USE OF AI & ANESTHESIA

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What is AI?

- AI is also known as Artificial Intelligence

- It is a technology that enables computers and machines to simulate human learning, comprehension, problem solving, decision making, creativity and authority.

- AI is used to understand and respond to human language; It can learn new information and make detailed recommendations to users and experts.

- In 2024, AI researchers, practitioners and news –related to AI, are focusing on the transition and breakthroughs with Generative AI (gen AI)- a technology that can create text, images and other content.

    – *Generative AI tools are built on Machine Learning (ML) and Deep learning*

1950's	🐾 **Artificial intelligence (AI)**
	Human intelligence exhibited by machines
1980's	☺ **Machine learning**
	AI systems that learn from historical data
2010's	🔍 **Deep learning**
	Machine learning models that mimic human brain function
2020's	[AI+] **Generative AI (Gen AI)**
	Deep learning models (foundation models) that create original content

Photo:
IBM

Machine Learning

- Involves creating models by training an algorithm to make predictions or decisions based on data.

- Different types:
  - *Linear regression*
  - *Logistic regression*
  - *Decision tress*
  - *Random forest*
  - *Support vector machines (SVM)*
  - *K-nearest neighbor (KNN)*

- Most important one – NEURAL NETWORK
  Modeled after human brain structure and function, consisting of interconnected layers of nodes that work together to process and analyze complex data

Deep Learning

Machine learning models that mimic brain function that uses multilayered neural networks, called deep neural networks that simulate the complex decision-making power of the human brain.

Does not require human intervention, it enables machine learning at a tremendous scale.

Enables semi-supervised learning, self-supervised learning, reinforcement learning and transfer learning
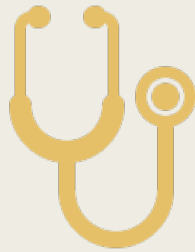
Benefits of AI

- Automation of repetitive tasks
- Faster data insight
- Enhanced decision making
- Fewer human errors
- 24x7 availability
- Reduced physical risks

https://youtube.com/shorts/MzFd8Jdk8EI?si=16XH8i-eNdXR8O5A

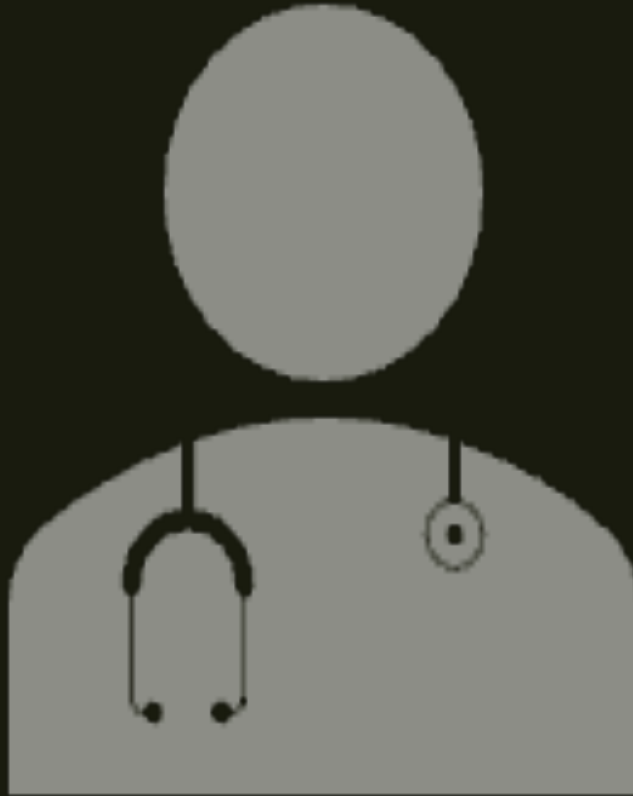# What are examples of AI and Anesthesia?

