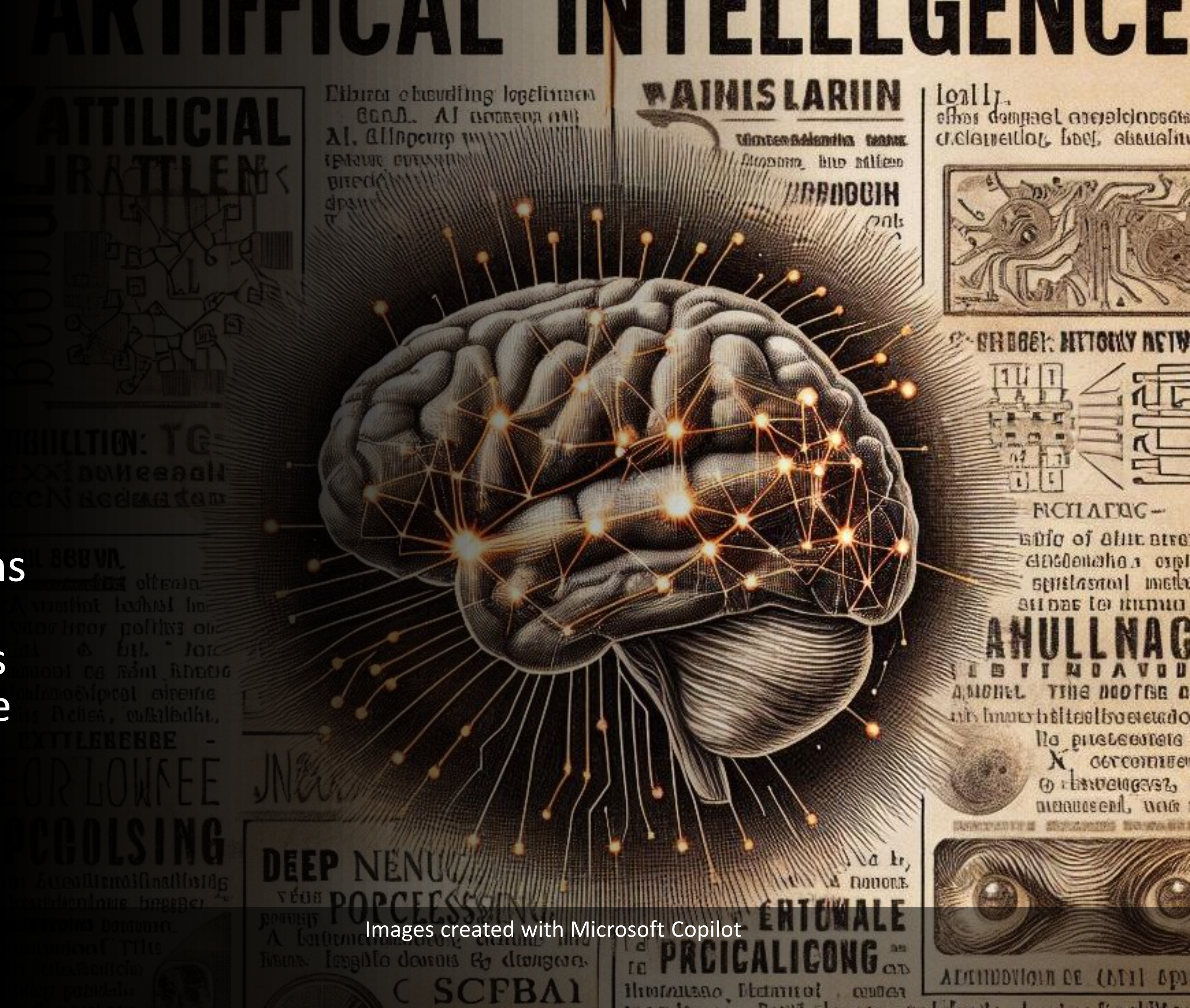
Common AI Terms

Machine Learning (ML): Computers learn without explicit programming. ML algorithms make predictions by identifying patterns and trends from data. Examples include chatbots, predictive text, and personalized recommendations



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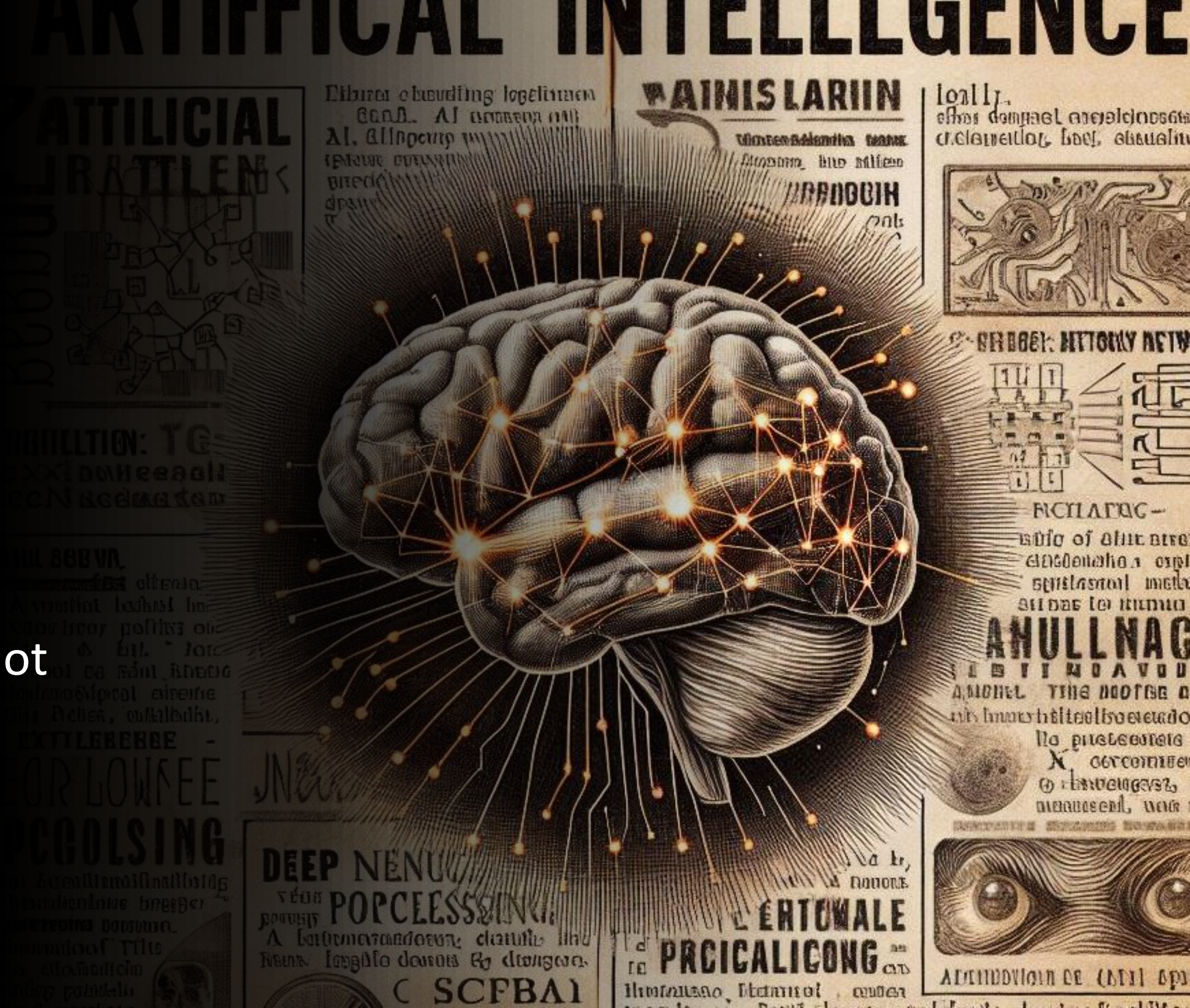
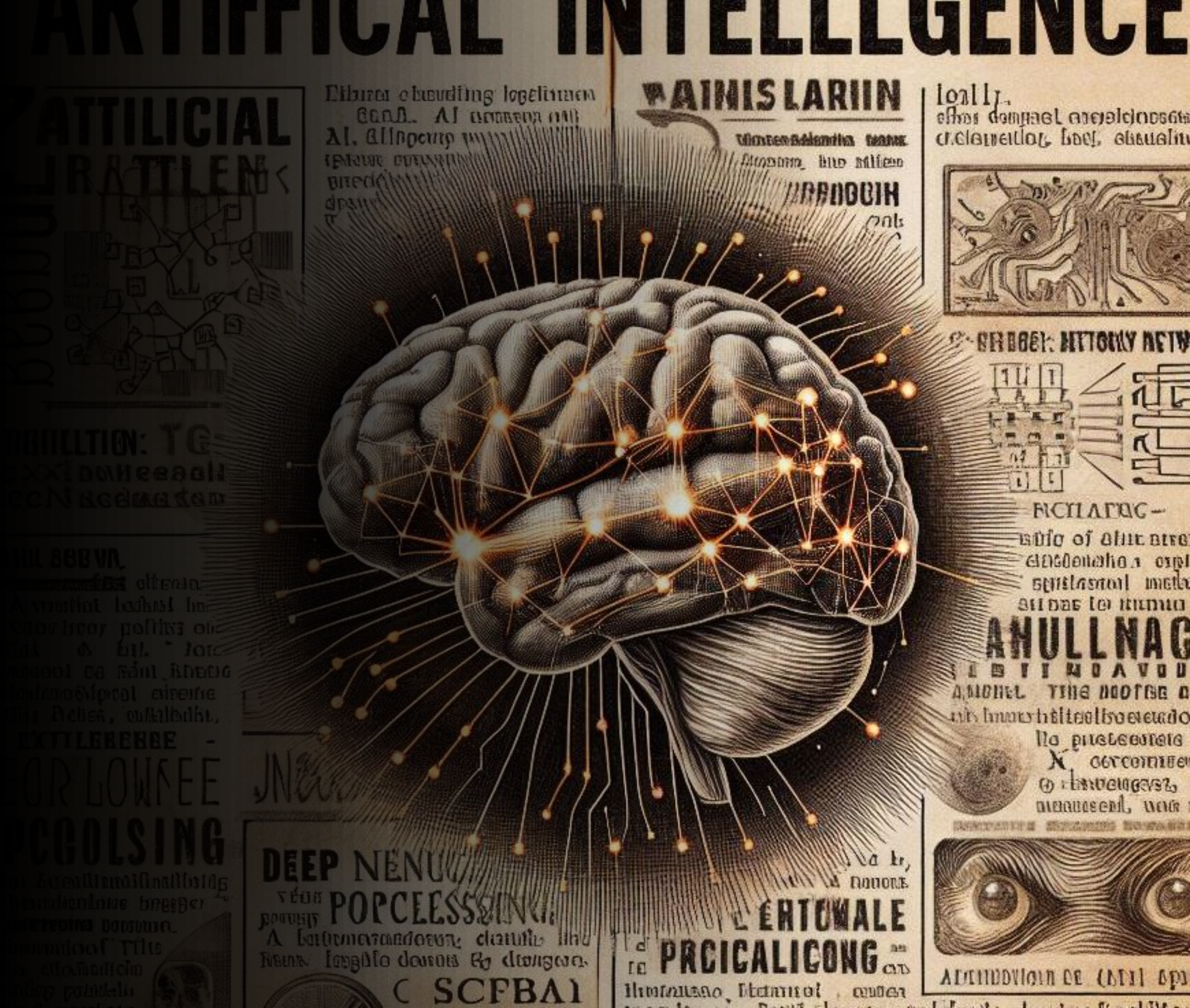
Common AI Terms

AI Hallucinations: When an AI model gets information wrong or completely makes up its own information that is not correct.



