The Implementation of AI in the Field of Anesthesiology

HINANUI SWIDER AND EMMANUEL HERNANDEZ,
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MENTOR: PROFESSOR KRISTEN SKJONSBY

ABSTRACT

The application of Artificial Intelligence in the field of anesthesiology has the ability to enhance patient care from preoperative assessment, to intraoperative management and postoperative care. It can use large-scale data sets from patient history to guide doctors in risk predictions, increased monitoring and dosage administration. Large Language Models (LLM) such as Chat GPT have the ability to be applied towards anesthesia, however there are ethical and safety concerns that must be addressed. We investigated how ChatGPT 4o would respond to a set of ten patients who are receiving anesthesia. We presented their age, race, weight, relevant medical and family history. It responded with the dosage that should be administered, what should be monitored, and what the risks are based on each patient. Given its responses it was compared to the current head physician in the speciality of anesthesiology in Kauai and analyzed to see how accurate its predictions were. Results demonstrated that AI in the field of anesthesiology has the potential to decrease the high risks for complications and death that patients face from anesthesia. Healthcare professionals must understand the capabilities that AI has to evolve anesthesia, creating a safer and more personalized anesthesia system that shapes the future of medicine.

METHOD

Anesthesiologists in Kauai, Hawaii were presented a table with 10 different patient scenarios. They were asked to give a recommended dosage amount along with any risks predictions that should be noted prior to the operation.
After excessive prompting with ChatGPT, we prompted the large language model " Imagine you are an anesthesiologist and your task is to calculate the dosage and risk predictions in the chance of an event or for post-operative care, to the best of your knowledge. For each patient, make sure to carefully examine all of the known factors such as Height, Race, Age, gender, medical history, and surgery type. Return your calculations with a csv table and make sure to THINK before outputting the results "

	Weight (Kg)	Ethnicity	Gender	Age	Medical History	Surgery Type	Height (feet, inches)	Type of Anesthesia	Medication
1	70	Mexican-American	Male	45	Hypertension, Type 2 Diabetes	Knee Replacement	5 ft 8 in	Spinal	Mepivicaine
2	60	African-American	Female	35	Asthma	Shoulder Surgery	5 ft 3 in	General	Fentanyl & Propofol
3	80	Caucasian	Male	55	No Significant history	Hip Replacement	5 ft 11 in	Spinal	Mepivicaine
4	75	Asian	Female	65	Hypertension, Kidney Issues	Spinal Fusion	5 ft 1 in	General	Fentanyl & Propofol
5	68	Mexican-American	Male	28	Allegeries to penicilin	Wrist Fracture Repair	5 ft 6 in	General	Fentanyl & Propofol
6	90	Caucasian	Female	40	High Cholesteral	Ankle Surgery	5 ft 9 in	General	Fentanyl & Propofol
7	55	Hispanic	Male	30	No Significant history	Elbow Surgery	5 ft 4 in	General	Fentanyl & Propofol
8	85	African-American	Female	60	Hypertension	Knee Replacement	5 ft 7 in	Spinal	Mepivicaine
9	62	HIspanic	Male	50	Hypothyroidism, Mild Arthitis	Hip Replacement	5 ft 5 in	Spinal	Mepivicaine
10	95	Caucasian	Female	70	Obesity, Sleep Apnea	Shoulder Surgery	5 ft 10 in	General	Fentanyl & Propofol

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RESULTS

Comparison of Chat GPT and the Head of Anesthesiology

Similarities:

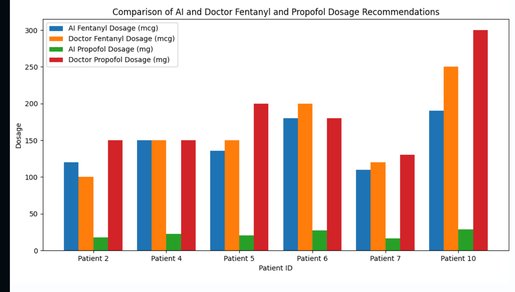
1. General Agreement on Specific Risks: For some patients, both ChatGPT and the Head of Anesthesiology identify similar types of risks. For example:
   a. Patient 3: Both sources agree on minimal risk.
   b. Patient 8: Both mention risks of cardiovascular events like myocardial infarction (MI) and stroke, as well as hypertension.
2. Respiratory Distress and Airway Concerns: Both sources recognize respiratory distress as a potential issue, though they differ slightly in the conditions specified:
   a. Patient 2 and Patient 5: ChatGPT mentions respiratory distress and potential for bronchospasm, while the Head of Anesthesiology is more specific, mentioning laryngospasm and asthma-related issues.

