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PERSPECTIVES

Understanding Code Blue Activations: Insights From Early Warning and Palliative Scores in a Tertiary Hospital

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Background: In-hospital cardiac arrest (IHCA) is a critical emergency, occurring at rates of 1–6 events per 1000 hospital admissions, necessitating immediate and efficient resuscitation efforts. This study aims to determine the frequency, demographic characteristics, and outcomes of Code Blue activations in a tertiary teaching hospital in a low-middle-income country.

Methods: This retrospective observational study was conducted at in National Referral and Teaching Hospital in a middle income country in Asia, covering data from January 1, 2017, to December 31, 2023. The study included 2184 Code Blue activations, with data on Early Warning Scores (EWS) and palliative scores available from 2021 onwards. Statistical analyses were performed to evaluate the relationship between these scores and patient outcomes.

Results: Out of 2184 Code Blue activations, 713 cases included both EWS and palliative scores. The highest number of activations was recorded in 2019 (535 cases), and the lowest in 2021 (152 cases). Calculated incidence where 5.46 per 1000 visits. The return of spontaneous circulation (ROSC) rates ranged from 11% to 27.6%, with an average of 17.7% per year. The mean EWS and palliative scores for Code Blue activations were 9.2 (SD ± 2.3) and 7.8 (SD ± 1.9), respectively.

Discussion: The findings highlight trends in IHCA incidence, causes, and outcomes, emphasizing the importance of early identification and management of patients at risk. The study underscores the need for continuous monitoring and early intervention, particularly for patients with high EWS. Additionally, the integration of palliative care considerations into hospital protocols is crucial for improving patient outcomes and resource allocation.

Conclusion: Early warning system and palliative care scoring may predict code blue activation and if managed can reduce its number.

Keywords: In-hospital cardiac arrest, code blue, early warning score, palliative care, emergency response, resuscitation

Introduction

In-hospital cardiac Arrest, or IHCA, represents a critical emergency condition, manifesting at rates of 1–6 events per 1000 hospital admissions, with the United States alone reporting approximately 290,000 cases annually. Such emergencies necessitate immediate and efficient resuscitation efforts to ensure patient survival and favorable outcomes.[1,2] Tertiary hospitals that function as significant referral centers and teaching institutions are bustling ecosystems comprising daily thousands of personnel, students, patients, families, and visitors. This dense and dynamic environment increases the likelihood of IHCA events among hospitalized patients and poses a significant, albeit less explored, risk to non-patients within these settings. Cardiac arrests within hospital settings can afflict various patient demographics, particularly those harboring pre-existing cardiac conditions, extensive comorbidities, or undergoing critical care. Yet, the unpredictability of IHCAs also encompasses individuals devoid of traditional risk factors, including hospital staff and visitors, highlighting the universal need for a hospital to have a versatile Code Blue readiness that covers both patients and non-patients IHCA.[3–5]

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To maintain safety standards, hospitals must deploy a 24/7 available resuscitation service known globally as the Rapid Response or Code Blue team. This specialized ensemble of trained personnel and advanced medical equipment is foundational to the rapid response mechanism for managing IHCAs.[3] International accreditation standards, such as those enforced by the Joint Commission International, underscore the necessity of an effective Code Blue system as a hallmark of excellence in emergency care and a crucial criterion for hospital accreditation. Such systems play a pivotal role in meeting accreditation benchmarks and enhancing the speed and efficacy of cardiac emergency responses, thereby elevating patient survival rates and overall outcomes.[3,4,6]

The Early Warning Score (EWS) is a clinical tool designed to assess patient severity based on physiological parameters such as consciousness level, heart rate, systolic blood pressure, oxygen supplementation, temperature, and oxygen saturation. It is widely implemented in emergency and outpatient departments to facilitate the early identification of patients at risk of clinical deterioration. Complementing this, the palliative score, grounded in the World Health Organization's criteria for chronic diseases, evaluates the need for palliative care in patients with conditions such as cardiac, hepatic, pulmonary, renal, neurological diseases, and cancer. Together, these scoring systems provide a structured approach to risk stratification, enabling healthcare teams to prioritize interventions and allocate resources efficiently. In the context of this study, EWS and palliative scores were applied to analyze their association with Code Blue activations, offering insights into the interplay between acute severity and chronic disease burden.[7]

This study aims to determine the frequency, demographic characteristics, and outcomes of Code Blue activations in a tertiary teaching hospital in a low-middle-income country (LMIC). By examining these critical events, we hope to understand better the risk factors involved and identify areas where emergency cardiac care practices could be improved.