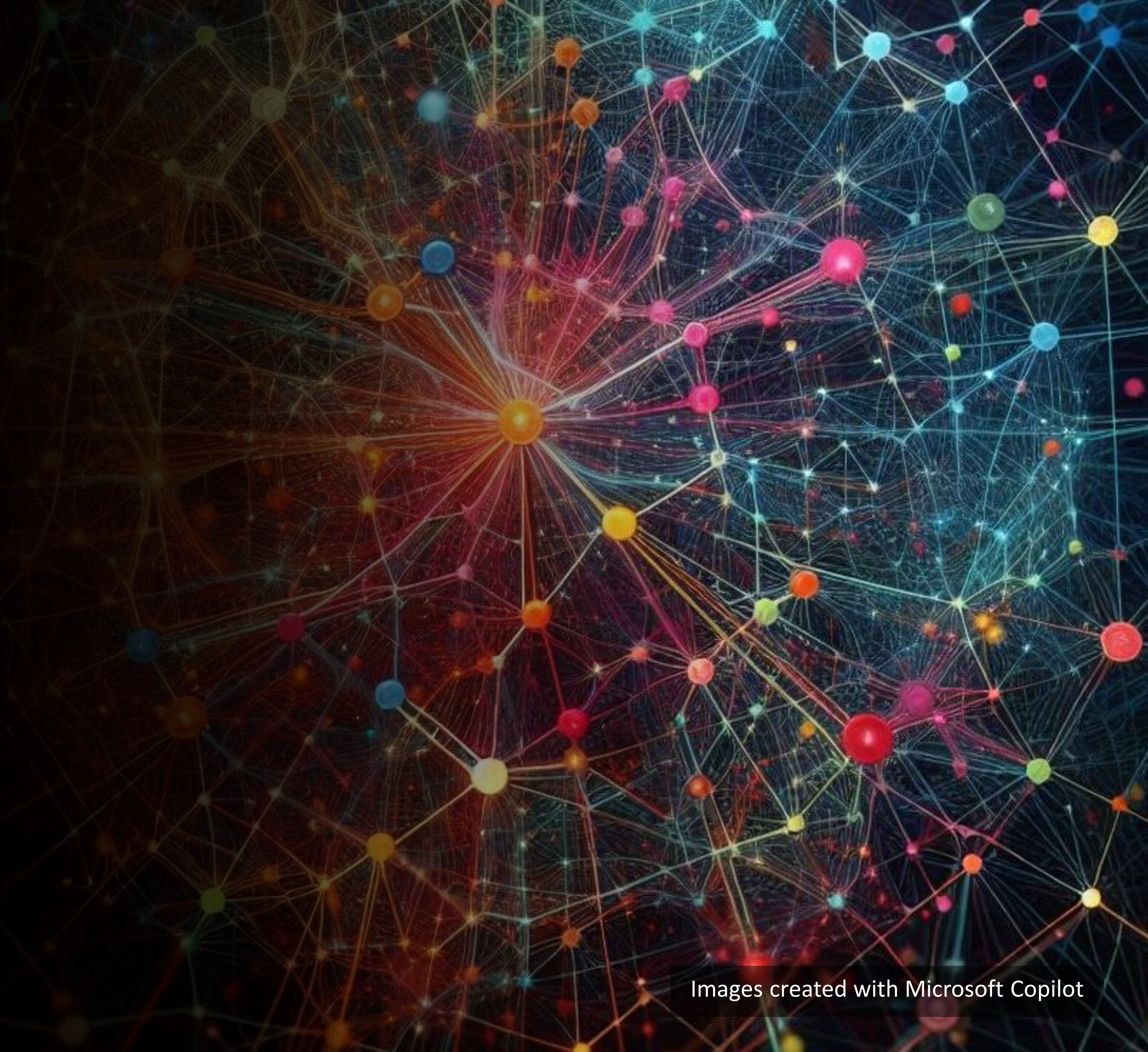
Common AI Terms

Deep Learning (DL): A specialized ML technique that teaches computers to learn by example.



Common AI Terms

Neural Network: A computational model designed to simulate the way the human brain analyzes and processes information. It is the foundation of deep learning and helps to perform tasks like image and speech recognition.



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Common AI Terms

Generative AI: An AI system that can create original content such as text, images, videos, etc.

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Common AI Terms

Synthetic Data: Data, information, or computer code that has been created by AI versus a human.

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Common AI Terms

Computer Vision: a field of AI that enables machines to interpret and analyze visual information from images and videos, allowing them to recognize objects, identify patterns, and make decisions based on visual data. It mimics human vision and is used in areas like medical imaging, autonomous vehicles, and facial recognition

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Common AI Terms

Large Language Model (LLM): A type of AI that uses deep learning to understand and generate human-like text, enabling it to perform tasks like translation, summarization, and question answering.

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Common AI Terms

Natural Language Processing (NLP): The ability of computers to understand and interpret human language.

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AI's Impact

The Good & The Bad

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Economic

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Economic

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Economic

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Societal

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Societal

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Healthcare

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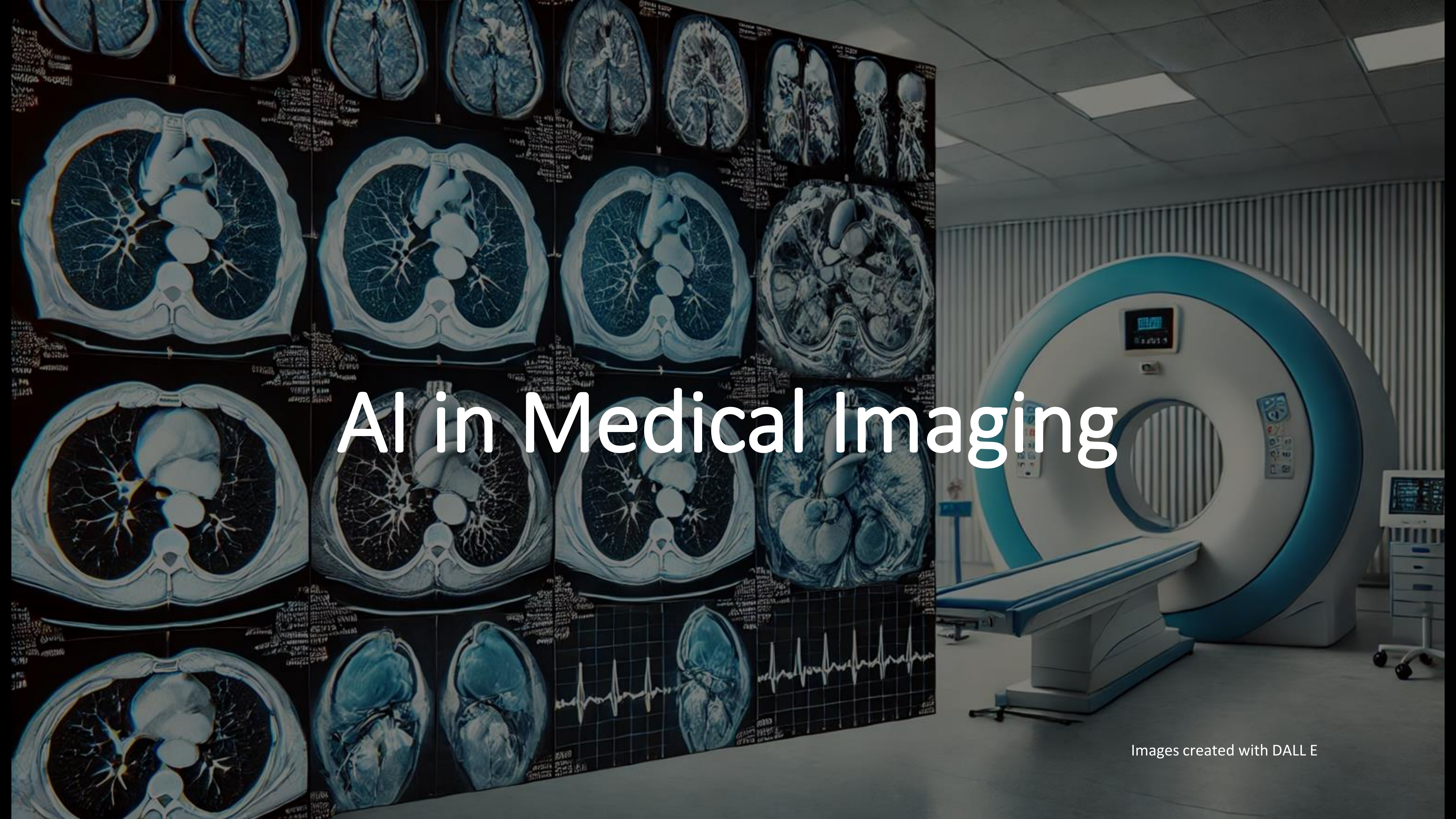
You are already surrounded by AI

