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Bridging Cases from Clinic to Basic Sciences: A Model of Integration in Medical Education

Klinikten Temele Köprü Vakalar: Bir Entegrasyon Örneği

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Abstract

Objective: The objective of this investigation was to strengthen the integration between basic and clinical sciences by utilizing a case-based learning approach in three separate instructional sessions for second-year medical students.

Methods: The study was conducted at Selçuk University Faculty of Medicine during the 2023–2024 and 2024–2025 academic years. It adopted a cross-sectional and descriptive design. Three integrated instructional sessions titled “Bridging Cases from Clinic to Basic Sciences” were delivered to second-year students. Each session was built around a real clinical case provided by a practicing clinician. A team of faculty members, including instructors from basic sciences, clinical sciences, medical education, and the education coordinator, collaboratively prepared and determined the learning objectives. The sessions included history-taking, physical exam findings, discussion of differential diagnoses, lab test interpretation, and explanation of relevant basic science concepts. Topics from anatomy, physiology, histology, embryology, microbiology, and biochemistry were integrated throughout the session. Each session concluded with the clinical diagnosis and treatment plan. To assess the impact of the sessions, student feedback was collected via a digital survey with a 5-point Likert scale. The survey included eight items evaluating students’ perceptions of relevance, content quality, integration, and overall satisfaction. Participation was voluntary and anonymous. Data were analyzed using SPSS 22.0, with results reported in frequencies

and percentages. Chi-square tests were used to compare responses across sessions.

Results: Across all three sessions, student responses were highly positive. In the first session (n=109), 95.4% agreed or strongly agreed that the session was relevant to their medical education. In the second session (n=70), 91.5% agreed that it successfully linked clinical and basic sciences, and 88.6% reported increased interest in medical education. In the third session (n=72), 95.8% were satisfied with its duration, and 95.8% agreed it helped connect basic sciences with clinical applications. Over 80% of students in each session expressed a desire for more such integrated sessions. Chi-square analysis showed no statistically significant differences between the sessions in terms of relevance, satisfaction, learning facilitation, or interest in basic sciences ($p > 0.05$).

Conclusion: The results demonstrate that case-based integrated sessions combining basic and clinical sciences were well-received by students. This instructional approach helped students understand the real-life relevance of foundational medical knowledge and fostered greater interest in learning. The model provides a practical example of how meaningful integration can be achieved even in the early years of medical education and may serve as a guide for other faculties aiming to implement similar strategies.

Özet

Amaç: Bu çalışma, temel tıp bilimleri ile klinik bilimler arasında entegrasyonu teşvik etmek maksadıyla, tıp fakültesi ikinci sınıf öğrencilerine sunulan vaka temelli üç ayrı entegre oturumuna ilişkin öğrenci görüşlerini değerlendirmeyi amaçlamaktadır.

Yöntem: Çalışma, 2023–2024 ve 2024–2025 eğitim-öğretim yıllarında Selçuk Üniversitesi Tıp Fakültesi'nde yürütülmüş olup kesitsel ve tanımlayıcı bir tasarım benimsenmiştir. "Klinikten Temele Köprü Vakalar" başlıklı üç bütünleşik oturum, ikinci sınıf öğrencilerine sunulmuştur. Her oturum, klinikte görev yapan bir hekim tarafından sağlanan gerçek bir hasta vakası etrafında yapılandırılmıştır. Temel bilimler, klinik bilimler, tıp eğitimi ve eğitim koordinatöründen oluşan bir öğretim üyesi ekibi, vakaları birlikte hazırlamış ve öğrenim hedeflerini belirlemiştir. Oturumlar; hasta öyküsü, fizik muayene bulguları, ayırıcı tanılar, laboratuvar sonuçlarının değerlendirilmesi ve ilgili temel bilim konularının açıklamalarını içermiştir. Anatomi, fizyoloji, histoloji, embriyoloji, mikrobiyoloji ve biyokimya gibi alanlar entegre şekilde sunulmuştur. Her oturum, klinik tanı ve tedavi planı ile sona ermiştir. Oturumların etkisini değerlendirmek amacıyla öğrenci geri bildirimleri 5'li Likert ölçeği ile dijital bir anket yoluyla toplanmıştır. Sekiz maddelik anket, öğrencilerin oturumların faydasına, içerik kalitesine, entegrasyon düzeyine ve genel memnuniyetine ilişkin algılarını ölçmüştür. Katılım gönüllü ve anonimdir. Veriler SPSS 22.0 programında analiz edilmiş, bulgular yüzde ve frekans olarak sunulmuştur. Oturumlar arası farklar ki-kare testi ile değerlendirilmiştir.