Methods

Study Setting, Study Design, and Data Collection

This retrospective observational study was conducted at a government-owned tertiary referral and teaching hospital in Indonesia, which has 40.000 patients per year and 1000beds. The hospital offers a comprehensive range of complex multidisciplinary services, including transplant surgery, cardiac surgery, and minimally invasive procedures. Advanced diagnostic examinations, such as PET scans and MRIs, are conducted within a 24-hour service framework. Additionally, the institution is dedicated to medical education, providing training for approximately 3000 residents each semester. The study was conducted on data extracted from the hospital code blue log from January 1st, 2017, to December 31st, 2023, and received institutional review board clearance from DR Hasan Sadikin Ethical Committee and patient consent was waived since the study was noted as a database study. In the course of the study, the confidentiality of patient data was strictly maintained in accordance with the principles outlined in the Declaration of Helsinki. The writing of this manuscript follows The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[5]

The hospital has formed a code blue team of one doctor and two intensive care nurses. These teams are available 24 hours a day, seven days a week. They are responsible for responding to medical emergencies for staff, visitors, and patients' families within the hospital, except for incidents in the emergency room, operating room, and intensive care units.

Before the merger of the code blue and early warning system teams, there was no record of pre-arrest data. Information on pre-arrest situations was only available from 2021 onwards due to the change in hospital policy and its adaptation of the new standards from the Join Commission International hospital accreditation. Hence data from 2021 onwards included two other criteria's which was the early warning score and the palliative score. In 2021, The early warning score (EWS) based on was implemented to evaluate patient severity in the emergency and outpatient departments before admission. The national early warning score includes physiological criteria such as consciousness, heart rate, systolic blood pressure, use of supplementary oxygen, temperature, systolic, and saturation.[6] In addition to the EWS, a palliative score based on the World Health Organization's list of chronic diseases was used to assess the need for palliative services in patients with chronic diseases related to the heart, liver, lungs, kidneys, neurological diseases, and cancer.[7] (Supplementary-S1) No formal statistical hypothesis testing was performed as this study is descriptive in nature.

Results

Out of 2194 cases, 10 were excluded because they did not meet the "true" code blue event criteria, meaning the patient was not in cardiac arrest. Of the 2184 Code Blue activations between 2017–2023, detail evaluation of EWS and palliative scores was conducted on 713 cases collected from 2021 onward as these scores were not previously recorded due to a new hospital policy implemented in 2020 (Figure 1).

2184 code blue activations occurred between January 1, 2017, and December 31, 2023. The highest number of activations was recorded in 2019, with 535 cases, while the lowest was observed in 2021, with 152 cases. Survival rates for code activation or return of spontaneous circulation (ROSC) ranged from 11% to 27.6%, with an average of 17.7% per year. (Figure 2). The incidence of Code Blue activations during the study period was approximately 5.46 events per 1000 hospital admissions, reflecting the hospital's role as a national referral and teaching center handling a high-acuity patient population.

The bar chart (Figure 3) illustrates the distribution of Code Blue activations related to various diseases over 2021–2023. Cancer-related Code Blue activations peaked in 2022 with 94 cases before decreasing to 78 cases in 2023. Sepsis-related activations increased from 14 cases in 2021 to 38 cases in 2022 and remained constant in 2023. The category of "Others" related to trauma, liver diseases, infection, trauma, and congenital diseases also saw a marked rise from 37 cases in 2021 to 88 cases in both 2022 and 2023. Cardiac diseases exhibited a similar trend, increasing from 11 cases in 2021 to 30 cases in 2022, then slightly decreasing to 26 cases in 2023. Central Nervous System Disease activations remained relatively stable, with 17 cases in 2021 and 2023 and a slight increase to 22 cases in 2022. Immunology and HIV-related activations were low throughout the period, though there was a slight increase in immunology-related cases in 2023. Kidney disease activations remained pretty consistent, with a slight increase in 2023. Obstetric cases increased modestly, from 1 case in 2021 and 2022 to 4 cases in 2023. Overall, the data indicate varying trends in Code Blue activations across different disease categories, highlighting fluctuations in cancer, sepsis, cardiac diseases, and other unspecified conditions.