Images created with Microsoft Copilot



AI in Medical Imaging

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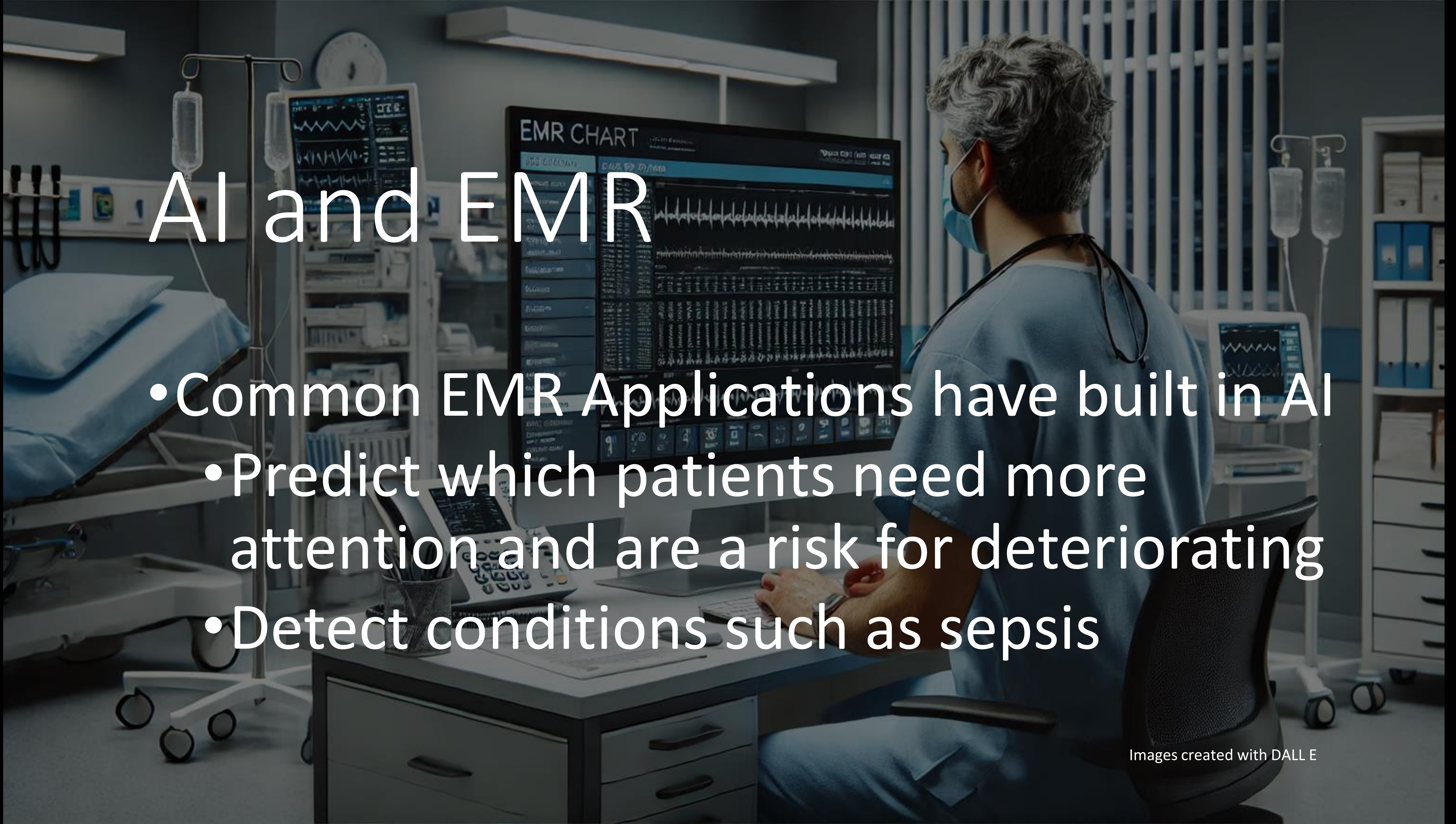
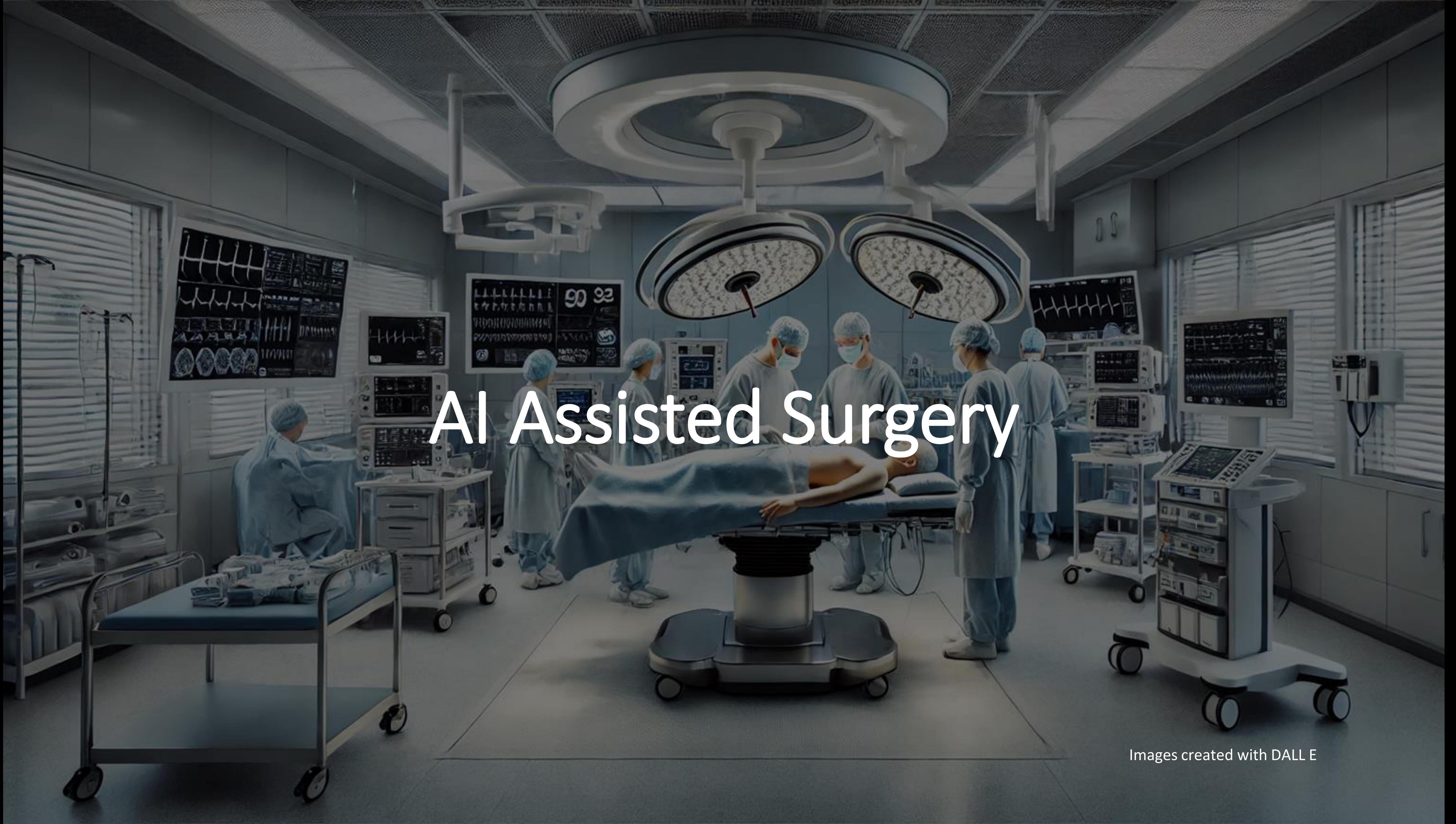


AI and EMR

- Common EMR Applications have built in AI
  - Predict which patients need more attention and are a risk for deteriorating
  - Detect conditions such as sepsis

Images created with DALL E

AI Assisted Surgery



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AI in Medical Research

Research

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Individualized Treatment Effects of Oxygen Targets in Mechanically Ventilated Critically Ill Adults

Kevin G. Buell, MBBS; Alexandra B. Spicer, MS; Jonathan D. Casey, MD, MSc; Kevin P. Seitz, MD, MSc; Edward T. Qian, MD, MSc; Emma J. Graham Linck, MS; Wesley H. Self, MD, MPH; Todd W. Rice, MD, MSc; Pratik Sinha, MBChB, PhD; Paul J. Young, MD, PhD; Matthew W. Semler, MD, MSc; Matthew M. Churpek, MD, MPH, PhD

IMPORTANCE Among critically ill adults, randomized trials have not found oxygenation targets to affect outcomes overall. Whether the effects of oxygenation targets differ based on an individual's characteristics is unknown.

OBJECTIVE To determine whether an individual's characteristics modify the effect of lower vs higher peripheral oxygenation-saturation (Spo_2) targets on mortality.

DESIGN, SETTING, AND PARTICIPANTS A machine learning model to predict the effect of treatment with a lower vs higher Spo_2 target on mortality for individual patients was derived

Editorial page 1179

Related articles pages 1185 and 1225

Supplemental content

AI in Medical Research

OBJECTIVE To determine whether an individual's characteristics modify the effect of lower vs higher peripheral oxygenation-saturation (Spo_2) targets on mortality.

DESIGN, SETTING, AND PARTICIPANTS A machine learning model to predict the effect of treatment with a lower vs higher Spo_2 target on mortality for individual patients was derived in the Pragmatic Investigation of Optimal Oxygen Targets (PILOT) trial and externally validated in the Intensive Care Unit Randomized Trial Comparing Two Approaches to Oxygen Therapy (ICU-ROX) trial. Critically ill adults received invasive mechanical ventilation in an intensive care unit (ICU) in the United States between July 2018 and August 2021 for PILOT (n = 1682) and in 21 ICUs in Australia and New Zealand between September 2015 and May 2018 for ICU-ROX (n = 965).

EXPOSURES Randomization to a lower vs higher Spo_2 target group.

MAIN OUTCOME AND MEASURE 28-Day mortality.

RESULTS In the ICU-ROX validation cohort, the predicted effect of treatment with a lower vs higher Spo_2 target for individual patients ranged from a 27.2% absolute reduction to a 34.4% absolute increase in 28-day mortality. For example, patients predicted to benefit from a lower

AI in Medical Research

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AI in Medical Research

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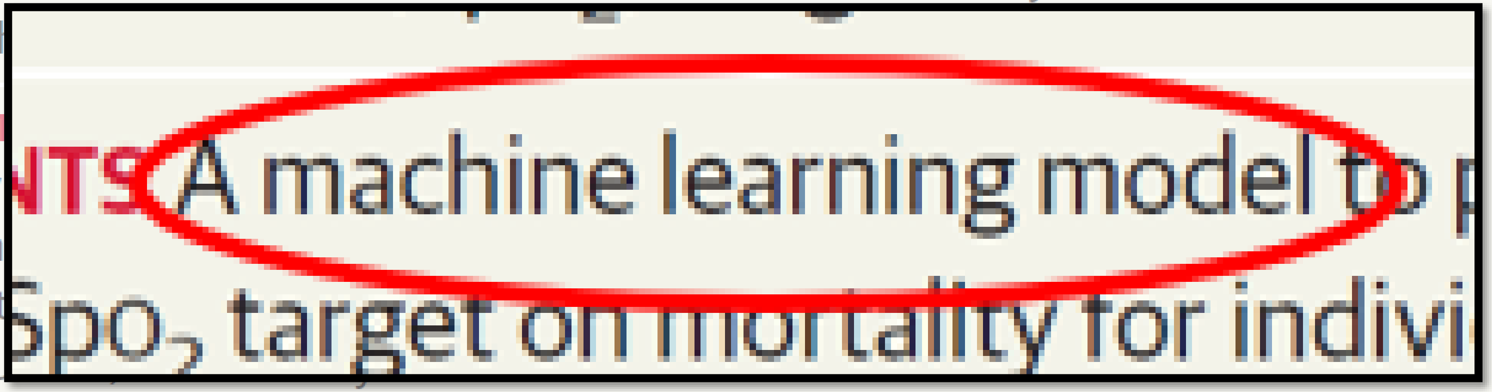

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AI in Medical Research

RESULTS In the ICU-ROX validation cohort, the predicted effect of treatment with a lower vs higher Spo_2 target for individual patients ranged from a 27.2% absolute reduction to a 34.4% absolute increase in 28-day mortality. For example, patients predicted to benefit from a lower Spo_2 target had a higher prevalence of acute brain injury, whereas patients predicted to benefit from a higher Spo_2 target had a higher prevalence of sepsis and abnormally elevated vital signs. Patients predicted to benefit from a lower Spo_2 target experienced lower mortality when randomized to the lower Spo_2 group, whereas patients predicted to benefit from a higher Spo_2 target experienced lower mortality when randomized to the higher Spo_2 group (likelihood ratio test for effect modification $P = .02$). The use of a Spo_2 target predicted to be best for each patient, instead of the randomized Spo_2 target, would have reduced the absolute overall mortality by 6.4% (95% CI, 1.9%-10.9%).

CONCLUSION AND RELEVANCE Oxygenation targets that are individualized using machine learning analyses of randomized trials may reduce mortality for critically ill adults.
A prospective trial evaluating the use of individualized oxygenation targets is needed.

