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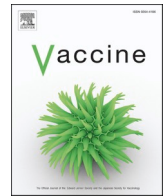
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A quick access to information on influenza burden and prevention in Lyon university hospital: A prospective QR code-based information campaign in 2022–2023

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ABSTRACT

Background: Influenza vaccines are effective in decreasing hospitalizations and mortality related to influenza and its complications. However, the Vaccine Coverage Rate of influenza remains low and multifaceted efforts are required to improve it. The aim of this study was to assess the impact on influenza vaccine perception using a digital tool among outpatients and health care workers (HCWs).

Methods: A study was performed among outpatients and the HCWs of 23 hospital departments from 4 hospitals affiliated to Lyon university Hospitals (France), between October 2022 and February 2023. By scanning QR (Quick Response) codes, displayed on posters for patients, their companions, as well as in the letters sent to HCWs, users accessed anonymously to a web-application (ELEFIGHT®), which provided information on influenza and invited them to initiate a discussion on influenza prevention with their physicians during the consultation. Patients were also invited to complete a questionnaire regarding their perception of influenza vaccination before and after reading the information on ELEFIGHT®. The retention rate (RR = proportion of people who remain on the page for >2 s), the conversion rate (CR = proportion of people who click on the “Call-To-Action” button) and the absolute variation (difference in the perception before/after) and relative variation (absolute change as a percentage of the initial perception) in perception regarding influenza vaccination before and after consulting the application were calculated.

Results: 3791 scans were performed by 3298 patients and/or their companions with a RR of 52% and a CR of 55.1% and 253 scans by 221 HCWs with a RR of 71.2% and a CR of 115.3%. Participants spent an average of 47 s on the application. The questionnaire on influenza vaccination perception was completed by 1533 participants (46.5%); 1390 (90.7%) maintained the same position (neutral, favorable or unfavorable) on this vaccination before and after consulting the application. The relative variations in favor of vaccination were + 7.2% (unfavorable then favorable) and + 19.8% (neutral then favorable).

Conclusion: This study suggests that a facilitated direct access to medical information through QR codes disseminated in health settings can help nudge people to foster their awareness of influenza and its prevention. Future deployments in a similar context or to other populations could be envisaged. Other vaccine-preventable and/or chronic diseases could also be the target of similar projects as part of public health programs.

1. Introduction

Worldwide, seasonal influenza is responsible for 1 billion influenza infections each year with at least 500,000 excess deaths, mainly among older adults and people at risk [1]. Influenza vaccines are effective in reducing hospitalizations, complications and mortality related to influenza [2].

In France, individuals who are at higher risk of severe or complicated influenza, people in contact with individuals at risk of severe or complicated influenza, as well as healthcare workers (HCWs), are invited by health authorities for influenza vaccination [3]. Every year, the Ministry of Solidarity and Health, Santé Publique France, French health insurance and other public institutions develop and oversee a range of initiatives to encourage promotion of influenza vaccination and vaccination coverage. In addition, the French health insurance sends influenza vaccine invitations or vouchers to the recommended population. However, the vaccine coverage rate (VCR) of influenza vaccination in France is far below the 75% objective set by the World Health Organization (WHO). In 2022–2023, the VCR was 56.2% in people ≥ 65 years [4]. This suboptimal rate can be explained by several factors including knowledge gaps, pre-existent beliefs around vaccination efficacy and its safety, and other factors promoting vaccine hesitancy [5].

Physician and patient environments have potential impact on health-related decisions and nudging can be used to influence behaviors in a predictable way without restricting choice [6]. A digital “nudge” might be an option to increase vaccination uptake among the risk groups as well as the HCWs by providing digital motivational messages and creating opportunities of sharing preventive messages in various health care settings, including hospitals [7]. Such information can be shared using a two-dimensional bar code, also known as QR (Quick Response) codes, for encoding information available through smartphones, tablets, and other electronic devices.

A pilot study showed that this technology is easy to use at hospital settings and is well accepted by patients visiting the hospital [8]. The objective of this multicentric study was to explore the benefits of using QR codes to enhance awareness of patients in hospital clinics on influenza disease and how it can be prevented and to assess the impact on influenza vaccination perceptions after anonymously consulting the

information given by ELEFIGHT® digital solution.

2. Materials and methods

ELEFIGHT® is a web-application that aims at sharing validated medical information about a disease or a risk to the public or HCWs, to encourage behavioral changes through the concept of nudge. As demonstrated in the lot study [8], patients visiting the hospital find this technology to be user-friendly and well-accepted. As ELEFIGHT® is a webapp, it is directly available on internet; no download of any app installation is needed to access to the information. ELEFIGHT® has been designed to guarantee the privacy of the users. For this reason, no personal information is requested. ELEFIGHT® multicentric study was carried out at 4 university hospitals, Hospices Civils de Lyon (HCL), Lyon, France between November 2022 and February 2023, in 21 departments with ambulatory activities for adult patients. A separate QR code was developed by the hospital and was printed on the posters installed in the waiting rooms of participating departments of each hospital. Once a week, a clinical research associate (CRA) went to the waiting rooms (except pharmacy) of participating units to explain the ELEFIGHT® pilot study to patients and encourage them to scan the QR code with their smartphone.