The two bar charts (Figure 4) provide insights into the severity and palliative status of patients who activated Code Blue for cardiopulmonary resuscitation (CPR) from 2021 to 2023. The first chart, depicting the Admission Early Warning Score (EWS), categorizes patients into three groups based on their severity scores: 1 to 3, 4 to 7, and above 7. The data reveal a major proportion of patients had EWS scores above 7, indicating severe conditions upon admission. In 2021, the

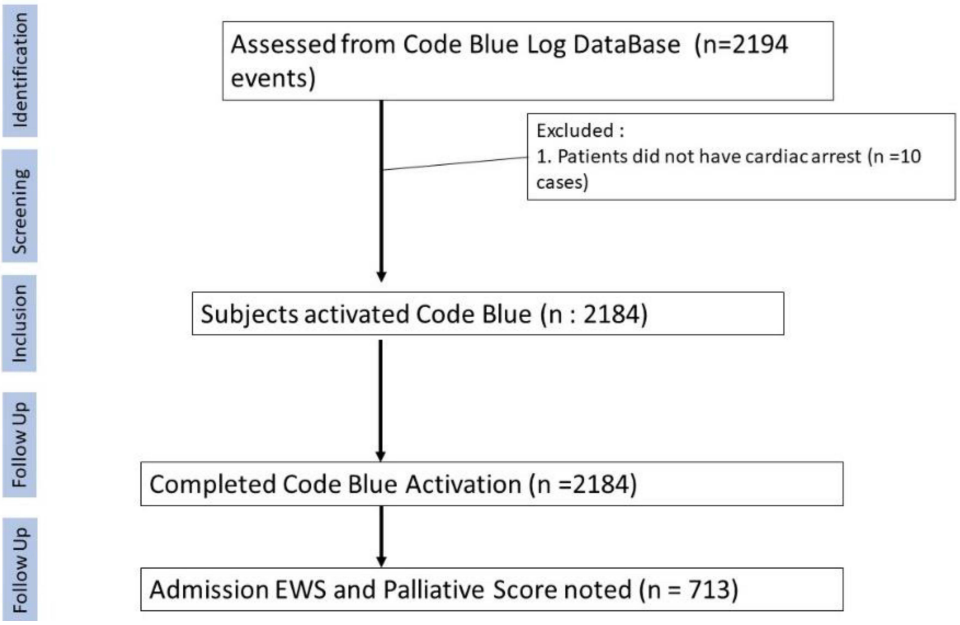
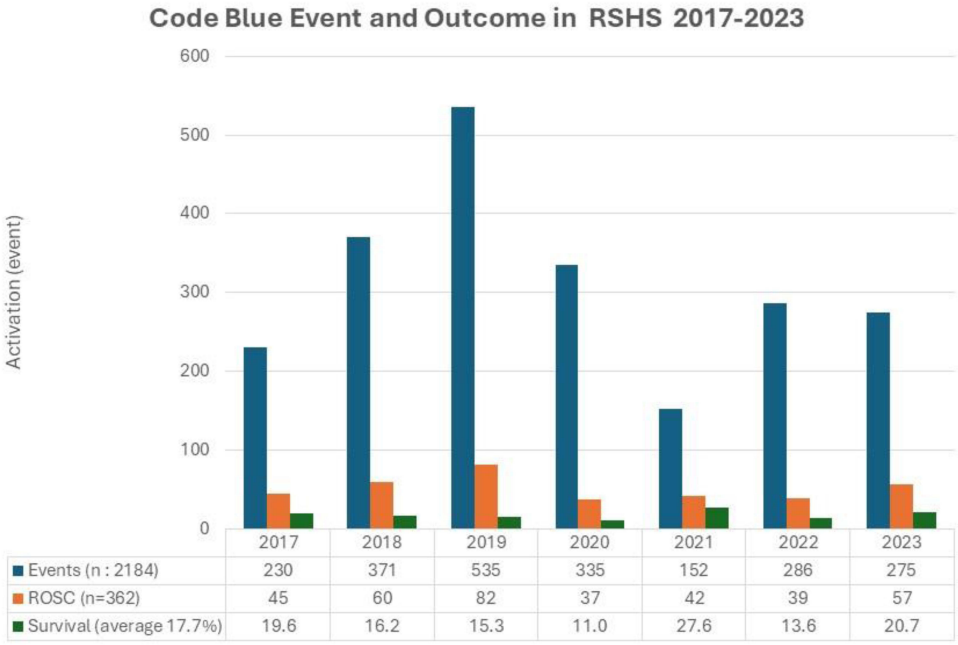
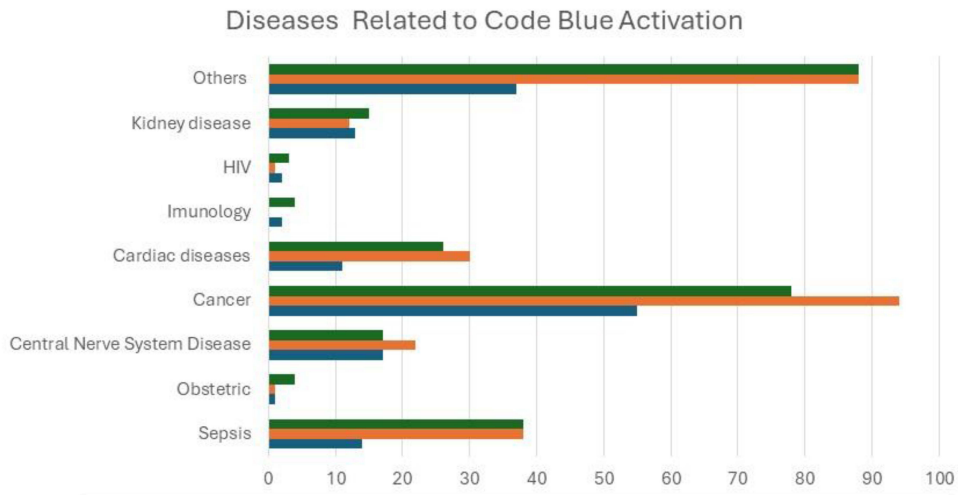


