



# Artificial Intelligence in Intensive Care Medicine: Toward a ChatGPT/GPT-4 Way?

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## Abstract

Although intensive care medicine (ICM) is a relatively young discipline, it has rapidly developed into a full-fledged and highly specialized specialty covering several fields of medicine. The COVID-19 pandemic led to a surge in intensive care unit demand and also bring unprecedented development opportunities for this area. Multiple new technologies such as artificial intelligence (AI) and machine learning (ML) were gradually being applied in this field. In this study, through an online survey, we have summarized the potential uses of ChatGPT/GPT-4 in ICM range from knowledge augmentation, device management, clinical decision-making support, early warning systems, and establishment of intensive care unit (ICU) database.

**Keywords** GPT-4 · Artificial intelligence · Chatbot · Biomedical engineering · New era

## Introduction

Intensive care medicine (ICM) is a discipline focusing on the characteristics and regularity of any injuries or diseases leading to the body's development process toward death, and providing systematic, high-quality medical care and life-saving treatment. Although ICM is a relatively young discipline, it has rapidly developed into a full-fledged and highly specialized specialty covering several fields of medicine. As we all know, the unexpected outbreak of the COVID-19 in 2020 has been unprecedented imposed on public health systems, economies, human life across the world. The COVID-19

pandemic also led to a surge in intensive care unit (ICU) demand that was not previously seen in history [1]. It was reported that during the early phase of the outbreak in Wuhan, 75% of the deceased did not receive mechanical ventilation due to shortages in equipment [2]. In view of this, ICM has obtained unprecedented development opportunities under the call of many scholars. In recent years, multiple new technologies such as artificial intelligence (AI) and machine learning (ML) were gradually being applied in this field. Take AI algorithms as an example, Elhazmi et al., [3] used a machine learning method called decision tree to identify the predictors of 28-day ICU mortality in critically ill COVID-19 patients. Their findings showed that decision tree could be a useful tool to identify critically ill COVID-19 patients who were at high risk of 28-day ICU mortality. In addition, another multicenter COVID-19 cohort from Germany also showed that Explainable Boosting Machine (EBM) approach was the most suitable ML method to predict the COVID-19 ICU patient outcomes [4].

When it came to AI, ChatGPT (OpenAI, San Francisco, CA, USA), an AI-based chatbot developed using supervised and reinforcement learning strategies, is an unavoidable topic of growing interest. Since its launch in December 2022, ChatGPT quickly became popular on social media and even the fastest growing consumer program in history [5]. Initially, ChatGPT was fine-tuned from a model in the GPT-3.5 series. As it gains more attention recently, the OpenAI company has quickly launched the advanced version of

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this large language model, GPT-4. Compared with GPT-3.5, GPT-4 is a newer multimodal system that accepts various types of input and output including text and images with increased accuracy [6]. Up to now, ChatGPT/GPT-4 have been shown to perform well on a range of academic tasks. For example, GPT-4 could achieve above-median scores on the Medical College Admission Test and pass the US Medical Licensing Exam. In recent times, more than 360 studies have explored the potential application value of this technique in a wide variety of areas in multiple ways [7–11]. However, to the best of our knowledge, there remains a lack of studies summarizing the potential of ChatGPT/GPT-4 in the field of ICM. Therefore, through an online survey from GPT-4, we have summarized and discussed ChatGPT/GPT-4's application prospects in ICM and how intensivists could benefit from this tool (Fig. 1).

### As an Intensivist from Intensive Care Medicine, How to Use ChatGPT/GPT-4?

Answer from GPT-4: As an intensivist, you can use ChatGPT/GPT-4 in various ways to augment your knowledge, enhance patient care, and improve overall efficiency in the intensive care unit (ICU). Here are some possible applications:

1. Knowledge enhancement: You can use ChatGPT to quickly retrieve information on medical topics, guidelines, recent research, drug interactions, and more. Simply ask a question, and the AI can provide a summary of relevant information based on its training.