Patient monitoring

Delivery of anesthetic gases

Postoperative risks

Real time use of AI and Anesthesia

- AI can revolutionize healthcare and medicine by improving patient outcomes, reducing costs, and enhancing the efficiency of anesthesia delivery

- Ways AI can be incorporated into anesthesia
  - *Patient monitoring*
  - *Anesthetic Delivery*
  - *Predictive Analysis*
  - *Decision Support Electronic Medical Record (EMR) Integration*

Pillars of AI and Anesthesia

Enhancing patient safety through predictive analysis

Smarter drug Delivery and Real time adjustments

Improving Pre-Operative Evaluation

Improving Pre-Operative Assessment

Real Time Monitoring and Intelligent Alerts

Enhancing Patient Safety Through Predictive Analytics

Gather, assess and scrutinize amounts of real-time data to discern patterns and trends that clinicians may oversee or neglect
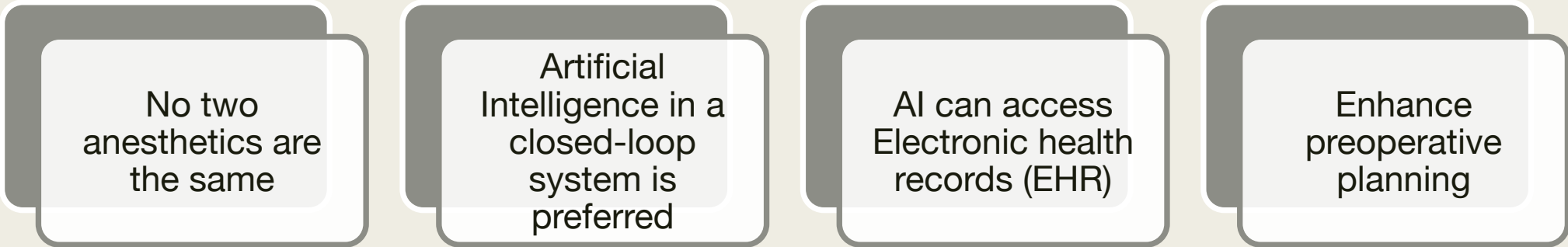
AI can alert clinicians to improve patient safety

Transition from REACTIVE to PROACTIVE models of care

Smarter Drug Delivery and Real-Time Adjustments

No two anesthetics are the same

Artificial Intelligence in a closed-loop system is preferred

AI can access Electronic health records (EHR)

Enhance preoperative planning

Improving Preoperative Evaluation

Transforming Preoperative assessment by optimizing data analysis, improving precision, and retrieving critical information

Assess Risk of anesthesia related complications

Anticipation of Medical problems on anesthetic administration

Increased Speed and Dependability

Uniformity of preoperative assessments

Improve long term outcomes, facilitate swift advancement in preoperative assessments

Improving Preoperative Assessment

ASA CATEGORY AUTOMATION

MEDICAL CONDITION EFFECTS OPTIMIZATION

ENHANCE CLOSED LOOP COMMUNICATION THROUGH SURGICAL TEAM
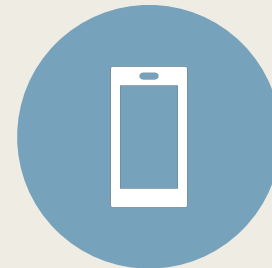
Real-Time Monitoring and Intelligent Alerts

Built upon the basis of basic monitoring

AI can distinguish between genuine physiological changes and clinically irrelevant alarms

Prevention of Alert fatigue

Personalization of monitoring devices

What is the name of a fully automated anesthesia delivery system?