AI in Medical Research

ORIGINAL ARTICLE
LUNG STRUCTURE AND FUNCTION

Artificial intelligence outperforms pulmonologists in the interpretation of pulmonary function tests

Marko Topalovic[1], Nilakash Das[1], Pierre-Régis Burgel[2], Marc Daenen[3], Eric Derom[4], Christel Haenebalcke[5], Rob Janssen[6], Huib A.M. Kerstjens[7], Giuseppe Liistro[8], Renaud Louis[9], Vincent Ninane[10], Christophe Pison[11], Marc Schlesser[12], Piet Vercauter[13], Claus F. Vogelmeier[14], Emiel Wouters[15], Jokke Wynants[16,17] and Wim Janssens[1] on behalf of the Pulmonary Function Study Investigators

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was reached for all these cases. Baseline characteristics are shown in table 1, covering a wide range of respiratory diseases that may present with an abnormal PFT. Other conditions (such as lung cancer, cardiovascular disease, and ear, nose and throat problems) were excluded from the test sample (n=3). The Ethics Committee of the University Hospital Leuven approved the study protocol (approval S60619; August 4, 2017). The study design can be found at ClinicalTrials.gov (identifier NCT03264417). All included patients provided informed consent for the use of their data (approval S60243; June 23, 2017).

AI software

The development of software for automated reading of PFTs was performed in R language and its machine learning framework. The software used the same lung function data as input as presented to the

cteristics of the 50 subjects whose lung function was evaluated in the study

COPD	OBD	NMD	TD	ILD	PVD	Healthy
11	4	3	5	10	4	5
8/3	3/1	2/1	4/1	6/4	3/1	3/2

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AI in Medical Research

ASTHMA: ORIGINAL RESEARCH · Volume 159, Issue 5, P1747-1757, May 2021

Novel Machine Learning Can Predict Acute Asthma Exacerbation

Joe G. Zein, MD, PhD [a,b] · Chao-Ping Wu, MD [a] · Amy H. Attaway, MD [a,b] · Peng Zhang, MD [a] · Aziz Nazha, MD [b,c,d]

Affiliations & Notes Article Info

Abstract

Background

Asthma exacerbations result in significant health and economic burden, but are difficult to predict.

Research Question

Can machine learning (ML) models with large-scale outpatient data predict asthma exacerbations?

AI in Medical Research

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AI in Medical Research

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machine learning (ML) models patient data predict asthma exacerbations?

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Results

Of 60,302 patients, 19,772 (32.8%) had at least one nonsevere exacerbation requiring oral glucocorticoid burst, 1,748 (2.9%) requiring and ED visit and 902 (1.5%) requiring hospitalization. Nonsevere exacerbation, ED visit, and hospitalization were predicted best by light gradient boosting machine, an algorithm used in ML to fit predictive analytic models, and had an area under the receiver operating characteristic curve of 0.71 (95% CI, 0.70-0.72), 0.88 (95% CI, 0.86-0.89), and 0.85 (95% CI, 0.82-0.88), respectively. Risk factors for all three outcomes included age, long-acting β agonist, high-dose inhaled glucocorticoid, or chronic oral glucocorticoid therapy. In subgroup analysis of 9,448 patients with spirometry data, low FEV_1 and FEV_1 to FVC ratio were identified as top risk factors for asthma exacerbation, ED visits, and hospitalization. However, adding pulmonary function tests did not improve models' prediction performance.

Interpretation

Models built with an ML algorithm from real-world outpatient EHR data accurately predicted asthma exacerbation and can be incorporated into clinical decision tools to enhance outpatient care and to prevent adverse outcomes.

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AI in Medical Research

JAMA Network Open

Original Investigation | Health Informatics

Comparison of Chest Radiograph Captions Based on Natural Language Processing vs Completed by Radiologists

Yaping Zhang, MD, PhD; Mingqian Liu, MSc; Lu Zhang, MD; Lingyun Wang, MD; Keke Zhao, MD; Shundong Hu; Xu Chen, PhD; Xueqian Xie, MD, PhD

Abstract

IMPORTANCE Artificial intelligence (AI) can interpret abnormal signs in chest radiography (CXR) and generate captions, but a prospective study is needed to examine its practical value.

OBJECTIVE To prospectively compare natural language processing (NLP)-generated CXR captions and the diagnostic findings of radiologists.

DESIGN, SETTING, AND PARTICIPANTS A multicenter diagnostic study was conducted. The

Key Points

Question Can natural language processing (NLP) be used to generate chest radiograph (CXR) captions?

Findings In this diagnostic study including 74 082 CXR cases labeled with NLP for 23 abnormal signs to train convolutional neural networks, an

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OBJECTIVE To prospectively compare natural language processing (NLP)-generated CXR captions and the diagnostic findings of radiologists.

DESIGN, SETTING, AND PARTICIPANTS A multicenter diagnostic study was conducted. The training data set included CXR images and reports retrospectively collected from February 1, 2014, to February 28, 2018. The retrospective test data set included consecutive images and reports from April 1 to July 31, 2019. The prospective test data set included consecutive images and reports from May 1 to September 30, 2021.

EXPOSURES A bidirectional encoder representation from a transformers model was used to extract language entities and relationships from unstructured CXR reports to establish 23 labels of abnormal signs to train convolutional neural networks. The participants in the prospective test group were randomly assigned to 1 of 3 different caption generation models: a normal template, NLP-generated

Key Points

Question Can natural language processing (NLP) be used to generate chest radiograph (CXR) captions?

Findings In this diagnostic study including 74 082 CXR cases labeled with NLP for 23 abnormal signs to train convolutional neural networks, an independent prospective test data set of 5091 participants was examined. The reporting time using NLP-generated captions as prior information was 283 seconds, significantly shorter than the normal template (347 seconds) and rule-based model (296 seconds), while maintaining good consistency with radiologists.

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Yaping Zhang, MD, PhD; Mingqian L

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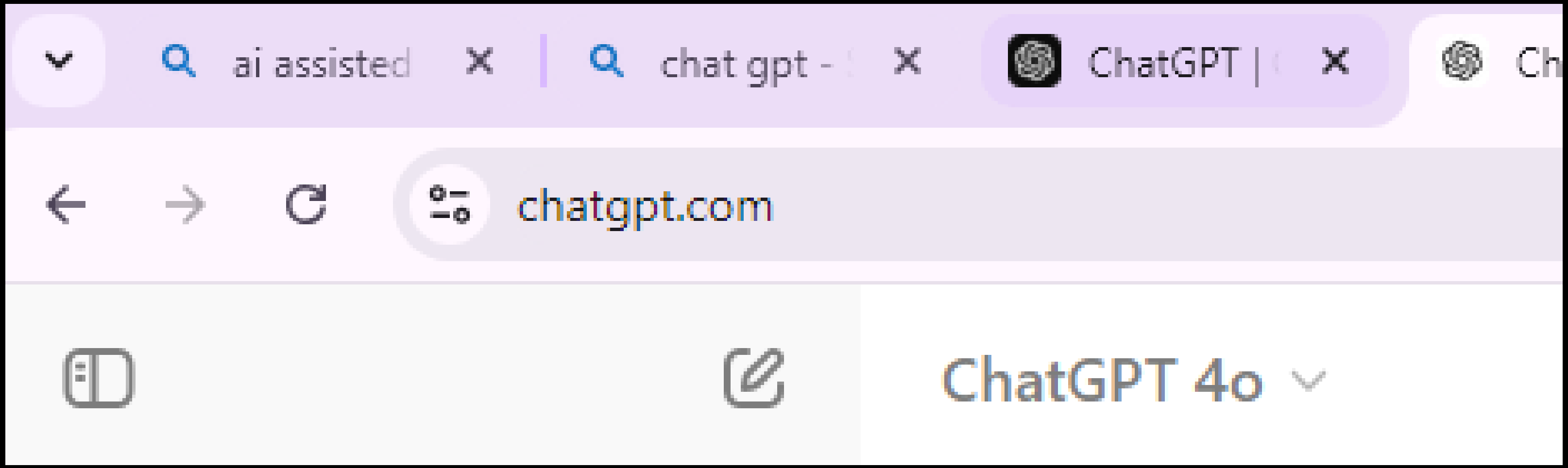
Generative AI



ChatGPT 4o

JA

Quiz me on world capitals

Experience Seoul like a local

Design a fun coding game

Text inviting friend to wedding

Message ChatGPT

ChatGPT can make mistakes. Check important info.

?

Generative AI Guard Rails

Generative AI Guard Rails

- No Personal or Personally identifying information
- No Business Confidential or Proprietary information
- No Protected Health Information
- No Enterprise Computer Code

Generative AI Guard Rails

When AI is quoted or paraphrased it should be cited.

Both MLA and APA styles have guidance how to cite generative AI content

Generative AI Guard Rails

APA example:

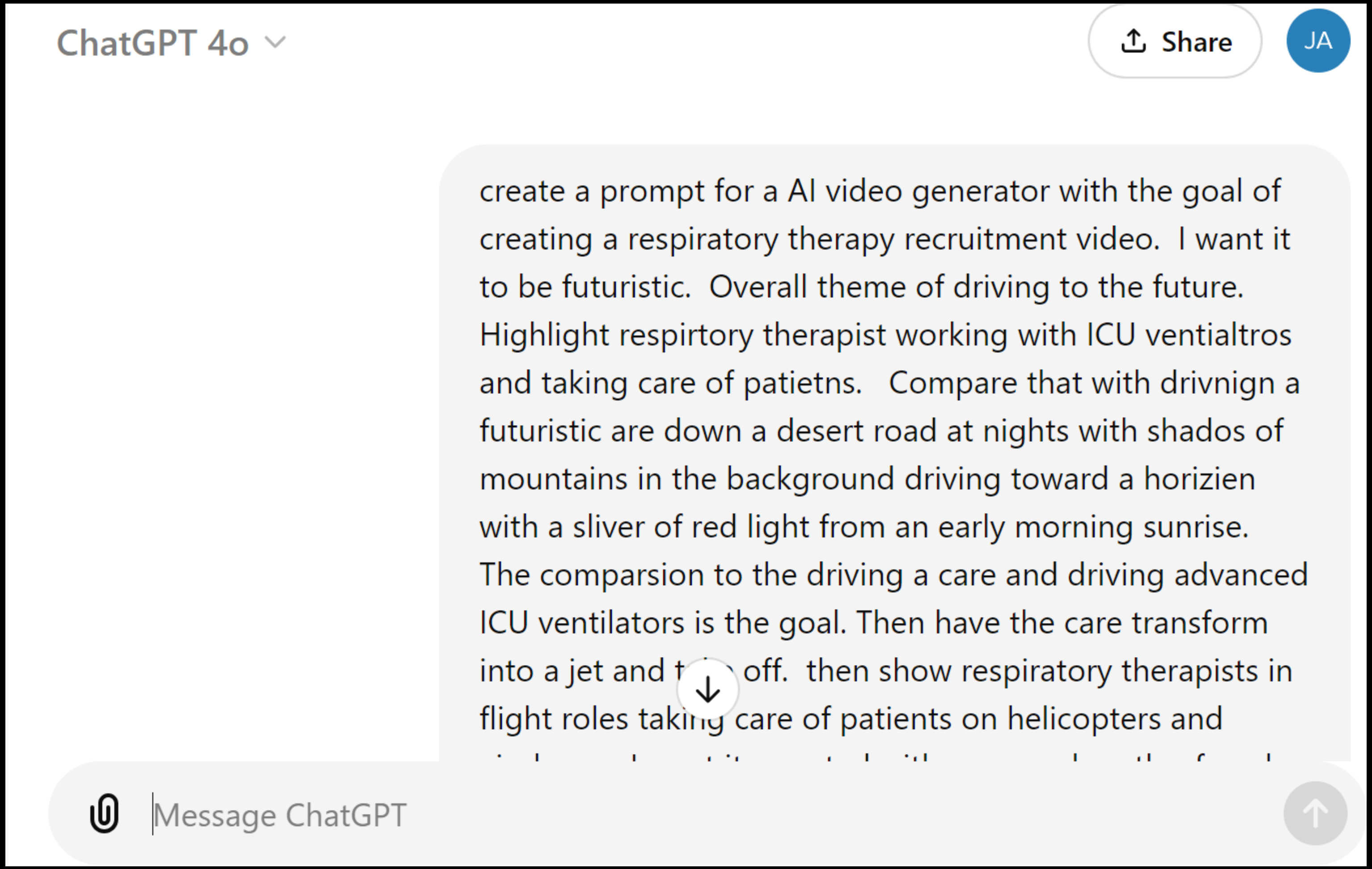
Microsoft. (2024). Copilot. https://www.bing.com/search?q=bing&qs=n&form=QBRE&sp=-1&lq=0&pq=bing&sc=12-4&sk=&cvid=0E3A219A00A54829A7F8E3AD769BD044&ghsh=0&ghacc=0&ghpl=&showconv=1

