ORIGINAL RESEARCH

Enhancing sepsis care through improved first-dose antibiotic turnaround time for hospital-based rehabilitation patients

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ABSTRACT

Background: Timely administration of the first-dose intravenous antibiotic is a key quality measure in hospital accreditation and sepsis care. This study aimed to identify barriers to first-dose intravenous antibiotic administration in an inpatient rehabilitation unit at a leading academic medical center and implement targeted interventions to improve the 60-minute turnaround rate.
Methods: In 2024, quality outcomes specialists used the Kaizen Rapid Cycle methodology to conduct a weekly review of all STAT intravenous antibiotic orders on the rehabilitation unit. Orders exceeding the 60-minute turnaround time were analyzed through root cause analysis (RCA) to identify delays. Findings from the RCA guided the development of interventions to improve compliance.
Results: At the start of 2024, the 60-minute antibiotic turnaround rate was 33.3%. After implementing key interventions, the turnaround rate increased to 68.4% by the end of March and remained stable throughout 2024. These interventions included stocking frequently used antibiotics in Pyxis, enhancing communication and notification for STAT antibiotic orders, maintaining ongoing surveillance, and providing individualized feedback to the frontline nurses.
Conclusions: Identifying and addressing barriers to timely antibiotic administration led to significant improvements in turnaround time. Enhancing communication, optimizing medication availability, and sustaining performance monitoring proved effective in improving compliance with sepsis care standards.

Key Words: Intravenous antibiotic, First-dose, Quality improvement, STAT order, 60-minute turnaround, Sepsis care

1. INTRODUCTION

1.1 Background and significance

Sepsis is a life-threatening medical emergency that occurs when the body mounts an extreme response to infection, leading to widespread inflammation, tissue damage, and organ failure. In the United States, sepsis affects over 1.7 million individuals annually and is responsible for an estimated 350,000 deaths.[1] Sepsis accounts for approximately 6% of all hospitalizations and contributes to 35% of in-hospital mortality.[2] The economic burden of sepsis is substantial, with acute hospitalization and post-acute care costs reaching an estimated $62 billion per year.[3] Additionally, sepsis is the leading cause of unplanned hospital readmissions, generating more than $3.5 billion in annual healthcare expenditures.[4] Given its high mortality, financial impact, and burden on healthcare resources, improving the timely recognition and treatment of sepsis remains a critical priority for patient outcomes and hospital quality initiatives.

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1.2 Literature review

Prompt administration of the first-dose antibiotic is a cornerstone of effective sepsis management. The Surviving Sepsis Campaign (SSC), developed collaboratively by the Society of Critical Care Medicine (SCCM) and the European Society of Intensive Care Medicine (ESICM), has long emphasized that early recognition and treatment—particularly antibiotic administration within the first hour—is associated with improved survival outcomes in sepsis and septic shock.[5,6] The Hour-1 Bundle, introduced by SSC, calls for rapid assessment, lactate measurement, blood cultures, fluid resuscitation, vasopressors if needed, and administration of broad-spectrum antibiotics ideally within one hour of sepsis recognition.[6]

National initiatives have reinforced this urgency. The Centers for Medicare and Medicaid Services (CMS) mandates timely antibiotic administration through the Severe Sepsis and Septic Shock Management (SEP-1) bundle, which requires broad-spectrum antibiotics within three hours of the initial presentation of sepsis symptoms.[7] Compliance with SEP-1 has been associated with improved survival in various studies, although adherence remains variable across institutions.[8,9]

The clinical evidence supporting timely antibiotics is robust. In a systematic review and meta-analysis of more than 30,000 patients, early administration of antibiotics (within one hour) was associated with a significantly reduced risk of death compared to delayed treatment.[10] Kumar et al. (2006) similarly showed that each hour of delay in administering effective antibiotics in septic shock increased mortality by 7.6%.[11] These findings were echoed in ICU and emergency settings where timely antibiotic delivery was directly linked to improved outcomes.[12,13]

Despite these established guidelines, implementation remains challenging. Diagnostic uncertainty, variation in clinician decision-making, and hospital workflow inefficiencies frequently hinder compliance with recommended timelines.[14] Additionally, concerns have emerged regarding the potential overuse of antibiotics when time-driven metrics override clinical discretion. The Infectious Diseases Society of America (IDSA), in its position statement, cautioned against rigid adherence to one-hour antibiotic rules without accounting for diagnostic complexity.[15] Balancing early empiric therapy with antimicrobial stewardship remains a critical concern in sepsis protocols.[16]

Efforts to optimize sepsis care must therefore include system-level interventions that facilitate prompt recognition and drug delivery without compromising diagnostic accuracy or contributing to antimicrobial resistance. This quality improvement project aligns with these goals by improving turnaround time through multidisciplinary coordination, pharmacy access optimization, and enhanced communication workflows.