Nite Nite 2000

McSleepy

Sweet Dreams

Gas –N- Go to Sleep Machine

MCSLEEPY

Examples of AI in practice

Application Area	AI Tool or System	Function
Airway Management	AI-assisted laryngoscopy, robotic intubation	Enhance safety and success in airway access
Hemodynamic Prediction	Hypotension Prediction Index (HPI)	Predict intraoperative hypotension
Analgesia Monitoring	ANI, nociception indices + AI	Optimize intraoperative opioid dosing
Drug Delivery	Closed-loop propofol/remifentanil systems	Real-time anesthesia titration
EEG Interpretation	SedLine, AI EEG analyzers	Advanced sedation and depth-of-anesthesia tracking
Workflow Optimization	OR scheduling AI (e.g., Clew, Qventus)	Improve OR efficiency and throughput
Decision Support	AI in EMR/AIMS systems	Risk prediction and care guidance

# Application of AI in the Deep monitoring and Regulation of Anesthesia

Depth of anesthesia (DoA) is the response to the CNS between the inhibition of anesthetic drugs and the irritation of the nociceptive stimuli.

Self-learning ability

AI and EEG relationship can help determine DoA

# Intelligent Automatic Drug Administration System

- Use mathematical models to calculate drug's quantity- effect relationship according to pharmacodynamics and characteristics

- However, the automatic drug administration system is imperfect. Limitations include:
    - *Simplicity vs complexity*
    - *Lack of accuracy*
    - *Lack of uniformity (manufacturing and personal practitioner)*
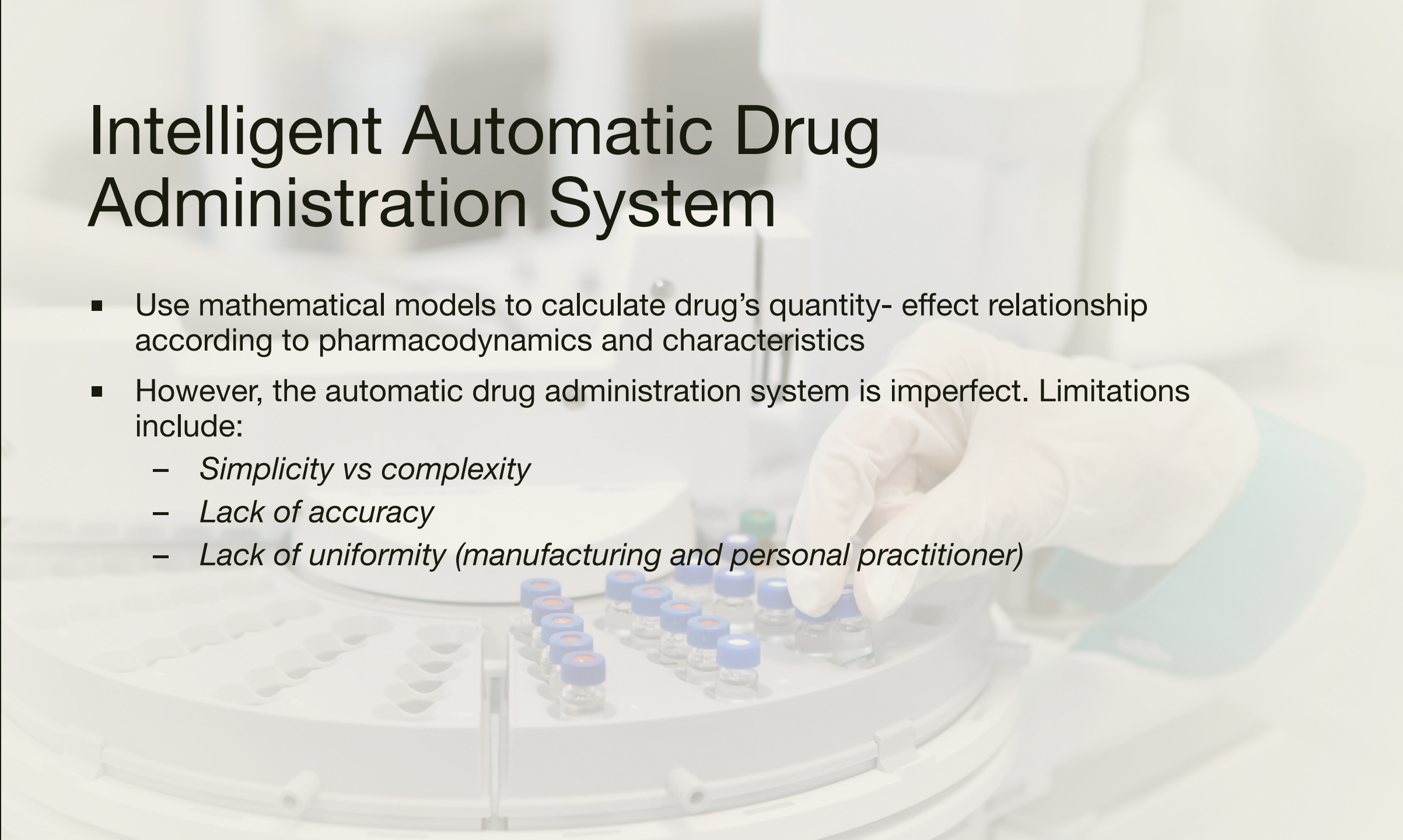
AI Application in the Operation of Anesthesia Skills
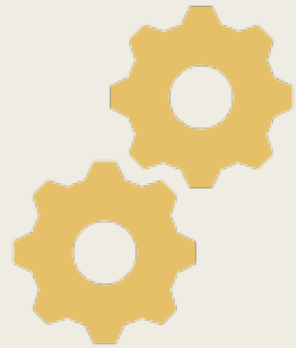
Robotic Intubation
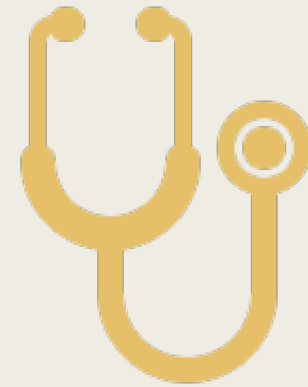
Ultrasound