Generative AI Guard Rails

MLA example:

"create an image of a guard rail". Copilot, Microsoft, 25 Apr. 2024. Microsoft. (2024). Copilot. https://www.bing.com/search?q=bing&qs=n&form=QBRE&sp=-1&lq=0&pq=bing&sc=12-4&sk=&cvid=0E3A219A00A54829A7F8E3AD769BD044&ghsh=0&ghacc=0&ghpl=&showconv=1.

Generative AI



Generative AI

- **Visuals:** Cut back to the car speeding down the road, now approaching the horizon where the sky is beginning to brighten. The car's speed increases, symbolizing progress and advancement.
- **Narration:** "You're on the front lines, navigating the most critical moments of care..."

Scene 4: Transformation

- **Visuals:** The car begins to transform, seamlessly morphing into a futuristic jet as it lifts off the ground, soaring into the sky.
- **Narration:** "...where the journey doesn't end, but takes off into the skies."

Scene 5: In-Flight Care

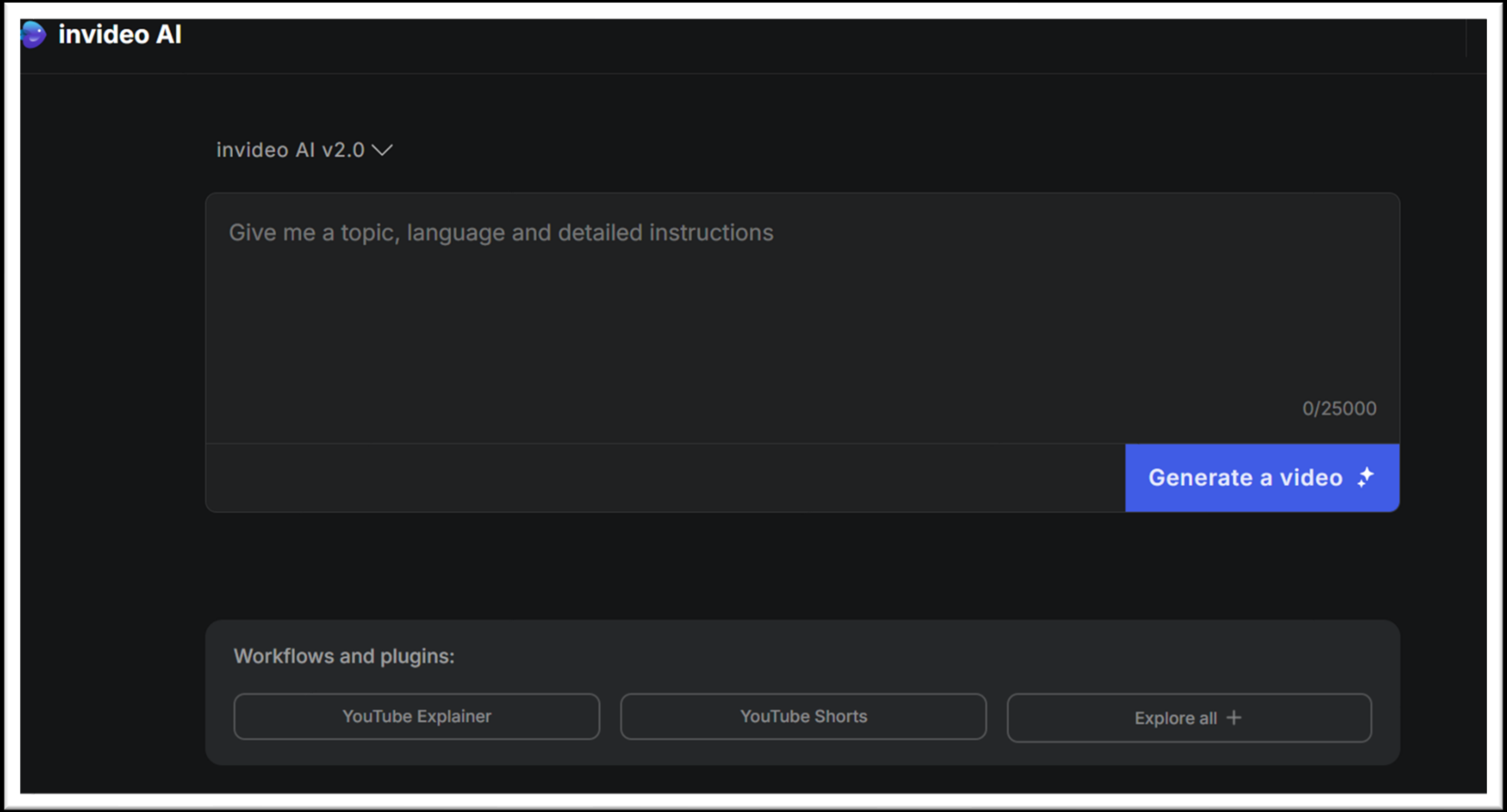
- **Visuals:** Cut to scenes of respiratory therapists in flight roles—working in helicopters and airplanes, providing critical care in the air.
- **Narration:** "From ground to sky, your skills are essential, your mission clear: to save lives, no matter where the road leads."

Scene 6: Closing

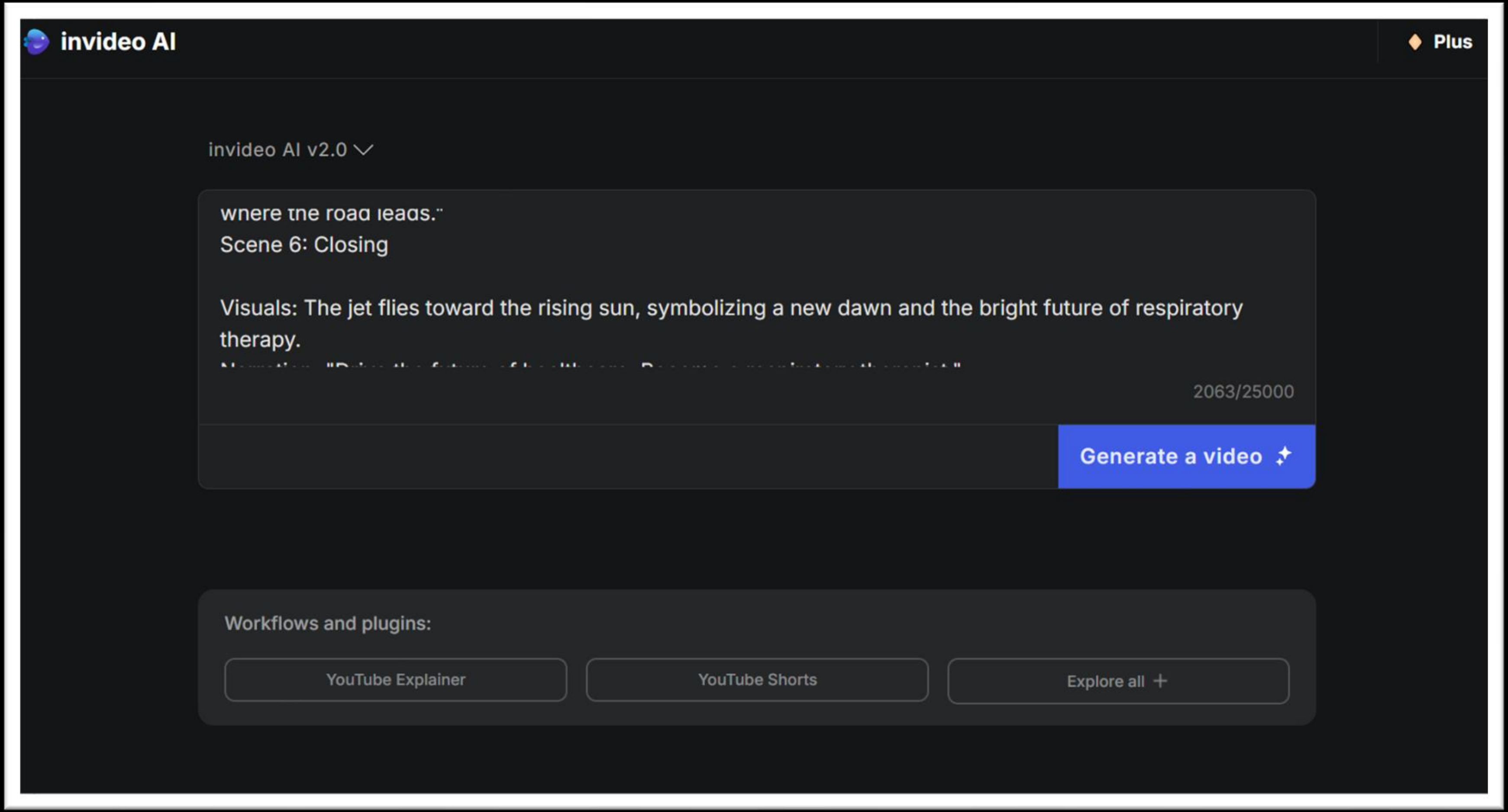
- **Visuals:** The jet flies toward the rising sun, symbolizing a new dawn and the bright future of respiratory therapy.
- **Narration:** "Drive the future of healthcare. Become a respiratory therapist."
- **Text on Screen:** "Join the future. Join us. [Insert Contact Information]"

Background Music: Fast-paced, exciting music that builds momentum and energy throughout the video, matching the pace of the visuals.