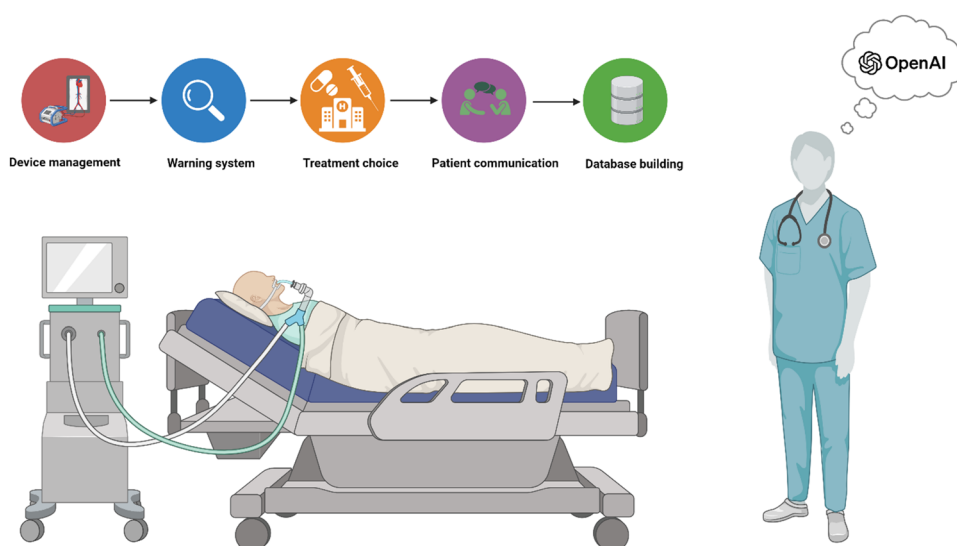
2. Clinical decision support: ChatGPT can help you review possible diagnoses, treatment options, or potential complications for a given patient case. By inputting relevant information, you can receive suggestions to consider alongside your clinical judgment.
3. Patient communication: ChatGPT can assist in creating patient education materials or discharge summaries. It can also help you draft clear explanations of complex medical concepts, improving patient understanding and engagement.
4. Collaboration and learning: Use ChatGPT to generate ideas for research, case presentations, or interdisciplinary discussions with colleagues. It can help you identify knowledge gaps and explore new perspectives on a topic.
5. Time management: ChatGPT can help with administrative tasks like creating meeting agendas, summarizing medical literature, or generating email drafts, allowing you to focus on more critical aspects of patient care.

### The Potential Applications of ChatGPT/GPT-4 in Early Warning System for Critically Ill Patients

Answer from GPT-4: Early warning systems (EWS) are designed to identify critically ill patients at risk for clinical deterioration and facilitate timely intervention. ChatGPT/GPT-4 can potentially enhance EWS through the following applications:

1. Data analysis: ChatGPT could aid in analyzing and interpreting large volumes of patient data, such as vital

**Fig. 1** The potential applications of GPT-4 in intensive care medicine (Created by BioRender)



### ChatGPT/GPT-4: in Intensive Care Medicine

- signs, laboratory results, and clinical notes. It could help identify patterns or trends that suggest a patient's clinical condition is worsening.
2. **Risk stratification:** By integrating patient information and existing EWS algorithms, ChatGPT may assist in calculating risk scores and stratifying patients based on their likelihood of deterioration. This can help prioritize clinical interventions and allocate resources effectively.
  3. **Alert generation:** ChatGPT can potentially generate automated alerts for healthcare professionals based on predetermined thresholds or patterns of clinical deterioration. By providing context-specific information alongside these alerts, AI can facilitate timely, targeted interventions.
  4. **Decision support:** ChatGPT can provide evidence-based suggestions for interventions or management strategies when a patient is identified as high risk. It can help guide clinical decision-making by offering a synthesized summary of the relevant guidelines and literature.
  5. **Continuous improvement:** ChatGPT can help identify areas of improvement in EWS by analyzing data trends, comparing the performance of different algorithms, or generating reports on false alarms and missed cases. This can contribute to the ongoing refinement of EWS protocols.
  6. **Education and training:** ChatGPT can create educational materials, case discussions, or simulation scenarios related to EWS for healthcare professionals. This can help ensure the staff is well prepared to recognize and manage clinical deterioration effectively.

### The Potential Applications of ChatGPT/GPT-4 in Extracorporeal Membrane Oxygenation

Answer from GPT-4: Extracorporeal Membrane Oxygenation (ECMO) is a complex and resource-intensive intervention used to support patients with severe respiratory or cardiac failure. ChatGPT could potentially play a role in several aspects of ECMO management, though it is crucial to remember that it should be used as an adjunct to your knowledge, experience, and professional guidelines.

