

ChatGPT: Transforming CRRT Fluid Management - Revolutionizing Calculations for Lightened Nurse Workload and Enhanced Patient Care

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Introduction

CRRT is a frequent dialysis method for the management of fluid balance in critically ill patients in the ICU. Accurately calculating ultrafiltration (UF) removal rates is a complex and essential task. Despite providing comprehensive training, nurses often encounter challenges in accurately calculating and documenting UF removal rates, which is crucial for patient care and safety.

In the age of technology, artificial intelligence (AI) chatbots have been integrated into various fields, including healthcare. Chat Generative Pre-trained Transformer (ChatGPT), an AI chatbot developed by OpenAI, has the potential for different medical applications, from research to patient care.

This study evaluates the performance of ChatGPT-3.5 and ChatGPT-4 in calculating UF rates.

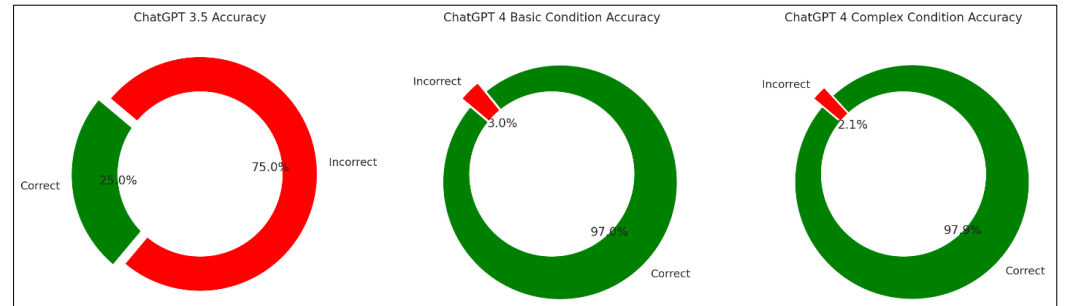


Figure 1. Comparison of accuracy of UF calculation between ChatGPT-3.5 and ChatGPT-4

Methods and Materials

- This study was conducted in November-December 2023.
- We developed 100 hypothetical case scenarios with varying fluid removal goals, intakes, and outputs. ChatGPT-3.5 and ChatGPT-4 were prompted with these cases to calculate UF rates.
- Inaccurate initial calculations were corrected by providing the right formula to ChatGPT.
- Further complexity was added by incorporating intermittent intravenous fluids, blood products, and sudden changes in intake and output at various time intervals after starting fluid removal. The accuracy of UF rate calculations in ChatGPT responses was assessed.

Results

- ChatGPT-3.5 calculated the correct fluid removal rates for 25 out of 100 cases (25%)
- ChatGPT-4 could calculate correctly 97 out of 100 cases (97%)
- Even after adding complexity by incorporating intermittent IV antibiotics, blood products or stopping and restarting CRRT with changes in intake and output values, ChatGPT-4 could calculate the correct UF rates for 95 of the 97 cases (98%).

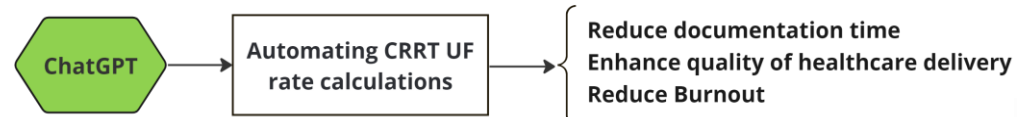
Discussion

Potential concerns and limitations when using ChatGPT for CRRT calculation:

- ChatGPT may forget instructions and require training before determining the UF rate.
- The quality of responses from ChatGPT depends on the quality of the input prompts
- Due to its nondeterministic nature, ChatGPT may produce varied responses to the same prompt when used by different individuals.
- This study relied on hypothetical case scenarios rather than real-world data, which may not comprehensively represent the complexities encountered in actual clinical settings.

Conclusions

ChatGPT-4 demonstrated significantly higher accuracy than ChatGPT-3.5 for complex CRRT UF rate calculations. This tool signifies a promising step toward automating CRRT UF rate calculations, with the potential to reduce the cognitive load on nurses and enhance the quality of healthcare delivery in ICUs. To truly understand the accuracy of ChatGPT in UF rate calculation, longitudinal studies using real-world data and involving nurses to assess the feasibility and reliability of language models are crucial.



One example of ChatGPT-4 answer for the basic condition

You could you provide fluid removal rate for CRRT machine? the information is here: we would like to keep patient 1 liter negative today, patient receives 25cc oral and IV intake every hour, how much the nurse can pull every hour to maintain 1 liter negative after 24 hours?