Generative AI



Generative AI

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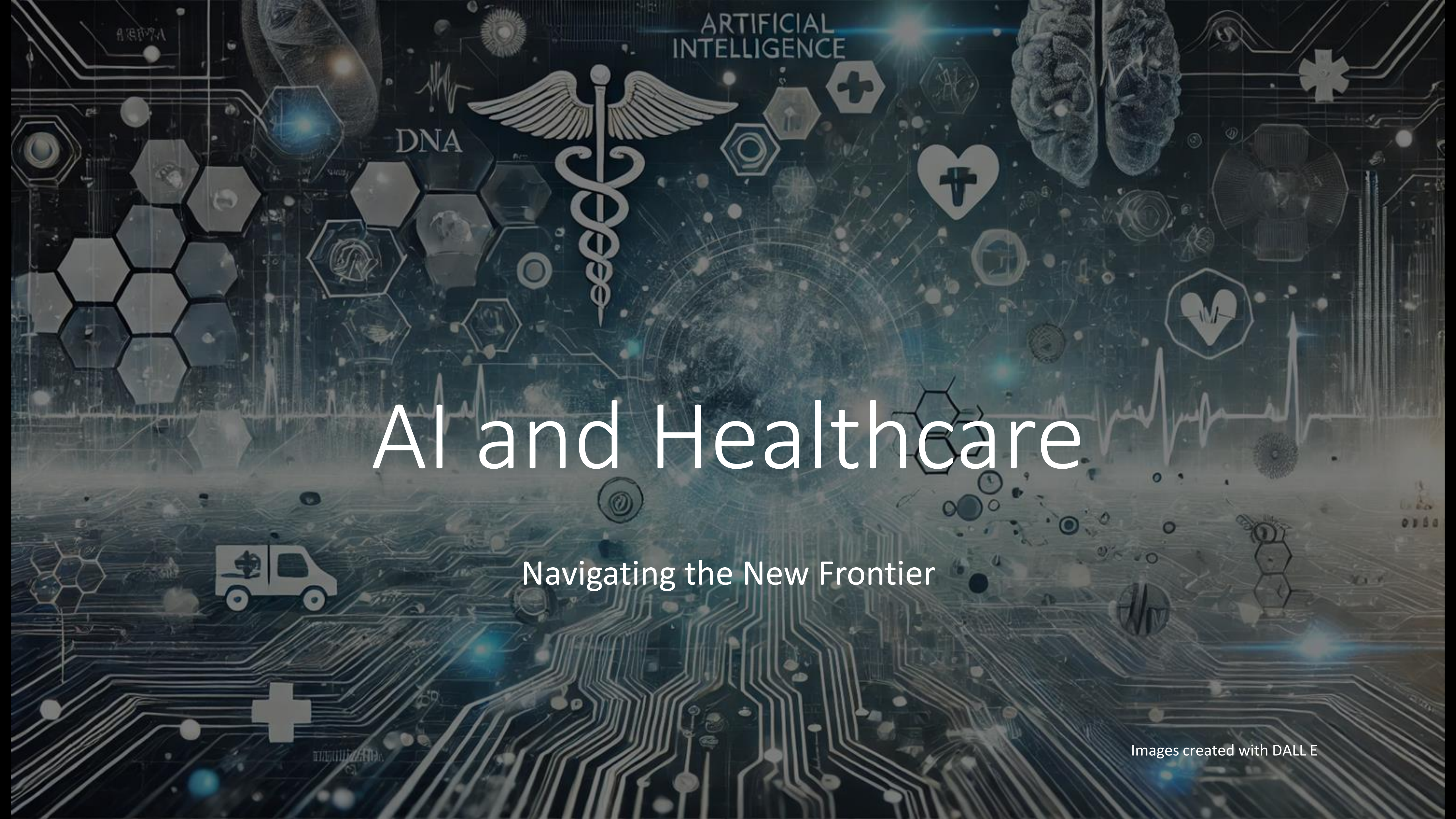

AI and Healthcare

Navigating the New Frontier

Images created with DALL E

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https://www.bing.com/search?q=bing&qs=n&form=QBRE&sp=-1&lq=0&pq=bing&sc=12-4&sk=&cvid=0E3A219A00A54829A7F8E3AD769BD044&ghsh=0&ghacc=0&ghpl=&showconv=1 Accessed 8/24/2024

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How to cite AI generated content Purdue University website. https://guides.lib.purdue.edu/c.php?g=1371380&p=10135074#:~:text=MLA%20in-text%20citation:%20(%22Explain%20antibiotics%22)%20Recommendations Accessed 8/29/2024

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Questions?

Little Victories

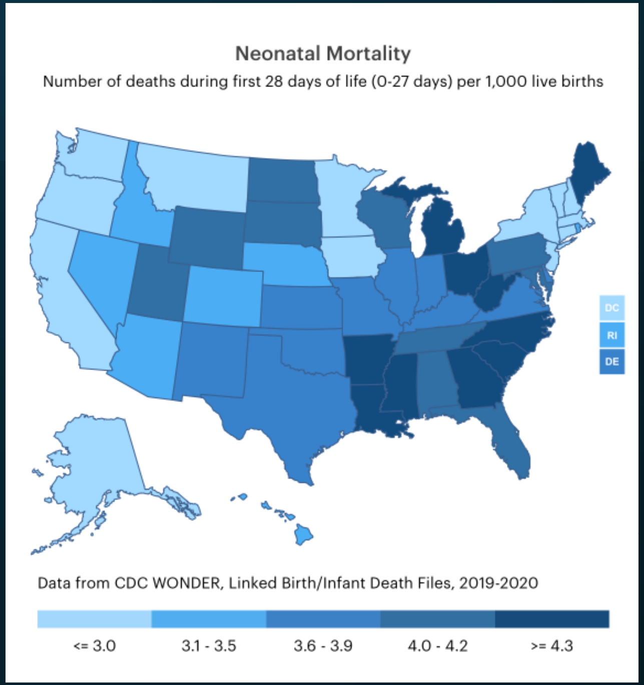
Preparing Your Resuscitation Team to Win

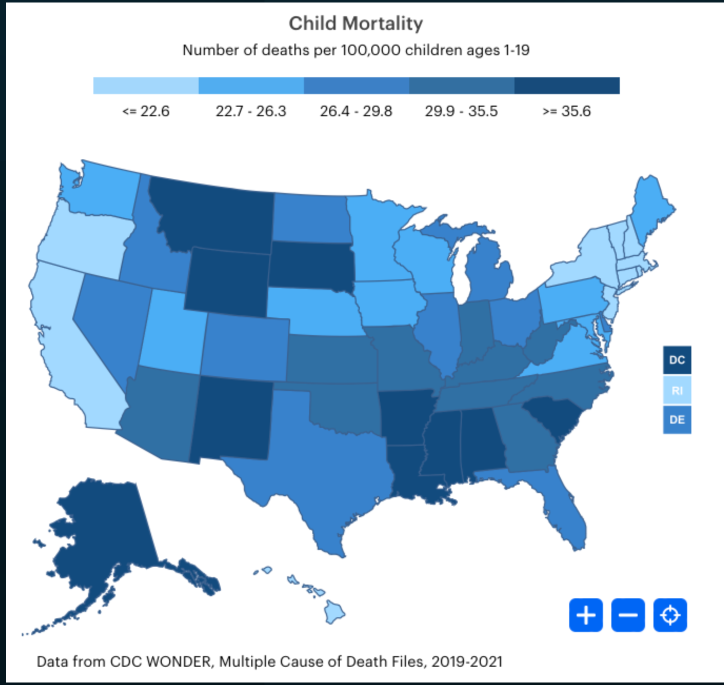
Objectives

- Neonatal & Childhood mortality stats
- Understanding the key elements of training your resuscitation team based on patient unique needs.
- To highlight the importance of teamwork, communication, and continuous practice in achieving success.

WHAT ARE WE BATTLING?

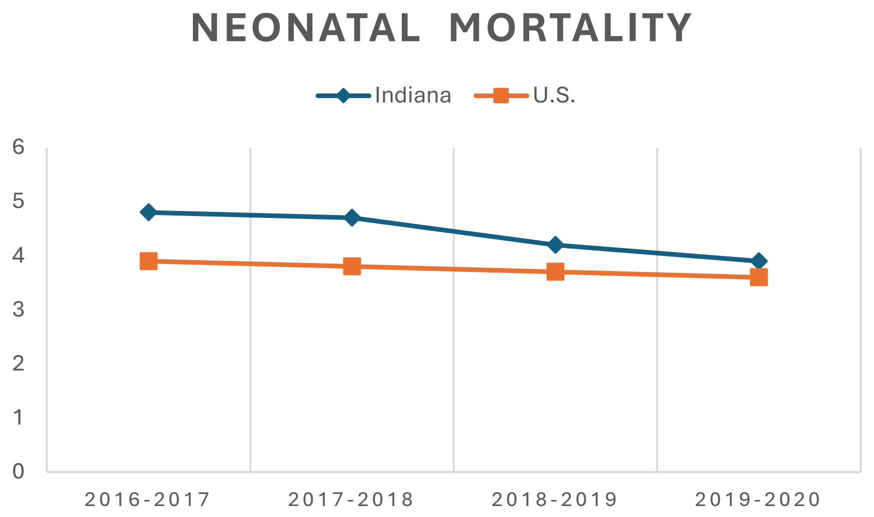
The Stats...


Neonatal Mortality
Number of deaths during first 28 days of life (0-27 days) per 1,000 live births
DC
RI
DE
Data from CDC WONDER, Linked Birth/Infant Death Files, 2019-2020
<= 3.0
3.1 - 3.5
3.6 - 3.9
4.0 - 4.2
>= 4.3

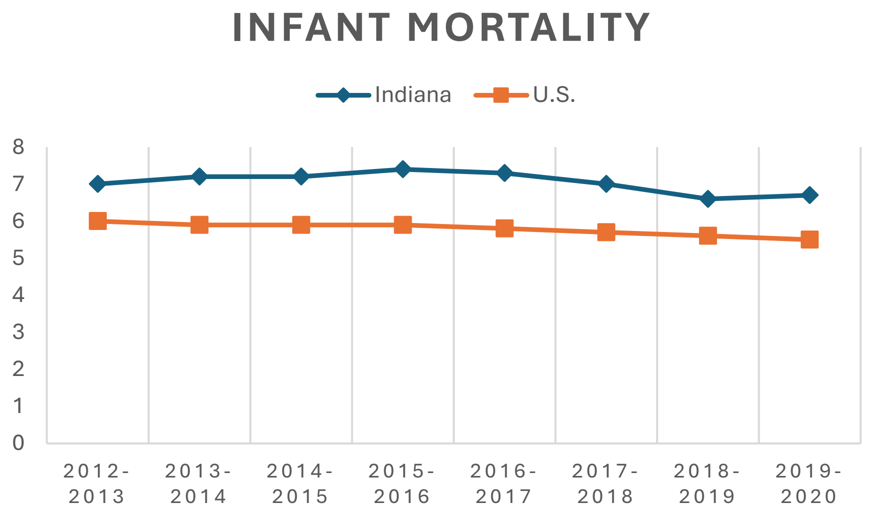

Child Mortality
Number of deaths per 100,000 children ages 1-19
<= 22.6
22.7 - 26.3
26.4 - 29.8
29.9 - 35.5
>= 35.6
DC
RI
DE
Data from CDC WONDER, Multiple Cause of Death Files, 2019-2021

Indiana stats for Neonatal & Infant Mortality …

- Neonatal Mortality (0-28 days):
  - Indiana rank: 26
  - Number of deaths per 1,000 live birth: 3.9



- Infant Mortality (up to first 365 days old)
  - Indiana rank: 39
  - Number of deaths per 1,000 live births: 6.7