Bulgular: Üç oturumdan elde edilen verilere göre, öğrencilerin geribildirimlerinin son derece uyumlu olduğu sonucuna ulaşılmıştır. İlk oturumda (n=109), öğrencilerin %95,4'ü oturumun tıp eğitimleriyle ilgili olduğunu kabul etmiş veya kesinlikle katıldığını belirtmiştir. İkinci oturumda (n=70), %91,5'i oturumun temel bilimlerle klinik bilimler arasında başarılı bir bağlantı kurduğunu ifade etmiş; %88,6'sı ise tıp eğitimine olan ilgisinin arttığını belirtmiştir. Üçüncü oturumda (n=72), öğrencilerin %95,8'i oturum süresinden memnun olmuş ve aynı oranda öğrenci temel bilimlerin klinik uygulamalarla ilişkilendirilmesine katkı sağladığını ifade etmiştir. Her üç oturumda da öğrencilerin %80'inden fazlası benzer entegre oturumların sayısının artırılmasını istediğini belirtmiştir. Ki-kare analizine göre, oturumlar arasında oturumun eğitime uygunluğu, memnuniyet düzeyi, öğrenmeye katkısı veya temel bilimlere ilgi açısından istatistiksel olarak anlamlı bir fark bulunmamıştır ($p > 0.05$).

Sonuç: Sonuçlar, temel ve klinik bilimleri bir araya getiren vaka temelli entegre oturumların öğrenciler tarafından olumlu karşılandığını ortaya koymaktadır. Bu öğrenme yaklaşımı, öğrencilerin temel tıp bilgilerini gerçek hasta vakalarıyla ilişkilendirmelerine yardımcı olmuş ve öğrenmeye olan ilgilerini artırmıştır. Sunulan uygulama, tıp eğitiminin erken dönemlerinde bile anlamlı bir entegrasyonun nasıl sağlanabileceğine dair uygulanabilir bir örnek sunmaktadır ve benzer stratejileri hayata geçirmek isteyen diğer fakülteler için yol gösterici olabileceği düşünülmektedir.

Introduction

The concept of integration, which refers to unification, is recognized as a highly important educational approach in medical education (1). Harden defines it as the organization of instructional materials to connect or combine topics taught in separate academic courses or departments (2).

The Flexner Report, prepared in 1910 by American education reformer Abraham Flexner, radically redefined the foundations of modern medical education. This report (3) laid out many standards shaping today's medical education, including the traditional "2 + 2" curriculum structure comprising two years of basic sciences followed by two years of clinical sciences. Its primary goal was to promote a science-based, standardized model of medical education (3).

Shortly after the near-universal adoption of the 2+2 format, medical educators observed a failure to effectively integrate basic and clinical sciences, leading to repeated calls for curriculum integration (4). Numerous educational reports define integration as a strategic priority for medical education (5,6) and emphasize that the lack of full integration remains a critical challenge in medical education. To support integration, the WHO Regional Office for Europe reviewed curricula in European medical schools and concluded that undergraduate medical education must be restructured (7). Similarly, the report Tomorrow's Doctors: Recommendations for Undergraduate Medical Education stated that moving away from discipline-based teaching and applying integrated medicine combining basic and clinical sciences would be more effective (8). The Association of American Medical Colleges (AAMC) defines the ultimate goal of medical education as training knowledgeable, scientifically curious, and compassionate physicians who can offer scientifically sound and optimal care. In this context, AAMC stresses that curricula should be designed based on interdisciplinary integration (9). The UK's General Medical Council also emphasizes the need for medical schools to offer "learning opportunities that integrate basic and clinical sciences and connect theory with practice" (10). A report by the Association of Faculties of Medicine of Canada (AFMC) similarly advocates that basic sciences be taught in connection with clinical content throughout the medical education period. It underscores the need to acknowledge the value of both basic and clinical sciences and to increase their integration so that students can grasp scientific principles while acquiring clinical skills (6).

