

Rub and Rinse Contact Lenses Before Wearing as a Protective Regimen Against Contact Lens-Related Eye Infections

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Purpose: Data on contact lens (CL) users in Thailand are limited, and previous reports have mainly focused on young populations. This study aims to determine demographic data, hygienic behaviour, and complications related to the usage of CLs in the general population.

Methods: This was a cross-sectional survey conducted from November 2020 to March 2021 using an anonymous questionnaire. Information on the demographic traits of the participants, characteristics of CL use, and CL care behaviours was collected. The responses were summarised and presented as a total behaviour score. Regression analysis was performed to evaluate the potential risk factors for a history of CL-related eye infections.

Results: A total of 134 CL wearers were recruited. Of all the participants, 83.58% were female and 16.42% were male. The average age was 31.14±10.69 years old. The total behaviour score showed that 62.69% of the population had good CL behaviour, while 37.31% exhibited poor CL behaviour. More than 50% of participants practised appropriate CL handling. Common unfavourable behaviours (>50%) reported were not using CL care solution to clean the storage case, not rubbing and rinsing the lens before storage, exposure to water during wear, use of makeup around the ocular area, and missing annual eye exams. Other less common but important instances of mishandling included using tap water to clean the lenses, topping off old CL solution, and exceeding the recommended planned-replacement period. However, no behaviours were significantly associated with a history of CL-related eye infections. Rubbing and rinsing CLs before wearing them was found to be a protective factor against a history of eye infections.

Conclusion: Rubbing and rinsing CLs before wearing should be mentioned as an additional recommendation for the user.

Keywords: behaviour, contact lens care, rubbing and rinsing, contact lens-related infection, mishandling contact lens

Introduction

Contact lenses (CLs) are thin lenses placed directly on the eye's surface, mainly for correcting refractive errors, cosmetic purposes, and as a therapeutic modality for some corneal pathologies.¹ The number of CL wearers continues to rise globally, both in developed and developing countries.² CLs provide a safe and effective way to correct vision. On the other hand, CL wearers may risk eye infections if their lenses are not correctly used, cleansed, disinfected, and stored.³ There are an estimated 125 million CL wearers around the world, with 6% of them experiencing complications each year.⁴ These problems can range from blepharitis, meibomian gland dysfunction, conjunctivitis, to sight-threatening ulcerative keratitis and endophthalmitis.⁵

A study of compliance behaviours for CL-related eye infections in the United States reported that 99% of CL wearers engaged in at least one compliance behaviour regarding CL hygiene, and 33% reported having experienced a previous CL-related eye complication requiring a doctor's visit. The most common poor CL behaviours were CL overuse and

sleeping with one's lenses on.⁶ Among university students in Thailand, poor CL behaviours were related to purchasing lenses from the internet, wearing them for over one year, and long wear duration (>12 hours).⁷ A number of studies provide information on the prevalence of usage, knowledge, and risky behaviours of CL care, especially in young populations.^{7–9} However, there are limited studies about the relationship between the behaviour and compliance of CL users in the general population in Thailand. This study aims to establish the demographic data, compliance, and history of complications related to the usage of CLs in Thailand, and to identify risky behaviours related to a history of eye infections. The results offer practical knowledge and underscore the importance of adherence to good CL routine care, which might be further integrated into public health prevention policies to prevent undesirable events for CL wearers in the future.