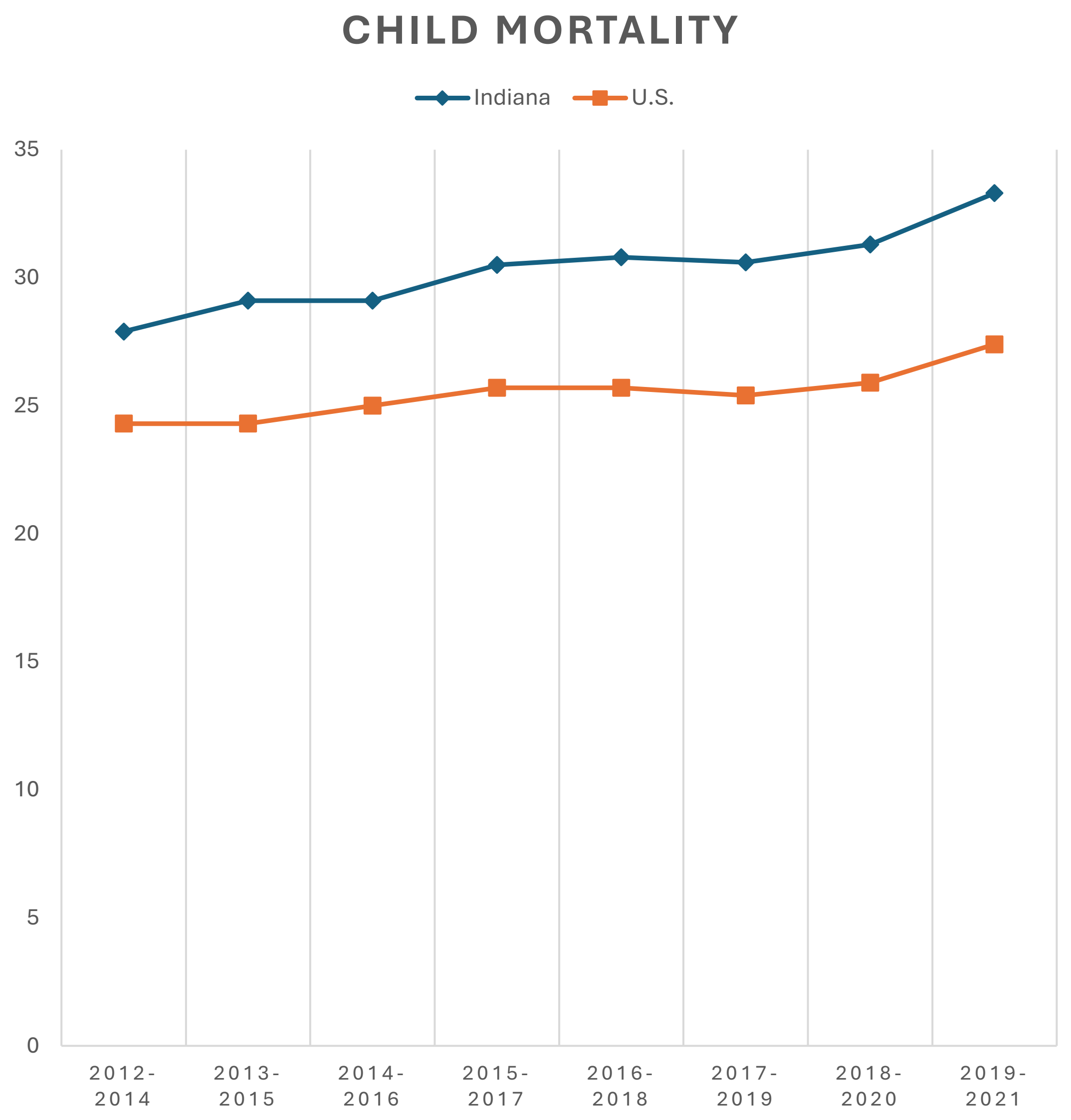
Outcomes…

- Neonatal Codes
    - 83% survived the code in the delivery room
        - 64% survive to discharge
    - Less than 1% of all infants require CPR
        - Higher incidence among preterm infants.

Gestational Age Born At	Survival Rates
>/= 36 %	83%
33-35 %	66%
29-32 %	60%
25-28 %	52%
25 %	25%

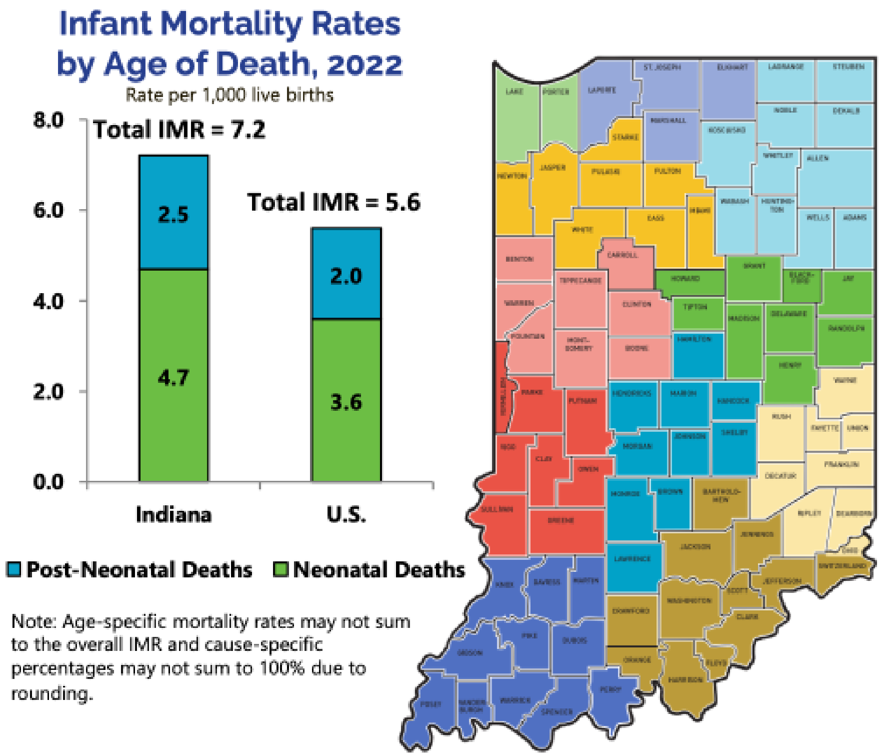
Indiana Stats for Childhood Mortality….

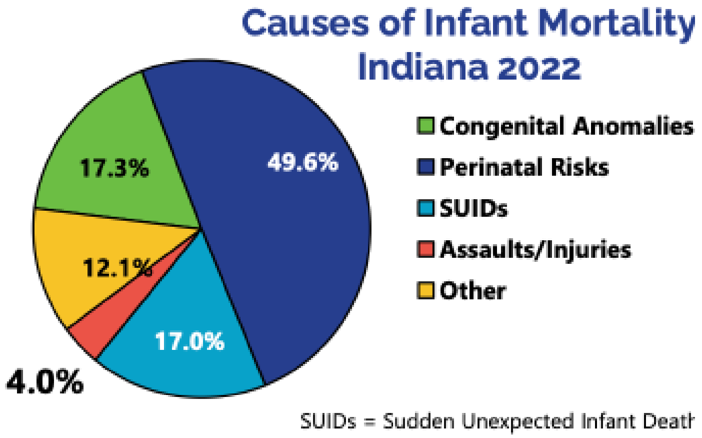
- Child Mortality in Indiana
    - Rank: 35
    - Number of deaths per 100,000 children ages 1-19: 33.3



Childhood

- Most childhood deaths are preventable
- Leading causes of death
    - Accidental (unintentional injuries): 9
    - Assault: 4
    - Intentional self harm: 3.6
    - Malignant neoplasms: 2.1
    - Congenital Malformations, deformations, and chromosomal abnormalities: 1.2





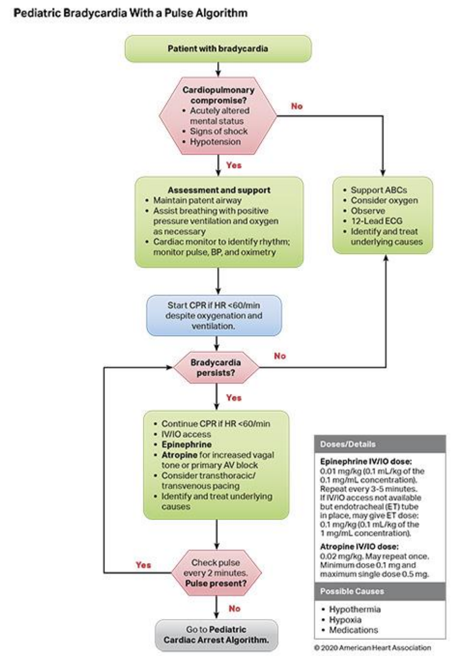
New Players

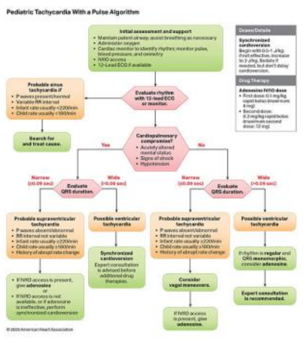
- Reality vs preparation
- Lack of confidence
- Feeling unprepared
- High patient acuity levels

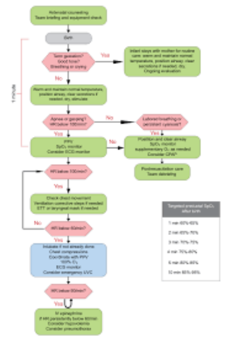
How do we increase our odds?

The Playbook

- Creating the playbook
    - Using the strengths and weakness of our team & our opponent
        - Protocols
        - Policies
        - Guidelines
        - Evidence based practice
    - Classes
        - NRP
        - STABLE
        - PALS / PEARS







Team Structure and Roles

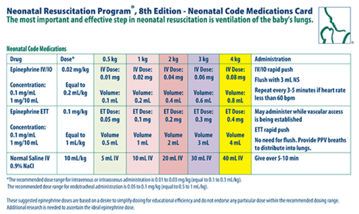
- Draft your players
  - Key players
    - Interdisciplinary
  - Readily available

Communication & Leadership

- Effective Huddles
- Leadership on the field
- Test Communication

Equipment and Environment Readiness

- Gear up for the Game
    - Ensure staff are familiar with equipment
    - Checking equipment
    - Reviewing skills
    - Reviewing dosing
    - Anticipate additional equipment needed



Neonatal Resuscitation Program®, 8th Edition - Neonatal Code Medications Card
The most important and effective step in neonatal resuscitation is ventilation of the baby's lungs.