1. **Patient selection:** ChatGPT could help you review the indications, contraindications, and risk factors for ECMO initiation in specific patient cases. By providing patient information, you can receive a synthesized summary of relevant considerations to help guide your decision-making.
2. **ECMO management and optimization:** ChatGPT can provide quick access to information on ECMO settings, troubleshooting, and management strategies. This could

- help you optimize patient care and ensure the ECMO circuit is functioning efficiently.
3. **Education and training:** ChatGPT can be used to create educational materials or facilitate simulation scenarios for ECMO training. You can also use it to generate case-based discussions and explore recent research on ECMO management.
  4. **Weaning and decision-making:** ChatGPT may assist in consolidating information about weaning strategies, criteria, and potential complications. It can help you analyze patient progress and consider the appropriate time for ECMO discontinuation.
  5. **Multidisciplinary collaboration:** ECMO management often requires collaboration between different specialists. ChatGPT can help in drafting communication or creating summaries of patient progress for team members, leading to more efficient interdisciplinary care.
  6. **Research and innovation:** ChatGPT can assist in generating research ideas, summarizing recent literature, or even reviewing statistical analyses related to ECMO management, contributing to the advancement of the field.

### The Potential Applications of ChatGPT/GPT-4 in Establishing Medical Information Mart for Intensive Care such as MIMIC

Answer from GPT-4: Medical Information Mart for Intensive Care (MIMIC) is a large, publicly available dataset of de-identified intensive care unit (ICU) patient data. ChatGPT/GPT-4 can potentially contribute to the development and utilization of similar medical information marts in several ways:

1. **Data extraction and preprocessing:** ChatGPT can help identify, extract, and preprocess relevant patient data from electronic health records (EHRs), ensuring that the medical information mart is comprehensive, well organized, and easy to analyze.
2. **Data annotation and labeling:** ChatGPT can assist in annotating and labeling patient data, which is crucial for creating structured datasets that can be used for various research and clinical applications.
3. **Natural language processing:** ChatGPT's NLP capabilities can be used to analyze unstructured clinical text data, such as clinical notes, and convert it into structured data that can be included in the medical information mart.
4. **Data quality assessment:** ChatGPT can help in identifying inconsistencies, duplicates, and missing values within the dataset, thereby improving overall data quality and reliability.

5. Data anonymization and de-identification: ChatGPT can contribute to the process of anonymizing and de-identifying patient data to ensure compliance with privacy regulations and protect patient confidentiality.
6. Predictive analytics and modeling: ChatGPT can be used to analyze the data within the medical information mart, develop predictive models for various clinical outcomes, and identify relevant risk factors in ICU patients.
7. Facilitating research: ChatGPT can help researchers generate research ideas, identify knowledge gaps, and develop methodologies using the data available in the medical information mart.
8. Education and training: ChatGPT can create educational materials, case studies, and simulation scenarios using the medical information mart dataset, enabling healthcare professionals to learn from real-life cases and improve their skills in managing ICU patients.

### **The COVID-19 Pandemic Led to a Rapid Influx of a Large Number of Patients Requiring Intensive Care, and Oversaturated the Intensive Care Unit (ICU) Resources Globally. In the Face of Future Surge in Critically Ill Patients Due to Unexplained Infectious Disease, What Suggestions Do You Have for Intensivist?**

Answer from GPT-4: The COVID-19 pandemic has highlighted the importance of being prepared for a sudden surge in critically ill patients due to infectious diseases. As an intensivist, the following suggestions may help you prepare for and manage future similar situations:

1. Enhance preparedness: Establish plans and protocols for the rapid expansion of ICU capacity, including designating surge spaces, procuring additional equipment, and training staff for ICU-specific care.
2. Collaboration and communication: Develop a strong network among local and regional healthcare institutions to enable efficient resource sharing, communication, and coordinated response to surges in patient numbers.
3. Telemedicine and remote monitoring: Implement telemedicine and remote monitoring solutions to provide expert consultation and support to ICUs that may be overwhelmed or have limited access to specialists.
4. Triage and resource allocation: Establish clear triage and resource allocation guidelines to prioritize the care of patients based on severity, prognosis, and the availability of resources, ensuring that the most critical patients receive appropriate care.