Methods

A cross-sectional survey was conducted from November 2020 to March 2021, with all eligible participants recruited consecutively. A recruitment notice was placed at Walailak University Hospital's Contact Lens Clinic, various institutions in Thailand, and online. Participants who were interested gave internet-based informed consent and completed an online questionnaire using the Google Form platform. All the tenets of the Declaration of Helsinki were adhered to, and the research team was granted permission from Walailak University's Institutional Review Board before the first participant was enrolled (WUEC-20-321-01). Inclusion criteria mandated that the participants have worn their CLs on average at least once weekly in the past month. There was no age limit for this study; however, participants who were younger than 18 needed to give their own consent, as well as obtain permission from their parents or guardians before taking part. Exclusion criteria included those who could not give informed consent. The questionnaire was adapted from the American Academy of Ophthalmology and a European study for CL-related microbial keratitis^{10,11} with permission and consisted of 4 parts. The first part involved demographic information (eg age, gender, education level, objective CL use, and experience wearing CLs). The second part entailed the CL type and details of CL use (eg type of lens materials, type of CL, frequency of wear, cleaning solution, consultation for CL care, and place of purchase). The third and fourth parts consisted of 35 items that asked about the participants' wear and care behaviours. Answers to the questions in the third and fourth parts were summarised to determine the total behaviour scores. Participants who received a score of $\geq 80\%$ were described as having good behaviour. All the questions in each part are available in the [Appendix](#). Both descriptive and inferential statistics were applied to the survey data. Demographic data were analysed using descriptive analysis, mean $\pm$ standard deviation (SD), median, frequency, and percentage as appropriate. Logistic regression analysis was performed to identify any association of the independent categorical variables, including participant demographic data, characteristics of CL use, wear and care behaviour, and total behaviour scores with a history of CL-related eye infections. The factors that showed univariate P value less than 0.2 and the variables that have been reported as a significant factor in previous studies were selected for determination of adjusted odds ratio (AOR) using multivariate method. Analyses were carried out using IBM SPSS Statistics for Windows, version 23.0 (SPSS, Chicago, IL). P values less than 0.05 were considered statistically significant.

Results

Demographics and Characteristics of CL Use in the Participants

A total of 134 CL wearers were recruited for this study. Of all the participants, 112 (83.58%) were female and 22 (16.42%) were male. The average age was 31.14 ± 10.69 years old (median: 31.00, range: 15–74 years). A summary of the participants' demographic data is shown in [Table 1](#). The education level of the population demonstrated that 20.90% had less than college degree, and 79.1% had received college degree education or higher. The main objective of using CLs was mostly to correct refractive errors (94.02%), less than 4.48% for cosmetics, and 1.50% for the treatment of corneal disease. Most of the participants (approximately 70%) had experience wearing CLs for more than a year, 33.58% had worn CLs for 1 to 5 years, and 36.57% had worn CLs for 6 to 10 years. The use of rigid gas-permeable (RGP) CLs and soft CLs were 5.22% and 94.78%, respectively. Soft CLs consisted of 61.42% of CLs for refractive correction, and 38.58% were cosmetic, coloured CLs. All soft CL wearers used either disposable or reusable CLs on a daily basis, or

Table 1 Participants' Demographic Data

Demographic Data	N=134 (%)
Sex	
Female	112 (83.58)
Male	22 (16.42)
Age (years old)	
≤18	22 (16.42)
19–30	41 (30.60)
31–40	51 (38.06)
41–50	15 (11.19)
≥50	5 (3.73)
Education level	
High school or less	14 (10.45)
Vocational/High vocational certificate	14 (10.45)
Graduate	67 (50.00)
Postgraduate	39 (29.10)
Objective	
Refractive errors	126 (94.02)
Cosmetic purposes	6 (4.48)
Treatment of corneal disease	2 (1.5)
Lens wear experience	
Less than 1 year	16 (11.94)
1–5 years	45 (33.58)
6–10 years	49 (36.57)
More than 10 years	24 (17.91)

planned replacements. The most popular replacement plan interval was monthly, utilised by 82.10% of the participants. The daily, weekly, and biweekly replacement plans were minorities. A proportion of 54.48% wore CLs daily. Multipurpose solutions were the most popular method for disinfecting reusable CLs (86.57%), and only 1.49% used a hydrogen peroxide system. Normal saline was used solely as a means to clean the lenses by 11.94% of the population. Regarding patient evaluation and education, most participants received CL handling instructions from opticians in optical shops. However, more than 25% sought information by themselves without any recommendations from eye care professionals. The data are shown in [Table 2](#).