Basic sciences play a vital role in the understanding of clinical sciences (11). However, many medical educators believe that the knowledge of basic sciences acquired in the early years of traditional curricula gradually fades (12), and studies confirm that this knowledge declines even further during clinical years (13,14,15,16). Therefore, curriculum integration has emerged as a key strategy in medical education (17). To promote meaningful learning, many medical schools have shifted to integrated curricula instead of fragmented approaches (18). McMaster University in Canada was one of the first to implement a progressive, interdisciplinary curriculum spanning all years. Known as the McMaster approach, this model has since been developed and revised (19). Its "integrated curriculum," structured in a repetitive yet progressive manner, breaks the boundaries between basic and clinical sciences, enhances interdisciplinary interaction, and is believed to improve both knowledge retention and clinical skill development.

Today, most medical curricula can be considered integrated. (20) Integration is generally categorized into three main types, based on two core components of the curriculum: time and subject/discipline (21):

- Horizontal integration refers to interdisciplinary integration within a limited time frame. Examples include combining formerly separate basic science courses into a unified introductory course over one academic year (21).
- Vertical integration aims to enhance learning by breaking down the traditional barriers between basic and clinical sciences over time. Its goal is to support meaningful learning (21).
- Spiral integration is the most comprehensive model, combining horizontal and vertical integration (21). It involves repeated presentation of themes in a structured manner where early knowledge is linked meaningfully with content presented in later cycles. This prevents cognitive overload in early stages by introducing topics in a limited and controlled way (22).

Although integration is defined across all curriculum

levels (23, 24), the most compelling evidence for its success comes from studies at the instructional session level. Ideally, integrated sessions should involve collaboration between professors and/or clinicians representing both basic and clinical sciences. This combination ultimately provides students with the true benefits of integration.

In this study, we aimed to reinforce the integration between basic and clinical sciences by delivering a case-based approach through three different instructional sessions to second-year medical students and evaluating their feedback on these sessions.

Materials and Methods

This cross-sectional and descriptive study was based on student feedback from second-year medical students at Selçuk University Faculty of Medicine, who attended three case-based integrated sessions titled "Bridging Cases from Clinic to Basic Sciences" during the 2023–2024 and 2024–2025 academic years. The questionnaire was developed by three researchers (RMU, HU, NUD) through a review of relevant literature medical education. At the end of each session, students were informed by the term coordinator that participation was voluntary and that responses would remain anonymous and be used solely for educational purposes. The sample size was not calculated; rather, the study aimed to reach the entire population. The survey consisted of 12 items, including 3 questions assessing demographic characteristics, 8 items evaluating students' opinions regarding the session using a 5-point Likert scale (1: strongly disagree – 5: strongly agree), and 1 open-ended question allowing participants to express their thoughts about the session.

The session schedules were determined by the second-year coordinator. For each session, a real patient case relevant to the curriculum was requested from a clinical instructor. After selecting the case, a team comprising faculty from basic sciences, clinical sciences, medical education, and the term coordinator collaborated to refine it. Learning objectives were identified, and the content and method were structured accordingly. The interactive lecture was conducted over two teaching hours.

In the implementation of the integrated case-based sessions, careful attention was paid to ensure thematic coherence with the students' concurrent preclinical modules. Clinical cases were deliberately selected in accordance with the content of the ongoing didactic curricula. For example, during the Gastrointestinal and Metabolism module, cases involving relevant gastrointestinal pathologies were presented. Likewise, cases pertaining to neurological disorders were chosen during the Neuroscience module. Each session was facilitated by a faculty member from the respective clinical department, thereby ensuring disciplinary relevance.

The session began with the clinician presenting the patient's history to contextualize the clinical problem. Following this, the anatomy instructor explained the vascular anatomy of the gastrointestinal system to help students understand the possible sources of bleeding. Next, the biochemistry instructor facilitated a question-and-answer discussion, guiding students to interpret the patient's laboratory results—such as elevated liver enzymes, bilirubin levels, and coagulation parameters—while exploring the underlying biochemical mechanisms.

In the final part of the session, the clinical lecturer discussed diagnostic imaging methods and shared the patient's actual endoscopy images. A group discussion followed, where students were encouraged to suggest potential diagnoses. The session concluded with an explanation of the final diagnosis and treatment approach. Each session was evaluated using two multiple-choice questions in the module-end exam.