5. Infection prevention and control: Implement robust infection prevention and control measures to minimize the risk of disease transmission among patients and healthcare workers, including proper use of personal protective equipment (PPE), isolation protocols, and environmental cleaning.
6. Education and training: Continually update the knowledge and skills of healthcare professionals through training programs, simulations, and sharing of best practices. This includes being prepared for emerging infectious diseases and understanding their management.
7. Emotional and psychological support: Provide emotional and psychological support for healthcare workers, who may experience significant stress and burn-out during a surge in critically ill patients. Encourage self-care, peer support, and access to mental health resources.
8. Research and innovation: Engage in research to better understand the epidemiology, pathophysiology, and treatment options for emerging infectious diseases. Collaborate with researchers and other healthcare professionals to share data, insights, and promote innovation in critical care medicine.
9. Public health and prevention: Work closely with public health agencies to promote preventive measures, such as vaccination and public health campaigns, to mitigate the impact of infectious diseases on the healthcare system.
10. Continuous evaluation and improvement: Regularly review and update surge response plans, protocols, and resource allocation strategies based on lessons learned from previous experiences and emerging best practices.

### **Conclusion and Future Perspectives**

With the rapid growth of big medical data and intelligent algorithms in recent years, the scope of AI in the medical field is also expanding. Advances in AI technology have also been increasingly perceived as a way to foster innovations in ICM that could result in more efficient and high-quality medical care and even improve the survival rate and prognosis of critically ill patients [12]. In order to better understand GPT-4's application prospects in ICM, we posed a series of survey questions addressing key theme areas of the application. For question one, we asked how intensivist could use ChatGPT/GPT-4 in clinic. GPT-4 summarized some possible applications including knowledge enhancement, clinical decision support, patient communication, collaboration and learning, as well as time management. We believe the most attractive of ChatGPT/GPT-4 for intensivists is that it could

provide clinical decision support. Severely ill patients often receive continuous observation, diagnosis and monitoring, and generate real-time monitoring of various data including vital sign data, laboratory examination data, and image data. Compared to the general patient population, these monitoring data from ICU patients have the characteristics of high real-time performance, strong continuity, and large datasets. Intensive care physicians need to discover the changes in patient conditions and make the corresponding clinical decisions based on their own experience. In this process, ChatGPT/GPT-4 could become a good assistant to reminder and even provide their own clinical judgment under intensivists supervision. Similarly, several studies have evaluated the value of ChatGPT for clinical decision support optimization. Their results showed that ChatGPT could be an important complementary part of optimizing clinical decision support and may even be able to assist experts in formulating their own suggestions [13, 14].

In addition, we also explored the potential applications of ChatGPT/GPT-4 in early warning system, ECMO management, establishing medical information mart, as well as suggestions to face future similar situations of surge in ICU demand due to unexplained infectious disease. From the above answers, it was not difficult to see that the application of ChatGPT/GPT-4 in the ICM domain showed tremendous potential. Take ECMO management as an example, it is a highly specialized, life-supporting technique that temporarily takes over the function of patients' lungs and hearts, allowing these organs to rest and recover. During the COVID-19 pandemic, ECMO has undoubtedly played a critical role in saving lives, especially for severely ill patients with severe respiratory or cardiac failure that is unresponsive to conventional treatments [15, 16]. However, the use of ECMO requires a multidisciplinary team of experienced intensivists with training and expertise in initiating, maintaining, and discontinuing ECMO therapy. ChatGPT/GPT-4 could potentially play a role in several aspects of ECMO management including patient selection, ECMO management and optimization, education and training, weaning and decision-making, multidisciplinary collaboration, and so on. All these processes are key steps to ensure the ECMO circuit functioning efficiently. Moreover, in addition to ECMO, it is not hard to deduce that ChatGPT/GPT-4 could also play a similar role in other commonly used ICU medical equipment such as ventilators, defibrillator, and electrocardiograms.

All in all, AI in ICM has made significant progress in recent years, especially in face of the unprecedented COVID-19 pandemic. The further integration of AI technique such as ChatGPT/GPT-4 and ICM opens up new possibilities for enhancing ICU medical care, decision-making, and resource allocation. In this study, we have summarized the potential uses of ChatGPT/GPT-4 in ICM range from knowledge augmentation, device management, clinical decision-making

support, early warning systems, and establishment of ICU database. As AI-based tools continue to evolve, it is critical for intensivists to understand and leverage these tools along with their clinical expertise to improve patient outcomes, streamline processes, and prepare for potential future crises involving critically ill patients.

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**Data Availability** Not applicable.

## Declarations

**Competing Interests** The authors declare no competing interests.

**Ethical Approval** This study does not include any individual-level data and thus does not require any ethical approval.

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