Wear and Care Behaviours

The questions used to determine the participants' wear and care behaviours are presented in [Table 3](#). The behaviours of CL wearing and hygiene practices were evaluated and scored to classify the participants as having either good or poor behaviour; 84 (62.69%) participants had good behaviour, while 50 (37.31%) had poor behaviour. More than 60% used CLs properly, such as wearing CLs for less than 8 hours a day, always checking the packaging and expiration date, correcting the sides of CLs before putting them in, washing one's hands with soap before lens handling, and putting CLs in and removing them starting from the same eye. However, part of the population harboured inappropriate behaviours that could contaminate the lens or disinfecting system, such as not washing one's hands with soap before putting CLs in and taking them out (2.24% and 11.19%, respectively), using a lens that had been dropped (41.04%), sleeping with CLs in (36.57%), sharing CLs with others (1.50%), exceeding the replacement plan (49.25%), applying eye makeup (55.97%), and missing annual eye examinations (76.87%). An evaluation of participants' CL care behaviour found that more than 50% of them showed good hygiene in handling CLs. Most of them performed the rub and rinse regimen after using their CLs and even before wearing them. Most used an appropriate CL care solution and soaked their CLs in the solution for at least 6 hours. However, some participants had risky behaviours, such as using tap water (8.96%) or

Table 2 Types and Details of CLs Used

Details of CLs Used	N=134 (%)
Type of lens material	
Rigid gas-permeable (RGP) lens	7 (5.22)
Soft CLs	127 (94.78)
-Contact lenses for refractive correction	78 (61.42)
-Cosmetic CLs	49 (38.58)
Replacement plan	
Daily	19 (14.18)
Weekly	1 (0.75)
Biweekly	4 (2.98)
Monthly	110 (82.10)
Frequency of wear in one week	
1–3 days	19 (14.18)
4–6 days	42 (31.34)
Every day	73 (54.48)
Cleaning solution	
Multipurpose solution	116 (86.57)
Hydrogen peroxide system	2 (1.49)
Normal saline solution	16 (11.94)
None	0 (0)
Whom did you consult when you first started using CLs?	
Ophthalmologist	29 (21.64)
Optometrist	9 (6.72)
Optician	38 (28.36)
Pharmacist	4 (2.99)
Friends	9 (6.72)
None	45 (33.69)
Did you receive any instructions about lens care and hygiene?	
No	35 (26.12)
Yes	99 (73.88)
Who explained to you how to put on/remove the lenses and lens care and hygiene?	
Ophthalmologist	31 (23.13)
Optometrist	8 (5.97)
Optician	42 (31.34)
Pharmacist	5 (3.73)
Friends	12 (8.96)
None	36 (26.87)

normal saline solution (27.61%) to clean the lenses. Apart from CL handling, the storage case was cleaned with a CL cleaning solution (39.55%); fresh CL solution was always used each time (90.30%), and the case was replaced at least every 3 months (95.52%). As for the CL solution, the caps were always closed after use (64.18%), the CLs were renewed within 3 months (91.04%), and participants did not top off the old cleaning solution (72.39%).

Risk Factors and CL Wearer Characteristics Associated with a History of CL-Related Ocular Infections

Univariate analysis was performed to determine the significance of the association between the participants' demographics, wear and care behaviours, and a history of CL-related eye infections. The data are displayed in Table 4. The demographic information of CL wearers regarding gender, age, and education level did not show a significant association with a history of eye infections. The number of participants with a history of infections was nearly similar among those

Table 3 CL Users' Wear and Care Behaviours

CL Users' Wear and Care Behaviours	N=134 (%)
Duration of wear	
Less than 8 hours	70 (52.24)
More than 8 hours	64 (47.76)
Always check the expiration date and integrity of packaging before use	
No	16 (11.94)
Yes	118 (88.06)
Check for the correct side (inside-outside) before use	
No	10 (7.46)
Yes	124 (92.54)
Hand washing before putting the CLs in	
With water only	40 (29.85)
With soap	91 (67.91)
Not performed	3 (2.24)
Routine before putting the CLs in	
Rub the lenses	5 (3.73)
Rinse the lenses	47 (35.07)
Rub and rinse the lenses	55 (41.04)
No management	27 (20.15)
Hand washing before CL removal	
With water only	35 (26.12)
With soap	84 (62.69)
Not performed	15 (11.19)
Routine after CL removal	
Rub the lenses	5 (3.73)
Rinse the lenses	34 (25.37)
Rub and rinse the lenses	56 (41.79)
No management	39 (29.10)
Products used to clean the CLs	
CL cleaning solution	84 (62.69)
Normal saline solution	37 (27.61)
Tap water	12 (8.96)
Saliva	1 (0.75)
Continued using a lens that had been dropped	
No	79 (58.96)
Yes	55 (41.04)
Start inserting and removing the lens from the same eye	
No	33 (24.62)
Yes	101 (75.37)
Soaking CLs in the cleaning solution for ≥ 6 hours before reuse	
No	14 (10.45)
Yes	120 (89.55)
Fill CL case with fresh CL solution every day	
No	13 (9.70)
Yes	121 (90.30)
Topping off the old cleaning solution	
No	97 (72.39)
Yes	37 (27.61)
Always close the cap of the cleaning solution tightly after use	
No	48 (35.80)
Yes	86 (64.18)