AI in Postoperative Analgesia

- Postoperative pain assessment
- Ai-PCA

Challenges of Practice with AI

Patient Privacy and information security

Limited number of DL programs with External Validation

Data sources and ethical issues

"Black box" phenomenon

Lack of Capital and Talent

AI, Patient Safety and Achieving the Quintuple Aim in Anesthesia

	"The Quintuple Aim"				
	Patient Experience	**Population Health**	**Lower Costs**	**Clinician Well-Being**	**Health Equity**
Preoperative	• Leveraging AI for improved perioperative communication of important health and event notifications. • AI to drive text messaging to communicate perioperatively.	• Understanding population health risk factors to help with anesthesia and surgical scheduling and planning. • Leveraging large datasets to safely triage patients to an ambulatory surgery center.	• Use of AI to analyze factors related to operating room logistics such as OR time scheduling.	• AI algorithms to improve anesthesia staff scheduling on electronic platforms. • Optimizing staffing ratios based on predictive factors of patient perioperative risk and clinical load.	• Using AI to study demographic, socioeconomic, and environmental risk factors that may be predictive of perioperative morbidity and mortality.
Intraoperative	• Using AI to assist in a successful placement, on first attempt, of vascular access and nerve blocks using ultrasound guidance. • AI to assist in difficult airway management risk stratification.	• Use of AI to help inform which patients need type and screen and/or cross match.	• Use of AI for anesthesia depth monitoring and optimization to reduce waste.	• Use of AI to reduce cognitive load in clinical care environments with smart alarms and clinical decision support tools. • Decreasing unnecessary interactions with the electronic medical record through optimizing charting with natural language processing.	• AI recommendation algorithms to reduce variation in care among different populations.
Postoperative	• AI decision support for postoperative risk stratification and disposition to optimize inpatient and critical care resources.		• Leveraging AI to assist in optimizing hospital bed management efficiency including time to discharge.		• Using large datasets to study race/ethnicity disparities in care among a large health care system.[18]

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