Figure 1 The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. Adapted from Brand RA. Standards of reporting: the CONSORT, QUORUM, and STROBE guidelines. Clinical Orthopaedics and Related Research®. 2009 Jun 1;467(6):1393–1394. Creative Commons.[5]



	2017	2018	2019	2020	2021	2022	2023
Events (n : 2184)	230	371	535	335	152	286	275
ROSC (n=362)	45	60	82	37	42	39	57
Survival (average 17.7%)	19.6	16.2	15.3	11.0	27.6	13.6	20.7

Figure 2 Legend: RSHS: Dr. Hasan Sadikin national referral and teaching hospital, ROSC: Return of Spontaneous Circulation.



	Sepsis	Obstetric	Central Nerve System Disease	Cancer	Cardiac diseases	Imunology	HIV	Kidney disease	Others
2023	38	4	17	78	26	4	3	15	88
2022	38	1	22	94	30	0	1	12	88
2021	14	1	17	55	11	2	2	13	37

Figure 3 Diseases Related to Code Blue Activation. Diseases noted here were the diseases that occurred upon entering the inpatient department. Others included diagnosis of liver failure, trauma, infection, autoimmune and congenital diseases. Legend: HIV: Human Immunodeficiency Virus.

majority had scores above 7, with a noticeable increase in 2022, where this category peaked. The trend continued in 2023, reinforcing the observation that many code blue activations involved patients already in critical condition upon admission.