(Continued)

Table 3 (Continued).

CL Users' Wear and Care Behaviours	N=134 (%)
Always close the CL case tightly after use	
No	9 (6.75)
Yes	125 (93.28)
Keep using the same bottle of cleaning solution for more than 3 months	
No	122 (91.04)
Yes	12 (8.96)
Keep using the same case for more than 3 months	
No	128 (95.52)
Yes	6 (4.48)
Clean the CL case with	
Water only	49 (36.57)
Water and soap	19 (14.18)
With CL solution	53 (39.55)
Not performed	8 (5.97)
Other	5 (3.73)
Dry the CL case	
No	49 (36.57)
Yes	85 (63.43)
Clean the CL case daily	
No	69 (51.49)
Yes	65 (48.51)
Source of CL purchase	
Hospital	4 (2.99)
Private ophthalmology practice	8 (5.97)
Pharmacy	4 (2.99)
Optical store	81 (60.45)
Internet	25 (18.66)
General store	10 (7.46)
Flea market	2 (1.49)
Source of disinfecting solution purchase	
Hospital	3 (2.24)
Private ophthalmology practice	4 (2.99)
Pharmacy	40 (29.85)
Optical store	57 (42.54)
Internet	2 (1.49)
General store	25 (18.66)
Flea market	1 (0.75)
None	2 (1.49)
Symptoms associated with CL wear	
Dryness	53 (39.55)
Grittiness	10 (7.46)
Tearing	34 (25.37)
Redness	17 (12.69)
Itchiness	2 (1.49)
Blurry vision	2 (1.49)
Discharge	5 (3.73)
None	11 (8.21)

(Continued)

Table 3 (Continued).

CL Users' Wear and Care Behaviours	N=134 (%)
What was your management when you experienced eye discomfort during CL wear?	
Consultation	8 (5.97)
Removing the lenses	74 (55.22)
Self-treatment with antibiotics	2 (1.49)
Use of eye drops	34 (25.37)
No treatment	15 (11.19)
Other	1 (0.75)
History of eye infections associated with CL wear	
Yes	29 (21.64)
- Keratitis	8 (5.97)
- Conjunctivitis	15 (11.19)
- Blepharitis or hordeolum	6 (4.48)
None	105 (78.36)
Annual eye check-up with ophthalmologist	
No	103 (76.87)
Yes	31 (23.13)
Sleeping with CLs in	
No	85 (63.43)
Yes	49 (36.57)
Sharing CLs with others	
No	132 (98.50)
Yes	2 (1.50)
Exceed the recommended planned replacement period	
No	68 (50.75)
Yes	66 (49.25)
Using expired CL solutions (opened for more than 3 months)	
No	109 (81.34)
Yes	25 (18.66)
Exposure to water during CL wear	
No	29 (21.64)
Yes	105 (78.36)
The use of eye drops with CLs	
No	52 (38.80)
Yes	82 (61.20)
-Artificial tears	80 (59.71)
-Antibiotics	2 (1.50)
First or second-hand smoker	
No	116 (86.57)
Yes	18 (13.43)
Use of makeup close to the eye	
No	59 (44.03)
Yes	75 (55.97)
Time spent working on a terminal screen per day	
Less than 12 hours	84 (62.69)
More than 12 hours	50 (37.31)
Exposure to an air-conditioned environment	
Less than 12 hours	104 (77.61)
More than 12 hours	30 (22.39)

Table 4 Association Between Demographic Data, Wear and Care Behaviours, and History of CL-Related Ocular Infections