1.3 Local problem

Houston Methodist Hospital Inpatient Rehabilitation (HMH IPR) is a 30-bed, hospital-based inpatient rehabilitation unit located within the Texas Medical Center in Houston, Texas. As part of Houston Methodist Hospital (HMH), a renowned tertiary care academic medical center, HMH IPR provides cutting-edge research, innovative treatments, and patient-centered care. The unit serves a medically complex patient population, including individuals recovering from solid organ transplants, strokes, advanced heart failure with left ventricular assist devices, oncology treatments, brain and spinal injuries, and other serious medical or surgical complications. Given these complexities, timely intravenous (IV) antibiotic administration is critical for patient outcomes.

However, several local barriers contribute to delays in first-dose STAT IV antibiotic turnaround time, defined as the time from order placement to administration. The benchmark for this project aligns with national sepsis care standards, targeting administration within 60 minutes of order placement to optimize patient outcomes. One primary challenge is the geographic separation of HMH IPR from the main hospital and pharmacy. Although connected by a crosswalk skybridge, nurses frequently report extended wait times for pharmacy technicians to deliver STAT IV antibiotics from the main hospital pharmacy. This logistical delay slows the administration process. Additionally, a lack of immediate nursing awareness of new STAT IV antibiotic orders presents another barrier. As frontline nurses focus on patient care and other workflow tasks, new orders may not be promptly acknowledged, sometimes leading to a delay of up to 30 minutes before they are noticed and addressed.

This quality improvement (QI) project aims to enhance STAT IV antibiotic turnaround time, increasing the 60-minute administration rate from 33.3% to 60% by the end of June 2024. Through root cause analysis (RCA), the project will identify specific factors contributing to delays and implement targeted interventions to improve efficiency and patient care. By reducing delays in antibiotic administration, this initiative has the potential to improve patient outcomes by decreasing the risk of sepsis-related complications and mortality. Additionally, optimizing workflow efficiency can enhance resource utilization, reduce nurse workload associated with urgent medication administration, and contribute to overall hospital performance improvements.

2. METHODS

2.1 Interventions

In 2016, the Executive and Quality Leadership at HMH implemented a hospital-wide initiative mandating the administration of all first-dose IV antibiotics within one hour of provider order placement. This initiative was the foundation for the current project, emphasizing the need for streamlined medication availability, efficient delivery processes, and improved bedside workflow compliance.

To ensure timely administration, the Electronic Medical Record EPIC was leveraged to track key time points: order placement, verification, preparation, delivery, and final administration. Frontline nurses used barcode scanning technology to ensure medication safety and provide real-time documentation of the exact administration time.

Due to the relatively low volume of STAT IV antibiotic orders on the inpatient rehabilitation unit, even a single missed dose can significantly impact the compliance rate. To address this challenge, the Kaizen Rapid Cycle methodology was employed to drive iterative process improvements. A multidisciplinary team—including nursing leadership, frontline nurses, pharmacy, and providers—convened to assess workflow barriers, identify opportunities for improvement, and implement targeted interventions. Key strategies included:

- **Enhanced Order Awareness:** Frontline nurses were instructed to utilize the STAT antibiotics notification in Epic, a real-time alert system that remained active until antibiotic administration was completed. This feature improved visibility and reduced delays caused by unacknowledged orders.
- **Real-Time Documentation & Coaching:** When antibiotic administration exceeded the 60-minute threshold, frontline nurses were required to document the reason for the delay in EPIC. The unit's nursing leader reviewed this data weekly to identify trends, recurring challenges, or staff requiring targeted coaching for timely administration.
- **Provider-Driven Communication Enhancements:** The lead nurse practitioner (NP) adjusted the priority of antibiotic orders and communicated directly with frontline nurses or via high-priority Epic secured chat notifications. This direct provider-to-nurse communication ensured immediate awareness and facilitated prompt action.
- **Medication Availability Optimization:** The clinical pharmacist analyzed antibiotic ordering trends and adjusted stock levels in the automated medication dispensing system Pyxis to ensure that commonly prescribed medications were readily accessible.