The second chart focuses on the palliative scores of these patients, divided into two categories: scores 1 to 7 and scores greater than 7. The data consistently show that a higher number of patients had palliative scores greater than 7

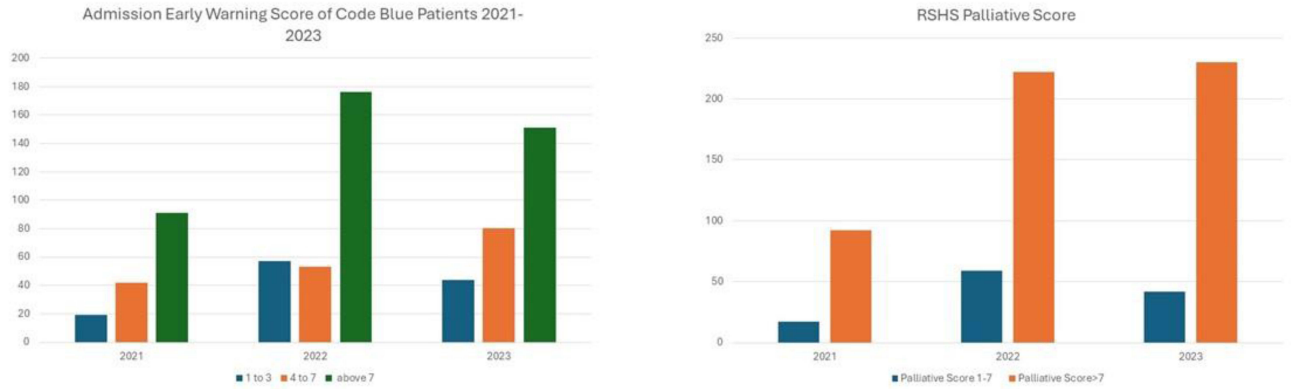


Figure 4 Comparison between admission early warning system (EWS) and admission palliative score on patients arrested during hospital stay. The mean EWS and palliative scores for Code Blue activations were 9.2 (SD ± 2.3) and 7.8 (SD ± 1.9), respectively. A higher EWS score indicates acute severity and a higher palliative score indicates a possibility of end of life.

across all three years. In 2021, the number of patients with higher palliative scores was greater than those with lower scores, a trend that persisted and slightly increased in 2022 and 2023. The mean EWS and palliative scores for Code Blue activations were 9.2 (SD ± 2.3) and 7.8 (SD ± 1.9), respectively, Patients with higher EWS often exhibited acute physiological deterioration upon admission, while higher palliative scores were indicative of advanced chronic illnesses requiring end-of-life considerations. These findings underscore the dual burden of acute and chronic disease management in triggering Code Blue events and the need for integrated care approaches. Cautions must be taken when interpreting there results in a different setting since our findings suggest a trend but were not supported by formal statistical testing since this study is descriptive in nature.

Discussion

Our research presents the first comprehensive description of code blue activations spanning six years at a prominent tertiary hospital in Indonesia, where many events have been documented. Also unique to this study was its description of a plausible connection between acute severity managed by an early warning system (EWS) and chronic states of diseases marked by palliative scores. Understanding the connection between code blue, EWS, and palliative scores provides insights for future studies and programs to reduce in-hospital cardiac arrest. A major strength of our study is the extensive dataset spanning six years, which provides a general basis for seeing trends in various social settings heavily affected by COVID-19. Additionally, using EWS and palliative scores allows for a deeper understanding of patient characteristics that may impact in-hospital cardiac arrest events.

The yearly variations in Code Blue activations observed in our study likely reflect changes in hospital operations, patient demographics, and external factors such as the COVID-19 pandemic. For instance, the notable decrease in activations during 2021 coincides with the pandemic's impact, which reduced non-COVID-19 hospital admissions and elective procedures, as well as stretched healthcare resources. Conversely, the higher number of activations in earlier years may indicate a lack of systematic early warning mechanisms before the introduction of scoring systems in 2021. These fluctuations underscore the dynamic nature of hospital operations and patient care demands over time, which warrant further investigation to identify specific contributors to these trends and their implications for resource allocation and patient outcomes. Note also that the Code Blue sequence in this study does not include high-care or intensive-care patients, where higher rates of COVID-19 in-hospital cardiac arrests were reported.[8,9]