ChatGPT To achieve a net fluid removal of 1 liter over 24 hours, while the patient receives 25 cc of oral and IV intake every hour, the nurse should set the CRRT machine to remove approximately 66.67 cc of fluid per hour. This rate will ensure the desired negative fluid balance after 24 hours. [-]

You how did you calculate

ChatGPT Certainly! Here's the breakdown of the calculation:

- Determine the Total Desired Negative Balance in cc:**
 - The desired negative balance is 1 liter over 24 hours. Since 1 liter equals 1000 cc (cubic centimeters), the total negative balance is 1 liter × 1000 = 1000 cc.
- Calculate Total Fluid Intake in 24 Hours:**
 - The patient receives 25 cc of fluid (oral and IV) every hour. Over 24 hours, the total intake is 25 cc/hour × 24 hours = 600 cc.
- Calculate Total Fluid Removal Required:**
 - To achieve the desired negative balance, the CRRT machine must remove not only the fluid intake but also the additional fluid to reach the negative balance. So, the total fluid removal required is the sum of the intake and the desired negative balance: 1000 cc + 600 cc = 1600 cc.
- Determine Hourly Fluid Removal Rate:**
 - Finally, to find out how much the nurse should set the CRRT machine to remove each hour, divide the total fluid removal required by the number of hours (24). Thus, 1600 cc ÷ 24 hours ≈ 66.67 cc/hour.

So, the CRRT machine should be set to remove approximately 66.67 cc of fluid per hour to maintain a 1 liter negative fluid balance after 24 hours, considering the patient's intake of 25 cc per hour.

One example of ChatGPT-4 answer for complex condition

You could you provide fluid removal rate for CRRT machine? the information is here: we would like to keep patient 1500 cc negative today, patient receives 72 cc IV intake every hour, how much the nurse can pull every hour to maintain 1500 cc net negative after 24 hours?

ChatGPT To achieve a net negative fluid balance of 1500 cc in 24 hours, considering the patient receives 72 cc of IV intake every hour, the nurse should set the CRRT machine to remove 134.5 cc of fluid per hour. This will ensure the desired fluid balance is maintained over the 24-hour period. [-]

You what if this pulling rates started from 10 am with this iv intake, then iv intake at 10 pm increased to 90 cc per hour, how the nurse should adjust the pulling rate after 10 pm reach the goal by 7 am next day

ChatGPT To reach the goal of a net negative fluid balance of 1500 cc by 7 AM the next day, considering the change in IV intake to 90 cc per hour starting at 10 PM, the nurse should adjust the CRRT machine to remove approximately 173.3 cc of fluid per hour from 10 PM to 7 AM. This adjusted rate accounts for the increased IV intake and the fluid removal that has already occurred from 10 AM to 10 PM. [-]

You how did you calculate

ChatGPT To calculate the adjusted fluid removal rate for the period from 10 PM to 7 AM, I followed these steps:

- Calculate Fluid Intake from 10 AM to 10 PM:**
 - The patient was initially receiving 72 cc/hour of IV fluid.
 - From 10 AM to 10 PM is 12 hours.
 - Total fluid intake during this period = 72 cc/hour × 12 hours = 864 cc.
- Calculate Fluid Intake from 10 PM to 7 AM:**
 - The IV intake increases to 90 cc/hour at 10 PM.
 - From 10 PM to 7 AM is 9 hours.
 - Total fluid intake during this period = 90 cc/hour × 9 hours = 810 cc.
- Total Fluid Intake for 24 Hours:**
 - Total fluid intake = Intake from 10 AM to 10 PM + Intake from 10 PM to 7 AM
 - Total fluid intake = 864 cc + 810 cc = 1674 cc.
- Calculate Fluid Already Removed Until 10 PM:**
 - From the previous calculation, we were removing 134.5 cc/hour from 10 AM to 10 PM.
 - Fluid removed in 12 hours = 134.5 cc/hour × 12 hours = 1614 cc.
- Calculate Remaining Fluid to be Removed from 10 PM to 7 AM:**
 - The goal is to achieve a net negative balance of 1500 cc over 24 hours.
 - The net fluid removal target = Total fluid intake + Desired negative balance
 - Net fluid removal target = 1674 cc + 1500 cc = 3174 cc.
 - Remaining fluid to be removed = Net fluid removal target - Fluid already removed until 10 PM
 - Remaining fluid to be removed = 3174 cc - 1614 cc = 1560 cc.
- Adjusted Hourly Fluid Removal Rate from 10 PM to 7 AM:**
 - The remaining period from 10 PM to 7 AM is 9 hours.
 - Adjusted hourly fluid removal rate = Remaining fluid to be removed / 9 hours
 - Adjusted hourly fluid removal rate = 1560 cc / 9 hours ≈ 173.3 cc/hour.

This adjusted rate will ensure that the total fluid balance by 7 AM the next day reaches the target of being 1500 cc negative, considering the changes in IV intake.