Covariates	History of CL-Related Ocular Infections		Univariate Analysis		Multivariate Analysis	
	Yes	No	OR	P value	AOR	P value
Gender						
Male	7	15	1		1	
Female	22	90	0.524	0.210	0.323	0.105
Age						
≤ 20 years-old	2	24	1		1	
20–40 years-old	23	65	4.264	0.062	2.011	0.527
>40 years-old	4	16	3.000	0.235	1.835	0.620
Education						
Undergraduate degree	3	26	1		1	
≥ Graduate degree	26	79	2.852	0.107	3.552	0.182
Duration of wear						
<8 hours	15	55	1		1	
≥8 hours	14	50	1.027	0.950	0.706	0.516
Annual eye check-up with ophthalmologist						
No	24	79	1		1	
Yes	5	26	0.633	0.398	0.542	0.329
Sleeping with CLs in						
No	16	69	1		1	
Yes	13	36	1.557	0.299	1.762	0.289
Shower during CL wear						
No	13	41	1		1	
Yes	16	64	0.788	0.575	0.058	0.331
Use of eye makeup						
No	12	47	1		1	
Yes	17	58	1.148	0.745	1.469	0.486
Exceed the CL recommended planned replacement period						
No	17	51	1		1	
Yes	12	54	0.667	0.340	0.519	0.220
Soaking CL with cleaning solution at less 6 hour						
No	3	11	1		1	
Yes	26	94	1.014	0.984	1.024	0.977
Rub and rinse CL with cleaning solution before putting in						
No	24	55	1		1	
Yes	5	50	0.229	0.005*	0.133	0.001*
Rub and rinse CL with cleaning solution after taking off						
No	17	61	1		1	
Yes	12	44	0.979	0.959	2.153	0.158
Total of wear and care behaviour score						
Good	18	69	1		1	
Poor	11	36	1.171	0.716	2.021	0.234

Notes: *P value ≤0.05 demonstrated the significance of regression analysis. Odds ratios represent the odds of reporting a more severe response on the scale, and in turn greater difficulty with the task, with a one-unit increase in the independent variable.

who wore CLs for more than 8 hours and ≤ 8 hours, without any significance. From univariate analysis, rubbing and rinsing CLs before putting them in was found to be significantly associated with less of a history of eye infections ($P=0.010$). Factors with P values less than 0.2 were further selected for multivariate analysis, those included education level, soaking CLs in CL cleaning solution at least 6 hours per day, rubbing and rinsing CLs before putting in, and total score of wear and care behaviours. Additionally, risky behaviours such as sleeping with one's CLs on, showering during CL wear, applying eye makeup, exceeding the recommended planned replacement period, and soaking CLs with cleaning

solution for less than 6 hours presented no statistical association with infections. The participants' total behaviour scores were evaluated; participants with either good or poor behaviour showed no significant difference regarding a history of eye infections, with 18 out of 84 (21.42%) and 11 out of 50 (22.00%) cases per group, respectively.

Discussion

Poor CL compliance could result in CL-related complications that can range from mild to sight-threatening conditions. Age, gender, and education have influencing factors on CL compliance.^{12–15} Age has been reported as a factor for CL-related complications. A recent study from a tertiary hospital in China found corneal infection or inflammation to be associated with young age.⁵ Similar findings were discovered in a population in the United States, suggesting that younger CL wearers are less compliant with CL hygiene in replacing lenses and cases at intervals longer than recommended.¹⁶ Another report from a North American population revealed that CL-related complications were most prevalent in individuals between 15 and 25 years old.¹⁷ In Thailand, where this study took place, most reports focus on young populations, indicating improper CL hygiene, such as lens overuse, not replacing fresh cleaning solution in storage cases, swimming while wearing CLs, using tap water to clean the lenses, and not performing hand washing before lens handling.¹⁸ To determine the difference between the behaviour of the young and adult groups, we performed research in diverse settings to better represent general CL users in Thailand, resulting in a wide population age range from 15 to 74. Nonetheless, age was not found to be a risk factor for a history of eye infections.