Targeted interventions were implemented to systematically improve STAT IV antibiotic turnaround time, focusing on leadership engagement, process optimization, and frontline staff support. The following sections outline these key strategies in detail.

2.1.1 *Leadership interventions*

HMH IPR leadership collaborated with the pharmacy department, using weekly antibiotic administration reports to optimize medication availability and expedite delivery. Leaders requested a review of Pyxis to ensure the most frequently ordered STAT IV antibiotics were readily accessible on the unit. The central pharmacy committed to delivering less commonly used antibiotics via the pneumatic tube system, typically within five minutes. For medications chemically unstable in the tube system, such as Daptomycin, a pharmacy technician was dispatched STAT, ensuring delivery within 15 to 20 minutes. Additionally, clinical pharmacists prioritized STAT IV antibiotic verification, completing the process within 5 to 10 minutes. The pharmacy department conducted routine audits of the order-to-administration process to maintain accountability and shared findings with the quality improvement department and unit leadership.

A Sepsis Champion nurse was designated to represent the unit at hospital-wide sepsis meetings to reinforce staff engagement and adherence to best practices in sepsis care. The Sepsis Champion was pivotal in bridging communication between leadership and frontline nurses by disseminating key updates during staff meetings and huddles. Educational content included sepsis statistics, mortality rates, and the critical impact of antibiotic turnaround time on patient outcomes.

To further promote sepsis awareness, the Sepsis Champion distributed "badge buddies" featuring quick-reference information on sepsis protocols. Additionally, pens imprinted with the slogan "KNOW SEPSIS" were provided as daily reminders of the importance of early recognition and intervention. These leadership-driven initiatives fostered a culture of accountability, knowledge-sharing, and continuous improvement in sepsis management, ultimately strengthening the hospital's commitment to high-quality patient care.

2.1.2 *Nursing interventions*

The unit manager generated and disseminated weekly performance reports to enhance antibiotic turnaround time, ensuring transparency and driving continuous improvement efforts. The unit manager and educator also developed comprehensive in-service training for all nurses to reinforce sepsis knowledge and emphasize the urgency of first-dose IV antibiotic administration. Frontline nurses were reminded during the midday shift huddle to check their worklists every 30 minutes to prevent delays in STAT orders, including IV antibiotics.

The unit manager provided direct, real-time feedback to front-

line nurses handling STAT IV antibiotic orders. Nurses who successfully administered a STAT IV antibiotic within 60 minutes received personal recognition from the manager and were publicly acknowledged on the unit's communication board, where their names and recorded administration times were displayed weekly as positive reinforcement. When the 60-minute benchmark was not met, leadership conducted root-cause analyses to identify barriers and implement targeted solutions. For example, when delays were attributed to patients being transported to dialysis, a new protocol was introduced: nurses were instructed to coordinate with the central pharmacy to deliver medications directly to the dialysis center and notify the receiving nurse in advance. Additionally, nurses were encouraged to seek colleague assistance for patients with limited IV access and escalate to the charge nurse if IV placement was unsuccessful after two attempts, ensuring timely medication administration.

Through timely feedback, targeted education, and strong leadership support, these nursing interventions fostered a culture of accountability, collaboration, and continuous quality improvement, ultimately driving meaningful advancements in sepsis care and patient outcomes.

2.1.3 *Provider interventions*

Targeted interventions were implemented to improve communication and streamline workflow to enhance STAT IV antibiotic turnaround time. The lead NP, the primary author of this project, was identified as the most frequent ordering provider at HMH IPR based on weekly antibiotic administration reports. The NP collaborated with two key physical medicine and rehabilitation physicians, reviewed ordering practices, and adjusted orders from STAT to routine when clinically appropriate. This was necessary due to the EPIC system's default setting, which classifies all new IV antibiotic orders as STAT, regardless of urgency.