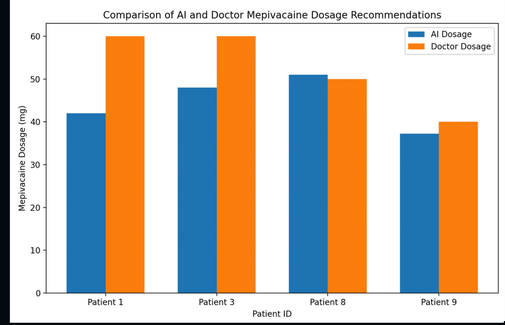
Differences:

1. Risk Detail and Specificity:
   a. ChatGPT often provides broader risk categories and additional related risks, like the possibility of deep vein thrombosis (DVT) or stroke, particularly for patients with hypertension and comorbidities (e.g., Patient 4 and Patient 10).
   b. The Head of Anesthesiology provides more concise, condition-specific risks, like "aspiration" for Patient 6 and "allergic reaction" for Patient 5.
2. Depth of Assessment:
   a. ChatGPT provides more comprehensive risk profiles that include multiple possible risks for each patient, whereas the Head of Anesthesiology tends to focus on a narrower set of specific risks.

Patient ID	Risk Predictions from Chat GPT	Risk Predictions from the Head of Anesthesiology
1	Risk of intraoperative and postoperative hypertension, increased stroke risk	Stroke,/MI, hyper/hypotension, hyper/hypoglycemia, aspiration, infection
2	Respiratory distress and potential for bronchospasm; monitor airway closely	Laryngospasm, bronchospasm, asthma attack
3	Minimal risk of adverse event	Minimal risk of adverse event
4	Risk of intraoperative and postoperative hypertension, increased stroke risk, risk of deep vein thrombosis (DVT) and pulmonary embolism; consider anticoagulant therapy. Respiratory distress and potential for bronchspasm; monitor airway closely. Potential for actue kidney injury; adjust anesthesia and medications to reduce renal load	MI/stroke, AKI (acute kidney injury), infection
5	Respiratory distress and potential for bronchospasm, monitor airway closely	Allergic reaction
6	Respiratory distress and potential for bronchospasm, monitor airway closely	Aspiration, difficult airway
7	Respiratory distress and potential for bronchospasm, monitor airway closely	Minimal risk of adverse event
8	Risk of intraoperative and postoperative hypertension, increased stroke risk, risk of deep vein thrombosis (DVT) and pulmonary embolism; consider anticoagulant therapy	MI/stroke/hypertension/hypotension
9	Minimal risk of adverse event	Thyroid storm (crisis), hypothyroidism
10	Increased risk of deep vein thrombosis (DVT) and pulmonary embolism; consider anticoagulant therapy, respiratory distress and potential for bronchospasm; monitor airway closely, high risk of postoperative infections, delayed healing and respiratory complications due to sleep apnea. Increased risk of respiratory arrest post-anesthesia; continous monitoring advised	Diabetes, infection, aspiration, difficult airway

RESULTS

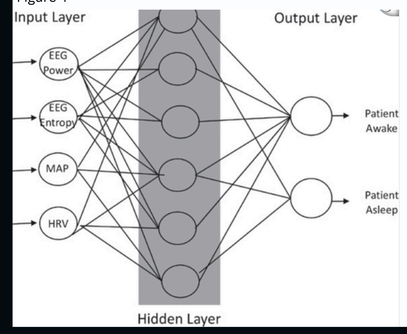




Chat GPT consistently recommended lower dosages, especially for complex anesthetics like Fentanyl and Propofol. This was most likely done to minimize risks such as respiratory issues. This cautious approach contrasts with doctor recommendations, which are often higher, especially for Patient 10. However, for simpler medications like Mepivacaine, AI dosages align more closely with doctors. Overall, AI’s conservative approach suggests it’s more suited to assist rather than replace human judgment in anesthesia, particularly for complex cases.