Data were analyzed using SPSS 22.0 for Windows. Categorical variables were reported as frequencies and percentages. Differences across years were evaluated using the chi-square test.

Results

We collected feedback from second-year students regarding the case-based sessions conducted jointly by basic and clinical science educators using the question-and-answer method. A total of 109 students responded to the survey in the first session (out of 185 attendees), 70 in the second (out of 248), and 72 in the third (out of 114).

Session 1 (n=109): 95.4% agreed or strongly agreed that the session was relevant to their medical education. 88.1% found the content sufficient, and 86.5% deemed the duration appropriate. 81.7% said it increased their interest in basic sciences,

and 78.8% found it facilitated learning. 88.9% reported increased interest in medical education, and 88% said it helped connect basic and clinical sciences. Over 80% wanted more such sessions

Table 1: Distribution of student feedback for the first integrated session

Session-1	Strongly disagree n (%)	Disagree n (%)	Neither disagree nor agree n (%)	Agree n (%)	Strongly agree n (%)
The lecture was related to my medical education	0 (0%)	0 (0%)	5 (4.6%)	41 (37.6%)	63 (57.8%)
The duration of the lecture was sufficient	1 (0.9%)	3 (2.8%)	9 (8.3%)	50 (45.9%)	46 (42.2%)
The content of the lecture was sufficient	0 (0%)	6 (5.5%)	11 (10.1%)	51 (46.8%)	41 (37.6%)
The lecture increased my interest in basic sciences	3 (2.8%)	4 (3.7%)	13 (11.9%)	44 (40.4%)	45 (41.3%)
The lecture made it easier for me to learn the subject	1 (0.9%)	4 (3.7%)	18 (16.5%)	43 (39.4%)	43 (39.4%)
The lecture increased my interest in medical education	0 (0%)	5 (4.6%)	10 (9.2%)	43 (39.4%)	51 (46.8%)
The lecture helped me to relate basic sciences with clinical sciences	0 (0%)	3 (2.8%)	10 (9.2%)	42 (38.5%)	54 (49.5%)
I want the number of such lectures to be increased	1 (0.9%)	5 (4.6%)	14 (12.8%)	34 (31.2%)	55 (50.5%)

(Table 1). Session 2 (n=70): 95.7% agreed or strongly agreed the session was relevant. 84.3% were satisfied with content and duration. 82.9% reported increased interest in basic sciences, and 72.9% said it improved learning. 88.6% expressed greater interest in medical education, and 91.5% felt it bridged basic and clinical sciences. Over 80% desired similar sessions (Table 2).

Session 3 (n=72): 98.6% found it relevant to their education. 95.8% were satisfied with the duration, and 88.9% with the content. 86.1% reported increased interest in basic sciences and improved learning. 90.3% showed increased interest in medical education, and 95.8% confirmed improved integration. Over 87% strongly preferred having more sessions like this (Table 3).

Chi-square tests were used to evaluate differences in student responses across the three sessions based on the combined percentage of “Agree” and “Strongly Agree” responses (Table 4). There were no statistically significant differences regarding the relevance to medical education ($p = 0.49$), content sufficiency ($p = 0.65$), or the ability to link basic and clinical sciences ($p = 0.59$). Similarly, interest in basic sciences ($p = 0.73$), ease of learning ($p = 0.15$), and demand for more sessions ($p = 0.56$) showed no significant differences. However, perceived adequacy of session duration approached significance ($p = 0.07$). Overall, the results indicate a consistently positive reception of the integrated case-based sessions.