Neonatal Code Medications

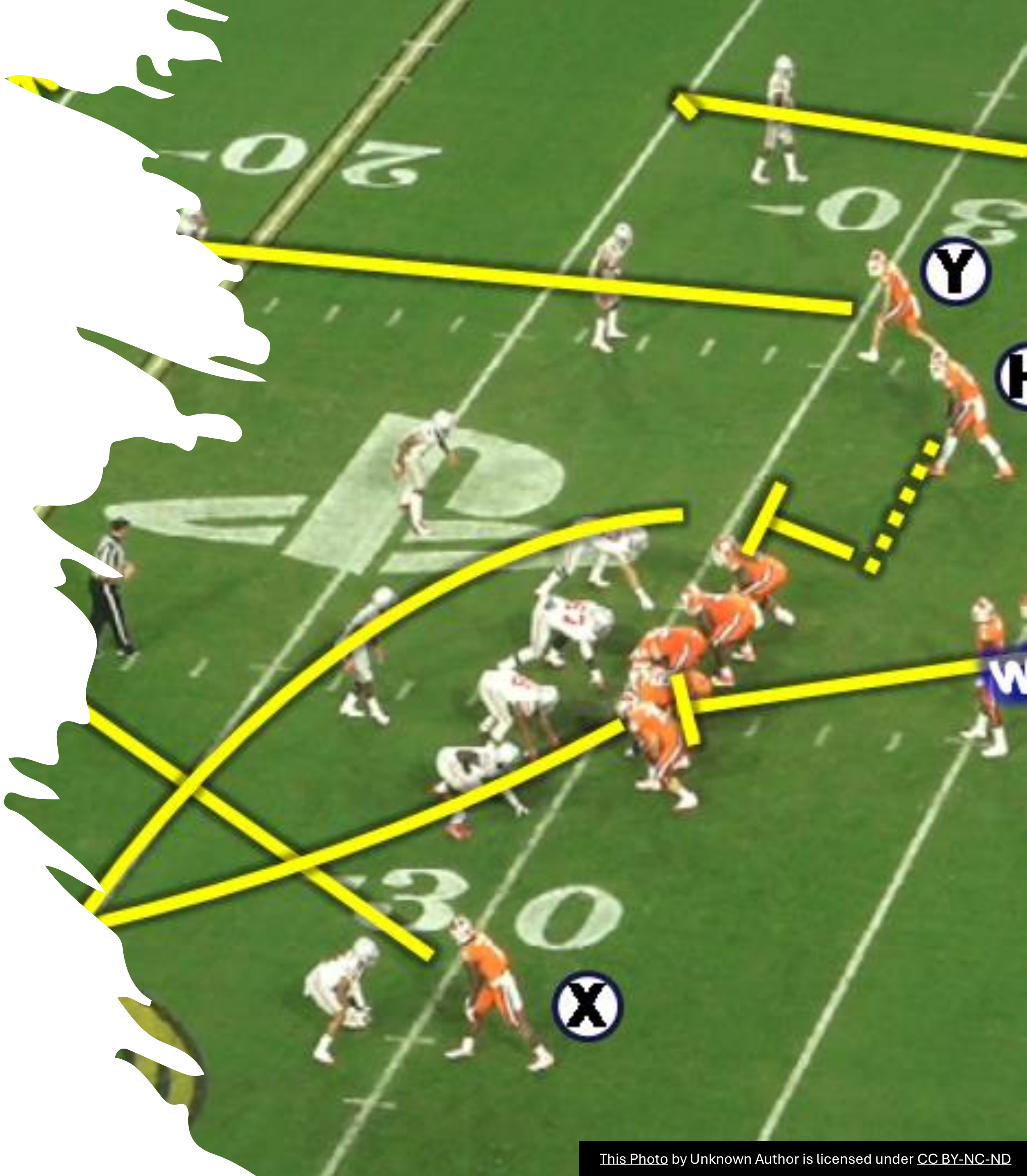
Drug	Dose*	0.5 kg	1 kg	2 kg	3 kg	4 kg	Administration
Epinephrine IV/IO Concentration: 0.1 mg/mL 1 mg/10 mL	0.02 mg/kg Equal to 0.2 mL/kg	IV Dose: 0.01 mg Volume: 0.1 mL	IV Dose: 0.02 mg Volume: 0.2 mL	IV Dose: 0.04 mg Volume: 0.4 mL	IV Dose: 0.06 mg Volume: 0.6 mL	IV Dose: 0.08 mg Volume: 0.8 mL	IV/IO rapid push Flush with 3 mL NS Repeat every 3-5 minutes if heart rate less than 60 bpm
Epinephrine ETT Concentration: 0.1 mg/mL 1 mg/10 mL	0.1 mg/kg Equal to 1 mL/kg	ET Dose: 0.05 mg Volume 0.5 mL	ET Dose: 0.1 mg Volume 1 mL	ET Dose: 0.2 mg Volume 2 mL	ET Dose: 0.3 mg Volume 3 mL	ET Dose: 0.4 mg Volume 4 mL	May administer while vascular access is being established ETT rapid push No need for flush. Provide PPV breaths to distribute into lungs.
Normal Saline IV 0.9% NaCl	10 mL/kg	5 mL IV	10 mL IV	20 mL IV	30 mL IV	40 mL IV	Give over 5-10 min

*The recommended dose range for intravenous or intraosseous administration is 0.01 to 0.03 mg/kg (equal to 0.1 to 0.3 mL/kg).
The recommended dose range for endotracheal administration is 0.05 to 0.1 mg/kg (equal to 0.5 to 1 mL/kg).

These suggested epinephrine doses are based on a desire to simplify dosing for educational efficiency and do not endorse any particular dose within the recommended dosing range. Additional research is needed to ascertain the ideal epinephrine dose.

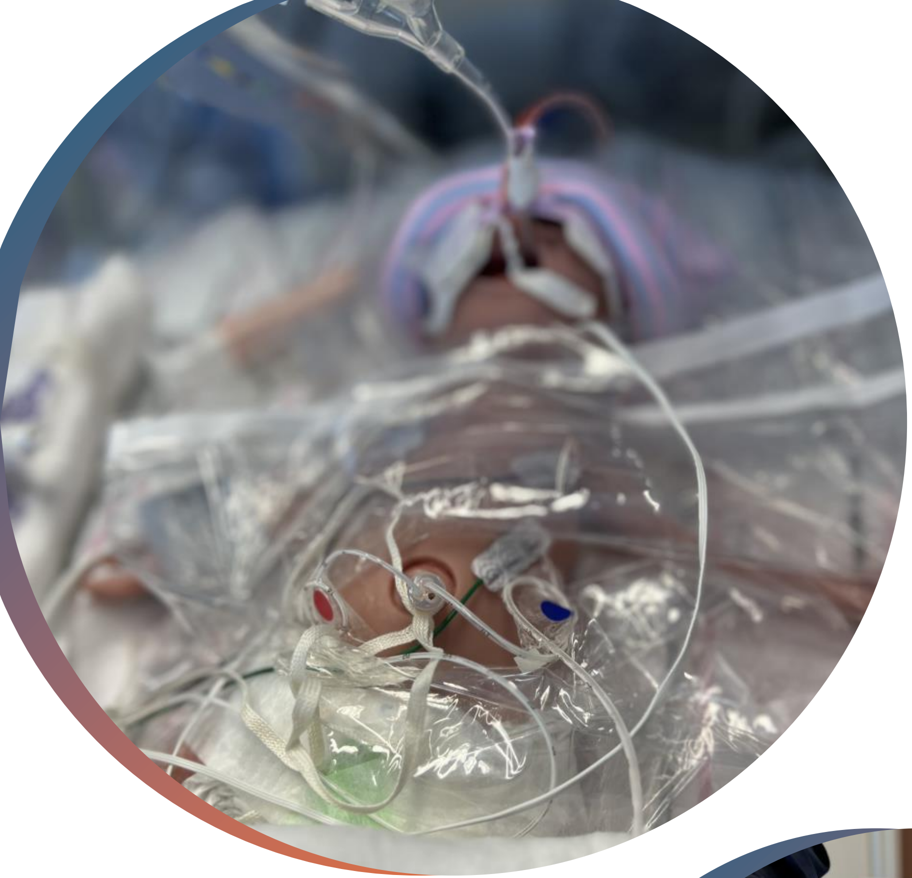
Tailoring the Playbook

- Continuous
- Patient
  - Adapting to their specific needs
  - Evidence based practice
- Staff
  - Needs assessment
    - Anonymous survey
  - Incidence Reports
  - Quality improvement measures



Practice Makes Perfect

- Repetition
  - Simulations
    - Adapt to the learners needs
  - Escape Rooms
  - Professional Development Opportunities
    - Topics of the Month / Quarter
    - Certification Review
  - Classes
    - NRP
    - STABLE
    - PALS / PEARS

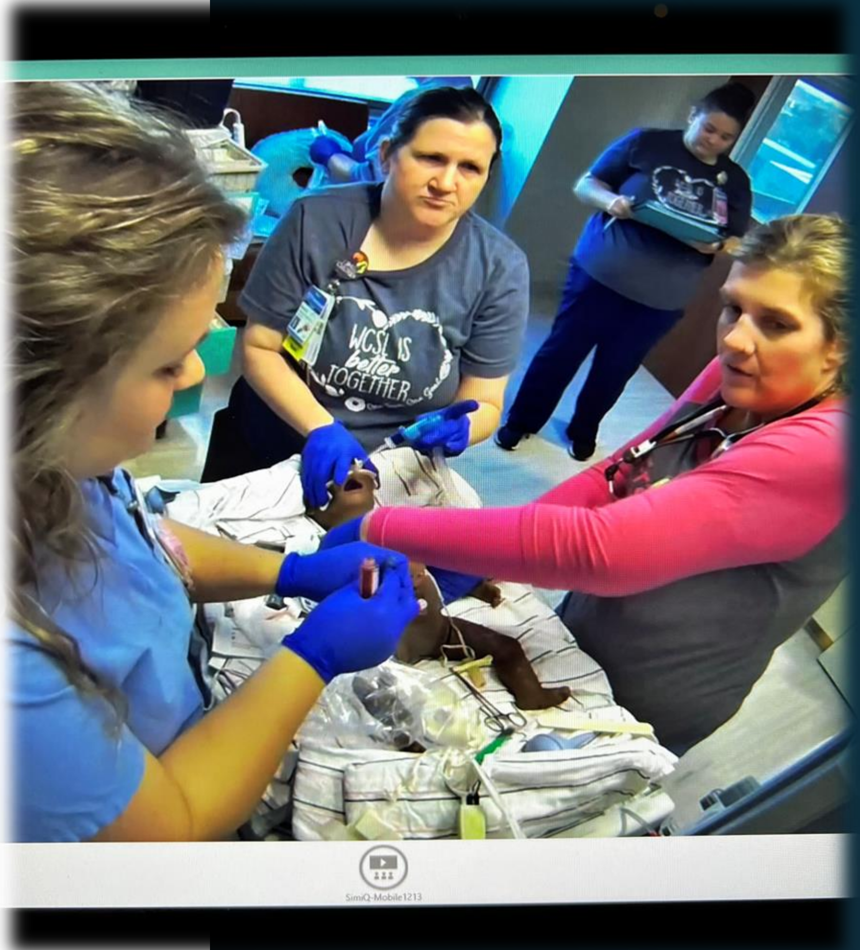


Simulate the Game

- Regular Drills
- Scrimmages
- Specialist / Assistance Coaches

Post-Game Analysis

- Debrief
- Feedback
- Video Replay



Human Factors & Stress Management

- Conditioning for the pressure
- Building team resilience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Legal & Ethical Considerations

- Ensure Safety
- Tough calls

Case Studies & Lessons Learned

- Reviewing the Experience
- Teaching the Lessons
- Applying the Lessons

Now what…

- Game Plan Recap
- Final Pep Talk

Post Conference

- Questions
- Comments

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