IMPLICATIONS

Figure 4[2]



- Enhanced patient care outcomes
  - Increased patient safety through risks predictions
  - Serves as a first defense mechanism
  - Could provide more cost-effective care
  - Increased depth of anesthesia monitoring
- Prioritization of patient centered care
  - Relief from time consuming tasks that can be automated (documentation, calculations of dosage)

FUTURE RESEARCH

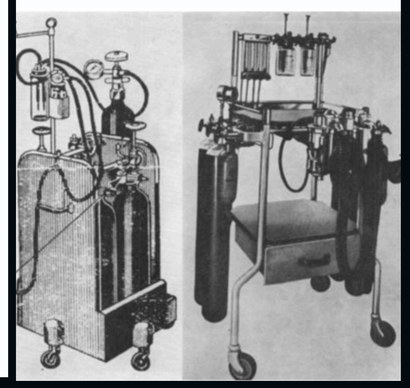
- Prompt doctors of other specialties (ex: emergency doctors) and compare their response to those of both anesthesiologists and the large language to find trends
- Identify its potential implementation in emergency, life-threatening situations where it could provide dosage calculations in shorter time with increased accuracy

CONTEXT

Anesthesia poses one of the greatest risks a patient must go through during their healthcare journey. At some point in life, patients will most likely have to go under anesthesia, demonstrating the importance of this field in innovating the greatest safety measures. Large language models such as, Chat GPT, have demonstrated impressive capabilities, but it is uncertain how it will perform in real-world scenarios in the medical field. Through testing its abilities professionals in the field can better understand its integration by preventing new risks while also maximizing its benefits towards patient care.

Henry Boyle’s fabrication of the anesthetic workstation revolutionized the administration of anesthesia from a primarily manual, inaccurate process to a highly dependable operated machine, allowing for a wider scope of surgeries that would reduce risks and increase the predictability of patient-care outcomes. Just as how Boyle’s anesthetic machine was able to revolutionize dosage administration, AI has the potential do the same. By understanding the early challenges faced by medical professionals in adapting to new technological advancements, AI can be approached with the same emphasis towards caution, ensuring that these innovations are safely implemented.

FIGURE 2
BOYLES FIRST WORKSTATION



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METHOD

Anesthesiologists in Kauai, Hawaii were presented a table with 5 different patient scenarios. They were asked to give a recommended dosage amount along with any risks predictions that should be noted prior to the operation.
After excessive prompting with ChatGPT in our preliminary study, we then fed LLM with more data and had it reavulate its dossage reccomendations. In the most recent trial, ChatGPT has provicded more accurate results, closely matching the doctor's reccomendations

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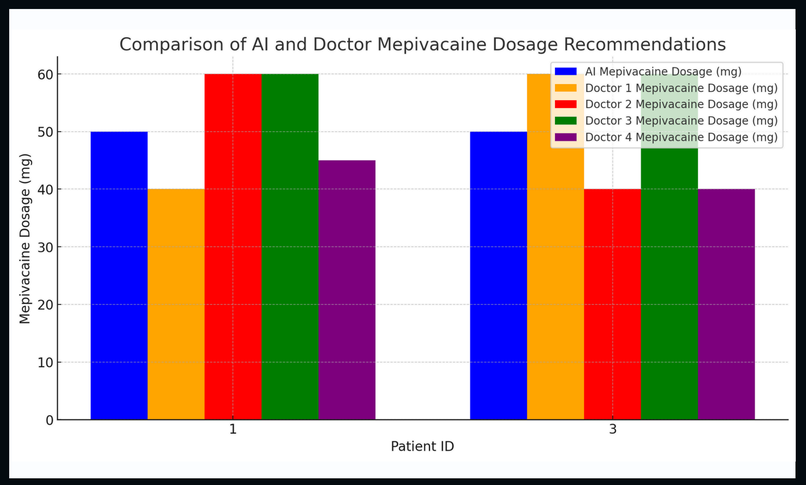


RESULTS

Comparison of Chat GPT and the Head of Anesthesiology

Similarities:

• General Agreement on Dosage Trends: AI predictions fall within doctor-recommended ranges, balancing between low and high values.
• Recognition of Higher Dosage Needs: AI and doctors align on patients needing higher dosages, such as Fentanyl (Patient 4, AI: 200 mcg vs. Doctors: 150-400 mcg) and Propofol (Patient 2, AI: 175 mg vs. Doctors: 120-200 mg).
• Moderate Adjustments Across Variability: When doctors provide a wide dosage range, AI predicts a middle-ground value (e.g., Mepivacaine Patient 1: AI 50 mg vs. Doctors 40-60 mg).

Differences:

- AI is More Conservative: AI avoids extreme doses, unlike Fentanyl (Patient 4, Doctor 2: 400 mcg vs. AI: 200 mcg) and Propofol (Patient 2, Doctors: 120-200 mg vs. AI: 175 mg).