Table 2: Distribution of student feedback for the second integrated session

Session-2	Strongly disagree n (%)	Disagree n (%)	Neither disagree nor agree n (%)	Agree n (%)	Strongly agree n (%)
The lecture was related to my medical education	1 (1.4%)	0 (0%)	2 (2.9%)	25 (35.7%)	42 (60.0%)
The duration of the lecture was sufficient	1 (1.4%)	5 (7.1%)	7 (10.0%)	32 (45.7%)	25 (35.7%)
The content of the lecture was sufficient	1 (1.4%)	1 (1.4%)	9 (12.9%)	36 (51.4%)	23 (32.9%)
The lecture increased my interest in basic sciences	3 (4.3%)	4 (5.7%)	5 (7.1%)	30 (42.9%)	28 (40.0%)
The lecture made it easier for me to learn the subject	3 (4.3%)	3 (4.3%)	13 (18.6%)	31 (44.3%)	20 (28.6%)
The lecture increased my interest in medical education	2 (2.9%)	0 (0%)	6 (8.6%)	30 (42.9%)	32 (45.7%)
The lecture helped me to relate basic sciences with clinical sciences	2 (2.9%)	1 (1.4%)	3 (4.3%)	34 (48.6%)	30 (42.9%)
I want the number of such lectures to be increased	2 (2.9%)	3 (4.3%)	9 (12.9%)	31 (44.3%)	25 (35.7%)

Table 3: Distribution of student feedback for the third integrated session

Session-3	Strongly disagree n (%)	Disagree n (%)	Neither disagree nor agree n (%)	Agree n (%)	Strongly agree n (%)
The lecture was related to my medical education	0 (0%)	0 (0%)	1 (1.4%)	26 (36.1%)	45 (62.5%)
The duration of the lecture was sufficient	1 (1.4%)	0 (0%)	2 (2.8%)	37 (51.4%)	32 (44.4%)
The content of the lecture was sufficient	0 (0%)	1 (1.4%)	7 (9.7%)	37 (51.4%)	27 (37.5%)
The lecture increased my interest in basic sciences	0 (0%)	3 (4.2%)	7 (9.7%)	29 (40.3%)	33 (45.8%)
The lecture made it easier for me to learn the subject	0 (0%)	0 (0%)	10 (13.9%)	35 (48.6%)	27 (37.5%)
The lecture increased my interest in medical education	1 (1.4%)	1 (1.4%)	5 (6.9%)	27 (37.5%)	38 (52.8%)
The lecture helped me to relate basic sciences with clinical sciences	0 (0%)	0 (0%)	3 (4.2%)	32 (44.4%)	37 (51.4%)
I want the number of such lectures to be increased	0 (0%)	0 (0%)	9 (12.5%)	25 (34.7%)	38 (52.8%)

Table 4: Comparison of student feedback across three integrated sessions

Condition	Session-1 n: 109	Session-2 n: 70	Session-3 n: 72	p-value*
The lecture was related to my medical education	104	67	71	0.49
The duration of the lecture was sufficient	96	59	69	0.07
The content of the lecture was sufficient	92	59	64	0.65
The lecture increased my interest in basic sciences	89	58	62	0.73
The lecture made it easier for me to learn the subject	86	51	62	0.15
The lecture increased my interest in medical education	94	62	65	0.71
The lecture helped me to relate basic sciences with clinical sciences	96	64	69	0.20
I want the number of such lectures to be increased	89	56	63	0.45

Discussion

Integrated approaches in medical education capture students' attention, increase their motivation to learn, and support long-term retention of knowledge (25). Additionally, this approach helps students learn how to apply acquired knowledge in clinical practice and promotes interdisciplinary collaboration (26). In our study, students reported that the integrated sessions enhanced their interest in medical education and facilitated learning.

Understanding basic and clinical sciences in an integrated way contributes to future clinicians' ability to acquire new knowledge using prior understanding, perform effectively in complex systems, and recognize and address health inequities (27, 28). Integration has been shown to increase the retention of in-depth knowledge among medical students (21). In one study, students exposed to an integrated curriculum were found to advance more quickly in problem-solving both in preclinical and clinical years (29).

A series of experimental studies (30–33) have shown that students who learn disease pathologies in an integrated manner are more successful in diagnosing complex clinical cases than those who study only textbook signs and symptoms. These studies demonstrate that integration, through a causal narrative linking physiology and clinical pathology, enhances diagnostic performance. In a similar study (34), integrating basic sciences into lessons using causal explanations was found to be more effective than merely presenting evidence-based structured algorithms. When basic science explanations were delivered without causal context, students had more difficulty diagnosing. This suggests that causal integration not only supports memory but also helps students build mental frameworks linking basic sciences (e.g., upper motor neuron physiology) with clinical signs (e.g., symptoms of paralysis) (35).