The average rate of Return of Spontaneous Circulation (ROSC) was 17.7%, and it varied significantly across different disease categories and patient conditions. When comparing this ROSC rate of 17.7% to other middle-income countries, studies have shown variations, for instance in the United Arab Emirates 40%, in Uganda 7.4%, and in Abu Dhabi 38.3%. These differences can be attributed to several factors. In some studies, the inclusion of codes that occurred in the intensive care unit, where advanced care and early intervention are available, may have influenced the results. Another

possible factor is the cause of the arrest. Most cases reported in other studies were of cardiac origin, which was not observed in our study.[2,8–11]

Sepsis-related deaths found in this study are a significant concern, and urgent measures must be implemented to control this preventable condition. Studies in Taiwan, sepsis patients with IHCA exhibited a higher 30-day mortality rate (HR, 3.45; 95% CI, 2.37–5.01) and a higher 1-year mortality rate (HR, 1.40; 95% CI, 1.01–1.96) compared to sepsis patients without IHCA.[12,13] The results suggest that hospitals should use sepsis management indicators as quality indicators, such as compliance with the one-hour and six-hour sepsis bundle, temperature and humidity control, hand hygiene compliance, and other sepsis control management in the hospital.[14,15]

Our findings underscore the importance of continuous monitoring and early intervention, particularly for patients with high EWS in the out-of-critical unit setting.[6] The hospital should consider additional training in early warning signs (EWS) management and the availability of more high-care and intensive care units to address the needs of a tertiary referral hospital and the spectrum of diseases seen in similar types of hospitals with ours, as indicated in this study.[6,16,17]

Palliative care, which has just been systematically understood as part of care in hospital setting has many challenges in Indonesia due to cultural and religious believes that also form the medical choices given by medical professionals. A study in Indonesia revealed that over 60% of hospitalized patients in Indonesia with non-communicable diseases (NCD) require palliative care, a need frequently overlooked by clinicians. Additionally, studies have found significant disagreement among clinicians in Indonesian hospitals regarding the identification of patients needing palliative care. Consequently, patients in palliative stages in this study were still classified as full-code patients.[18–20]

This study has several limitations that should be considered when interpreting the findings. Firstly, data on Early Warning Scores (EWS) and palliative scores were only available from 2021 onwards, limiting the analysis to a subset of the total cases. Secondly, conducted in a single tertiary hospital in Indonesia, the findings may not be generalizable to other settings or populations, particularly those in different geographic or healthcare contexts. Furthermore, the absence of pre-arrest data prior to 2021 and the reliance on the accuracy of the hospital's code blue log may affect the reliability of the results. While the study focuses on descriptive outcomes, further research is needed to explore additional variables such as long-term survival or discharge outcomes.

Strategic quality improvement measures to address the issues presented in this paper must be implemented chronologically. By identifying the process diagram, which includes hospital admission, care, and discharge, it is clear that effectively managing the admission phase can reduce the number of code blue incidents. Early identification of patients as acute care, palliative, or end-of-life upon admission can potentially halve code blue activation and enhance the quality of patient care. This approach ensures efficient resource allocation for patients that will benefit from it, minimizes unnecessary procedures and provides a dignified death for those for whom it is the best-offered outcome.

Conclusions

In conclusion, this descriptive study offers valuable insights into the characteristics and context of Code Blue events in a tertiary hospital setting in Indonesia. Our findings suggest that higher Early Warning Scores (EWS) and palliative scores are frequently observed in patients requiring Code Blue activations, indicating their potential relevance in identifying high-risk patients. While no formal statistical analysis was performed, the observed trends emphasize the importance of effective management and utilization of these scoring systems to potentially reduce the occurrence of in-hospital cardiac arrests. Future research incorporating comprehensive longitudinal data and formal statistical methods could further elucidate these associations and guide targeted interventions.

Generative AI Statement

During the preparation of this work, the author(s) used [Grammarly], in order to [correct language and improve readability]. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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This paper is also available on SSRN as a preprint https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4890230.

Author Contributions

All authors made a significant contribution to the work reported such as conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest in this work.

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