Doctors Show Greater Variability: Some patients have significant doctor dosage differences, while AI remains more stable (e.g., Propofol (Patient 5): Doctors 150-200 mg vs. AI 180 mg).

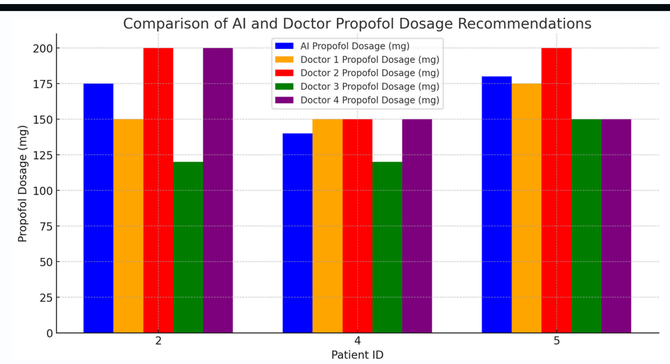
- Doctors Consider Patient-Specific Factors: AI bases predictions on observed trends, while doctors adjust for individual needs, leading to higher or lower dosages based on medical history.

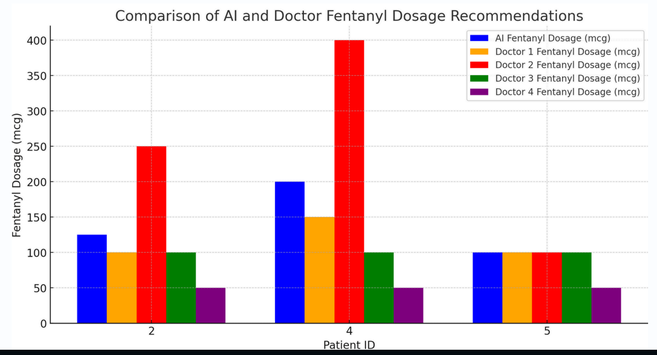
Patient ID	ChatGPT Risk Prediction	Anesthesiologists Risk Prediction
1	SSI, infection, stroke, aspiration risk, fluctuations in blood pressure (hypertension/hypotension)	SSI, infection, stroke/MI, aspiration, hyper/hypotension, hyper/hypoglycemia
2	Bronchospasm, increased airway reactivity, potential for hypoxia	Bronchospasm, laryngospasm, asthma attack
3	Risk of arrhythmia, potential for significant blood loss	Cardiac dysfunction, blood loss
4	AKI (acute kidney injury), post-op pain management difficulty, risk of sepsis, hypotension	AKI (acute kidney injury), uncontrolled pain, hypotension, infection
5	Anaphylaxis risk, potential for delayed hypersensitivity reaction	Allergic reaction

Table displaying similarlities and differences between ChatGPT and Anesthesioloigist risk predictions

The AI (ChatGPT) predictions generally align with the anesthesiologists' risk assessments, but introduce slightly broader categories, such as emphasizing aspiration risk and blood pressure fluctuations instead of explicitly mentioning stroke/MI (Patient 1) and hypoxia risk rather than just laryngospasm (Patient 2). While anesthesiologists focus on specific clinical conditions, AI tends to highlight broader physiological risks and potential complications, such as arrhythmia risk instead of cardiac dysfunction (Patient 3) and sepsis risk as part of AKI concerns (Patient 4).

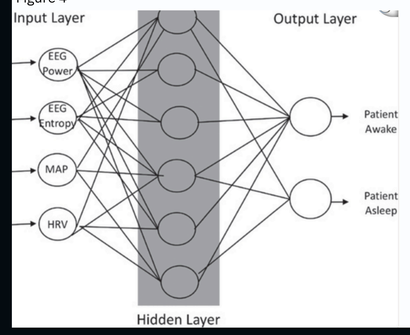
RESULTS





IMPLICATIONS

Figure 4[2]



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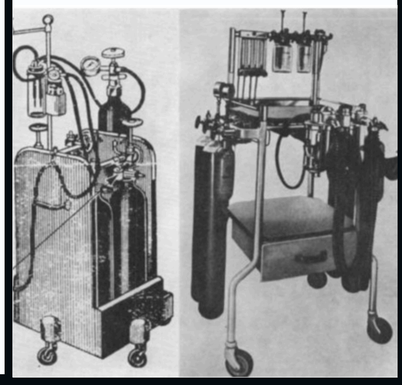

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