Beyond optimizing ordering practices, the lead NP actively promoted closed-loop communication for STAT antibiotic orders. Immediately after placing a STAT order, the frontline nurse was notified in person or via a high priority secured EPIC chat. This ensured timely awareness and allowed immediate action. Additionally, the NP verified that the frontline nurse had sufficient time and expertise to administer the medication, escalating concerns to the charge nurse or unit manager when additional support was required. These best practices were shared at monthly NP service meetings and hospital sepsis championship meetings to encourage system-wide adoption.

To further minimize delays, the NP proactively engaged clinical pharmacists to verify STAT orders and expedite medication delivery. Given the geographic separation between HMH IPR and the main hospital pharmacy, direct communication with pharmacists was critical in reducing turnaround time.

Through these targeted interventions—enhanced provider-nurse communication, strategic order refinement, and pharmacist collaboration—this initiative optimized interdisciplinary coordination, reduced unnecessary STAT orders, and significantly improved first-dose IV antibiotic administration efficiency. These efforts reinforced the importance of proactive provider involvement in driving meaningful improvements in sepsis care.

2.2 Measures

2.2.1 *Primary measure*

The primary measure of this QI project is the 60-minute turnaround rate for the first-dose of STAT IV antibiotics. This rate is determined by calculating the proportion of STAT IV antibiotics administered within 60 minutes of the order being placed in EPIC compared to the total number of STAT IV antibiotic orders at HMH IPR.

The starting point, or time zero, is defined as the moment the initial STAT IV order is placed in EPIC. If a clinical pharmacist modifies the original order based on the patient's renal function, time zero is adjusted to reflect the pharmacist's modification time. Pharmacists usually verify STAT IV antibiotic orders within 10 minutes of placement.

2.2.2 *Process measure*

The process measure for this project is the staff training participation rate before implementation. Ensuring strong training participation is essential, as well-trained staff are more adept at recognizing early signs of deterioration, responding promptly, and delivering timely patient care.

2.2.3 *Balancing measure*

To assess any unintended consequences of expedited antibiotic administration, the project tracked the percentage of unplanned 30-day readmissions from HMH IPR to HMH as a balancing measure. This helped ensure that improving antibiotic turnaround time did not negatively impact patient outcomes. This measure excluded patients being discharged to the community but later rehospitalized within 30 days.

By incorporating these measures, the project ensures a comprehensive evaluation of its impact on efficiency, staff preparedness, and patient safety.

3. RESULTS

3.1 STAT IV antibiotic turnaround rate

In 2024, 262 new STAT IV antibiotic orders were placed at HMH IPR. The 60-minute antibiotic turnaround rate was

33.3% at the beginning of the year. Following the implementation of key interventions, including stocking frequently used antibiotics in Pyxis, enhancing communication and notification processes, maintaining ongoing surveillance, and providing individualized feedback to the frontline nurses—the antibiotic turnaround rate rose to 68.4% by the end of March, exceeding the 60% goal three months ahead of schedule. This improvement remained stable throughout the year (see Table 1). As a result, the unit was recognized with the Sepsis Care and Management Banner for two consecutive quarters, acknowledging the frontline team's dedication to optimizing sepsis care through timely antibiotic administration.

Table 1. STAT IV antibiotic 60-minute compliance

Month	Total STAT Orders	Orders Given on Time	%
January	30	10	33.3
February	13	6	46.2
March	19	13	68.4
April	14	9	64.3
May	18	15	83.3
June	29	21	72.4
July	28	17	60.7
August	23	18	78.3
September	23	17	73.9
October	22	19	86.4
November	17	15	88.2
December	26	19	73.1
TOTAL	262	179	68.3

In July, a lower turnaround rate was observed, with nine cases of STAT IV antibiotics not administered within 60 minutes. Four were due to delayed delivery from the pharmacy, three resulted from difficulty with IV access, and two had no documented reasons. To address these issues, nurses were encouraged to escalate IV access challenges to leadership and ensure documentation of the reasons for all delays. Additionally, the pharmacy was contacted regarding the delayed deliveries. With continued surveillance and targeted interventions, the 60-minute turnaround compliance rate remained above 70% for the remainder of the year.