Vertically integrated curricula have been shown to better support students' skills in independent working, medical problem-solving, handling unfamiliar situations, prioritizing tasks, and collaborating with others compared to non-integrated curricula (36). Additionally, students educated in vertically integrated models were found to make career choices earlier and feel more prepared for employment or graduate training (36). In another study, two groups of participants trained either through isolated algorithms or causal explanations were presented with complex cases containing unfamiliar terminology. Despite similar practice exposure, the group with knowledge of underlying mechanisms transferred what they learned more effectively and reached correct answers more often than those who focused only on clinical features (31). A separate undergraduate study found that providing simple biochemical and pathophysiological explanations of clinical findings was important for consistent diagnostic performance in neurological and rheumatological diseases (32).

In the literature, several shared teaching models—similar to our study—have been described where basic science educators and clinicians co-teach in parallel or sequentially (37,38). In these studies, students also stated that such sessions positively contributed to their learning and helped them better understand and apply the material taught in integrated classes (37,38).

On the other hand, some authors have highlighted challenges in transitioning to integrated or co-teaching models due to traditional departmental structures (39,40). The approach that encounters the least resistance is sequential delivery of basic and clinical content. However, if educators fail to establish sufficient connections between the topics, this method risks becoming a small-scale replica of the traditional "2+2" model. Overcoming such challenges can be difficult, as conflicts may arise between basic science and clinical educators regarding the appropriate depth of basic science instruction (25). In our study, students were generally satisfied with the shared teaching format and found the content and duration of the sessions sufficient.

An integrated curriculum is regarded as an effective approach that facilitates students' ability to connect different subjects (41). In our study, students reported that the sessions helped them relate clinical and basic sciences. Developing a conceptually coherent mental model linking clinical and basic science knowledge makes it easier for students to interpret clinical problems (42). Vertical integration between clinical medicine and basic sciences supports deep learning over superficial learning, thus improving comprehension of fundamental scientific principles. This approach enhances both long-term retention and the application of basic sciences in appropriate clinical contexts (23).

On the other hand, some studies have shown that students exposed to excessive basic science content found academic courses more boring and irrelevant, questioning the applicability of this information in their future careers (43). However, early clinical exposure in medical training has also been shown to facilitate deeper learning of basic science concepts (21). Therefore, as medical instructors, it is essential that we provide students with opportunities to integrate their foundational knowledge and skills across different topics and transfer this knowledge into clinical practice.

Limitations

This study has several limitations. First, the generalizability of the findings is limited, as the participant group consisted solely of second-year medical students from Selçuk University Faculty of Medicine. This restricts the ability to make direct inferences about the effectiveness of similar interventions across different academic years or institutions. Nevertheless, the study is considered a pilot implementation, and there are plans to expand similar sessions to other cohorts, particularly within the first three years of medical education, which are predominantly focused on basic sciences.

Another limitation concerns the evaluation of the session's effectiveness. Although two multiple-choice questions were added to the end-of-module examination, no objective and structured assessment tool specific to the session was implemented. This limits the ability to directly measure the impact of the sessions on learning outcomes.

Conclusion

Integration is a fundamental principle underlying the operation of all systems in the universe. The organs and systems of the human body must work in constant interaction and harmony to sustain life. Accordingly, in medical education, lessons should not be presented in isolation but within an interdisciplinary framework. This approach supports better understanding and long-term retention of knowledge.

Through this study, we provided second-year students—who had not yet encountered clinical sciences—with an opportunity to experience the clinical reflections of basic sciences. The commonly asked student question, "Where will I use this information?" was addressed meaningfully through these interdisciplinary case-based sessions. We believe that this approach not only enhances student motivation but also serves as an exemplary model of integration in medical education and may guide other faculties in adopting similar initiatives.

This application provides a practical and adaptable approach to promoting integration in undergraduate medical education. Incorporating structured, case-based sessions in the early years can help link basic and clinical sciences in a meaningful way, especially when supported by collaboration between educators from both domains. Using real

patient cases aligned with curricular goals enhances relevance and engagement. To further validate the impact of such sessions, future studies should include broader and more diverse student groups and employ objective, standardized assessment tools to measure long-term learning outcomes.

Ethics Committee Approval

Ethics approval was obtained from Selçuk University Faculty of Medicine Ethics Committee (Decision No: 160).

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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