In agreement with previous studies, CL wearers were predominantly female.^{12,19} Although findings from Saudi Arabia and India imply that the most common reason in females for choosing CLs is cosmetic purposes,^{20,21} the majority of females in the present study wore CLs to correct refractive errors. Females were previously found to be less likely to follow the replacement schedule;²² however, this outcome was not established in our study. Additionally, no significant association between sex and history of ocular infections was detected. The type of CL and behaviour were investigated to understand users' preferences, which could suggest proper CL care and hygiene practices. The majority of CLs in the present study were monthly soft CLs, leaving RGP CLs for a minority of approximately 5%. The popularity of soft CLs was mentioned in 2020 market research from Contact Lens Spectrum, where soft lenses account for nearly 90% of lens fits in the market, with silicone hydrogels predominating. Reusable lenses were more commonly used and prescribed than daily disposable lenses.²³ As long as the prescribing trend still favours reusable CLs, the risk for microbial accumulation and eye infections should always be considered. In addition, the hydrophilic properties of soft CL materials, such as hydroxyethyl methacrylate and silicone, have been recognized as the most susceptible to bacterial adhesion and may resist disinfectants, such as biofilm formation by *Staphylococcus aureus* and *Pseudomonas aeruginosa*.²⁴ Reusable lenses require care using disinfecting solutions, daily cleaning regimens, and storage cases, in which contamination can lead to serious microbial infections in the eyes.

Focusing on CL wear and care behaviour, although most participants reported good CL care behaviour (62.69%), a large proportion of the population was confused about the steps of the CL care regimen. Most eye care professionals recommend washing, rubbing, and rinsing CLs with CL care solution immediately after taking them off and before submerging them in disinfecting solution. Most participants performed some kind of CL cleaning (rub, rinse, or rub and rinse the CLs with cleaning solution) before putting the CLs in. Paradoxically, fewer people performed such routines after taking off the CLs, and less than half of participants performed both rubbing and rinsing their CLs. This reflects the awareness of CL wearers of the CL cleaning and disinfecting process, despite inadequate knowledge. Interestingly, the practice of cleaning CLs before wearing them is the only behaviour demonstrated as a protective factor against eye infections. The actual impact of this regimen needs more clarification through research in microbiology, aiming to specifically answer this question. Should the action provide true benefit against eye infections, implementation should be encouraged. Most of the participants used CL cleaning solution and normal saline solution to clean their CLs; however, there were 12 participants and 1 participant who used tap water and saliva to clean their lenses, respectively. Using tap water led to more risk for eye infections and microbial keratitis caused by bacterial species and *Acanthamoeba spp.*, since microorganisms from environmental contaminants may adhere to the surface of CLs.²⁵ Another risk was noted: Half of the participants overused the recommended planned replacement period. Exceeding the lens's planned-replacement schedule was reported to be associated with a large number of eye complications.²⁶

Poor behaviours may be influenced by a lack of patient education and an understanding of possible complications. Since the distribution of CLs in Thailand is not regulated, it is unnecessary to consult a professional for CL fitting; thus, people receive no professional advice at the beginning. Forty percent of the studied population did not have their CLs prescribed by an eye care professional. Roughly a quarter bought their CLs from unreliable sources such as from the internet, general stores, and flea markets. Most participants did not have their eyes checked annually, but this number still reflected a healthier estimate than that of university students from a previous study in Thailand.⁷ Annual eye examinations can detect complications such as dry eye, conjunctivitis, and corneal neovascularisation early, and provide opportunities for ophthalmologists or optometrists to re-evaluate and emphasise good CL hygiene. Thus, CL wearers should be encouraged to check their eyes on a regular basis.

Conclusion

The observed undesirable habits, such as topping off old cleaning solution, inadequate or lack of hand washing, using lenses that have been dropped, failing to clean the CL case daily, exposure to potentially contaminated water, and overusing CLs, although were not found to be statistically associated with a history of eye infections, should still be discouraged. A finding of protective effect from cleaning CLs by rubbing and rinsing before wearing them should be mentioned as an additional recommendation for the user.

Abbreviations

AOR, adjusted odds ratio; CI, Confidence interval; CL, Contact lenses; e.g., For example; IRB, Institutional review board; N, Number; OR, odd ratio; RPG, Rigid gas permeable; SD, Standard deviation.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the 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 report no conflicts of interest in this work.

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