Figure 1 presents a monthly trend analysis of STAT IV antibiotics 60-minute compliance alongside the unplanned 30-day readmissions, illustrating the intervention's impact over time.

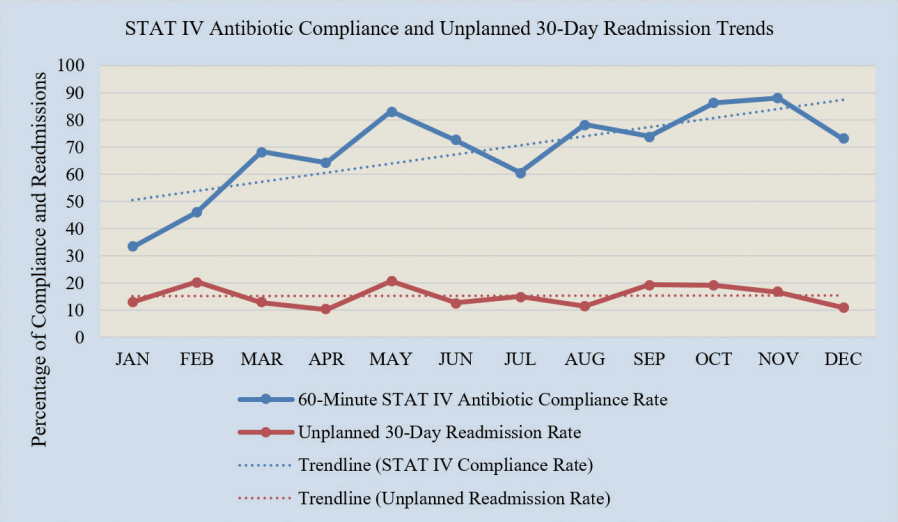

Figure 1. STAT IV antibiotic 60-minute compliance and unplanned 30-day readmission trends

3.2 Staff training

All nursing staff successfully completed training prior to the implementation of the project, ensuring readiness and adherence to best practices in antibiotic administration.

3.3 Unplanned readmission results and IV antibiotics usage

In 2024, HMH IPR recorded a total of 730 discharges. Of these, 112 patients experienced unplanned 30-day readmissions to HMH, representing 15.3% of total discharges (see Table 2).

Among the 112 unplanned 30-day readmissions, 51 patients (45%) required IV antibiotic treatment during their hospitalization at HMH. Within this group:

- 27 patients received their first-dose of STAT IV antibiotics at HMH IPR within 12 hours prior to unplanned discharge.
- 15 patients received their first-dose of new IV antibiotics at the receiving unit within 12 hours of unplanned readmission.
- 9 patients had already received IV antibiotics at HMH IPR for more than 24 hours before discharge and continued treatment after transfer to HMH.

Table 2. All-cause unplanned 30-day readmissions from HMH IPR to HMH

Month	Total Rehab Discharge	Unplanned Readmissions	%
January	61	8	13.1
February	54	11	20.4
March	62	8	12.9
April	58	6	10.3
May	58	12	20.7
June	55	7	12.7
July	60	9	15.0
August	52	6	11.5
September	67	13	19.4
October	73	14	19.2
November	66	11	16.7
December	64	7	10.9
TOTAL	730	112	15.3

These findings provide insight into the relationship between IV antibiotic administration at HMH IPR and unplanned 30-day readmissions, highlighting the importance of optimizing antibiotic timing and treatment continuity.

4. Discussion

A high staff training participation rate and closed-loop communication between providers and frontline nurses were critical in this initiative's initial success and long-term sustainability. Comprehensive training empowered frontline nurses with the confidence and preparedness to respond effectively to changes in patient conditions, fostering a proactive care environment. A well-trained team is likelier to adhere to best practices, ensuring consistency, reducing variability in care, and reinforcing the integration of new processes into routine practice.

By the end of March 2024, the 60-minute antibiotic turnaround rate had improved to 68.4%, exceeding the initial goal of 60% and maintaining stability throughout the year. However, despite this significant improvement in antibiotic turnaround compliance, there was no clear impact on unplanned 30-day readmission rates at HMH IPR.

A considerable number of patients initially diagnosed with sepsis are later found to have noninfectious conditions. This raises concerns that stringent antibiotic timing targets may contribute to overuse and potential harm, particularly in cases where sepsis is not confirmed.[17] Striking the right balance between ensuring prompt antibiotic administration for true sepsis cases and allowing clinicians sufficient time for rapid diagnostic assessment is essential to minimizing the risk of overtreatment and antibiotic resistance. Given the complex patient population at HMH IPR—many of whom have multiple comorbidities and a high severity index—early aggressive intervention at the first signs of sepsis is critical. However, ongoing evaluation through culture results and laboratory findings should guide the appropriate de-escalation or discontinuation of antibiotics, ensuring optimal outcomes and antimicrobial stewardship.[18]

4.1 Limitations

One notable limitation of this QI project is its specific institutional setting. This inpatient rehabilitation unit operates

within a tertiary care academic medical center, benefiting from extensive resources to support patient-centered care. For example, patients receive care from nurses at a 1:5 ratio, with 24/7 rapid response team availability. Additionally, the presence of a unit-based NP working four days per week facilitates real-time leadership, staff engagement, and behavioral change initiatives. In contrast, community-based rehabilitation facilities may lack similar infrastructure or resources, making it more challenging to implement these quality improvement strategies.

Another limitation is the unique characteristics of the patient population. Many patients in this rehabilitation unit have multiple comorbidities and a high severity index, placing them at an elevated risk for rapid progression to severe sepsis or septic shock. Facilities with lower-acuity patient populations may require a less aggressive approach, which could affect the generalizability of this intervention. Finally, this project only evaluated unplanned 30-day readmissions from HMH IPR to HMH, excluding hospital readmissions from the community. The project did not assess the impact of improved antibiotic turnaround time on other key clinical outcomes, such as mortality or length of stay. Future studies should explore other key clinical outcomes to validate the benefits of expedited antibiotic administration in rehabilitation settings.

4.2 Implication

Although the recommended time-to-antibiotic guidelines for suspected sepsis remain debated, both the Surviving Sepsis Campaign and the Infectious Diseases Society of America advocate for aggressive treatment in high-risk patients who are more likely to progress to septic shock.[6, 15] This QI project provides a structured, step-by-step strategy to ensure antibiotics are readily available and promptly administered, ultimately reducing the time from order placement to administration.

There is limited research on antibiotic turnaround compliance in rehabilitation settings. Most studies on antibiotic turnaround compliance have been conducted in emergency departments[19] or intensive care units.[12] By examining this issue in a rehabilitation environment, this project contributes evidence-based insights that can inform sepsis care practices in similar clinical settings. Additionally, the strategies implemented in this study could be adapted to other inpatient and outpatient settings, potentially improving patient outcomes across diverse healthcare environments.

5. Conclusion

Timely administration of the first-dose IV antibiotic is crucial in sepsis management, yet significant delays persist in hospital-based rehabilitation settings. This QI project utilized the Kaizen Rapid Cycle methodology to systematically identify barriers to prompt antibiotic administration, leading to the development and implementation of targeted interventions by stocking frequently used antibiotics in Pyxis, enhancing communication protocols, and providing continuous feedback to nursing staff. The antibiotic turnaround rate improved from 33.3% at the beginning of 2024 to 68.4% by the end of March, exceeding the 60% goal three months ahead of schedule. These improvements were sustained throughout the remainder of the year, demonstrating the effectiveness of structured interventions. The findings from this QI project emphasize the critical role of early recognition, interdisciplinary collaboration, and nursing leadership in enhancing sepsis care through efficient antibiotic administration.

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Authors contributions

Dr. Yu Wang was responsible for study design and revising. She drafted and revised the manuscript. Quality Outcomes Specialist Lavicka Q. Stewart was responsible for data collection. Unit manager Ryan Obremski was responsible for ongoing nursing surveillance and providing individualized feedback. He also proofread the final revisions. Post-acute unit director Monica A. Nichols was responsible for coordinating with the pharmacy department and securing leadership support. All authors read and approved of the final manuscript.

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Conflicts of Interest Disclosure

The authors declare that there is no conflict of interest.

Informed consent

Obtained.

Ethics approval

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DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

DATA SHARING STATEMENT
No additional data are available.

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