A specific QR code was also developed for HCWs, with the same content as for patients. In fact, an information letter with this specific QR code was mailed in September 2022 to all the HCWs, as well as via the HCL intranet portal.

After scanning the QR codes, participants were able to access information that highlighted key diseases about influenza disease, its risks, and the recommended national vaccination guidelines. In addition, ELEFIGHT® webapp invites the participants to initiate a discussion about influenza vaccination with their respective physicians during the consultation - by offering them a list of potential questions they would like to ask, after clicking on the call-to-action button “Talk to my doctor” [8].

The following data were computerized anonymously in real time:

- (1) number of users who scanned the QR code.

- (2) bouncing rate (users who closed the webapp right after the opening); this rate was used to calculate the retention rate (RR): proportion of people who remain on the page for >2 s.
- (3) average connection time to the webapp.
- (4) number of clicks on the “Talk to my doctor” button, and.
- (5) conversion rate (CR): number of users who clicked the “Talk to my doctor” button divided by the number of users who scanned the QR code and stayed on the webapp.

Patients were also invited to complete a questionnaire regarding their opinion about flu vaccination (Favorable, Neutral or Unfavorable) before and after reading the information on ELEFIGHT®.

The absolute (difference in the perception before/after) and relative (absolute change as a percentage of the initial perception) variations in perception regarding influenza vaccination before and after consulting the application were calculated.

The McNemar non-parametric test was applied to evaluate the influence on perception of influenza vaccination prior to and subsequent to reading information on ELEFIGHT®. Participants were categorized into four groups based on their perceptions: (1) those who had a positive perception both and before, (2) those who had a positive perception before but a neutral or negative one after, (3) those who had a negative or neutral perception before but a positive one after, and (4) those who had a negative perception before and after the study. The data analysis was conducted using IBM SPSS 21.

3. Results

3.1. Patients and their companions

Between November 17, 2022 and February 17, 2023, 3791 scans were performed by 3298 people (patients and companions) and 1817 participants clicked on the Call-To-Action button (55.1%). The retention rate (=staying on the page for >2 s) was 52.0% with an average time spent on the application of 47 s (min-max: 40–52 s). The discrepancy between the number of scans and the number of people scanning is explained by the fact that a unique user may perform multiple scans or even scan multiple times.

The intervention of CRA to encourage patients to scan the QR code was crucial for many reasons. First, it is possible that patients simply did not notice the QR poster due to its understated design/color, which may make it not enough visual compared to the multiple information posters at hospital. Second, it could be that they were unaware of the functionality of scanning QR codes and the additional content they can provide. Third, the lack of interest in the topic. People who were already vaccinated against flu were less motivated to participate in this study. In addition, some patients declared a low interest in influenza disease and influenza vaccination but would be ready to test the digital tool for

another medical subject. Another observation is the elderly people who are rarely equipped with a smartphone at all or suitable for reading QR codes.

Fig. 1 below describes the number of scans (unique person) performed by patients (and their companions) and the HCWs.

3.2. HCWs

Between September 30, 2022 and February 16, 2023, 253 scans were performed by 211 HCWs, with a conversion rate of 115.3%. A total of 171 HCW (81.0%) clicked on the Call-To-Action button. The retention rate (=staying on the page for >2 s) was 71.2%, and participating professionals stayed on the application for an average of 55 s.

3.3. Influenza vaccination perception: Position of patients and their companions

Of the 3298 patients and their companions, 1533 (46.5%) participants answered the questionnaire concerning the perception of influenza vaccination. Since the data was collected anonymously, it was not possible to stratify these analyses by hospital and/or by participants' characteristics.

Among the participants, 1390 (90.7%) kept the same position concerning influenza vaccination before/after reading the information given by the application: positive opinion before/after (63.2%, $n = 969$), unfavorable opinion before/after (12.2%, $n = 187$) or neutral opinion before/after (15.3%, $n = 234$). These results are presented in Fig. 2.

A group of 237 participants (15.5%) were unfavorable to the influenza vaccination and 17 of them (7.2%) became favorable after consulting of ELEFIGHT®. A negative impact (unfavorable or neutral opinion after consulting the application while the participant was in favor before) was observed in 17 patients. The absolute and relative variations are summarized in the Table 1 (values in favor of vaccination). The variation was statistically significant in favor of vaccination ($P < 0.001$).

4. Discussion

The purpose of this multicentric study was to inform patients, their companions and HCWs on influenza disease and its vaccination, in accordance with French recommendations, and to identify perceptions towards influenza vaccination, using ELEFIGHT® anonymous digital solution.

The feasibility of using QR codes to provide medical information on influenza and its prevention was assessed in a previous study [8]. A call-to-action button was implemented to encourage discussion with specialist physicians during the medical visit. In the current study, patients and their companions were invited to complete anonymously a

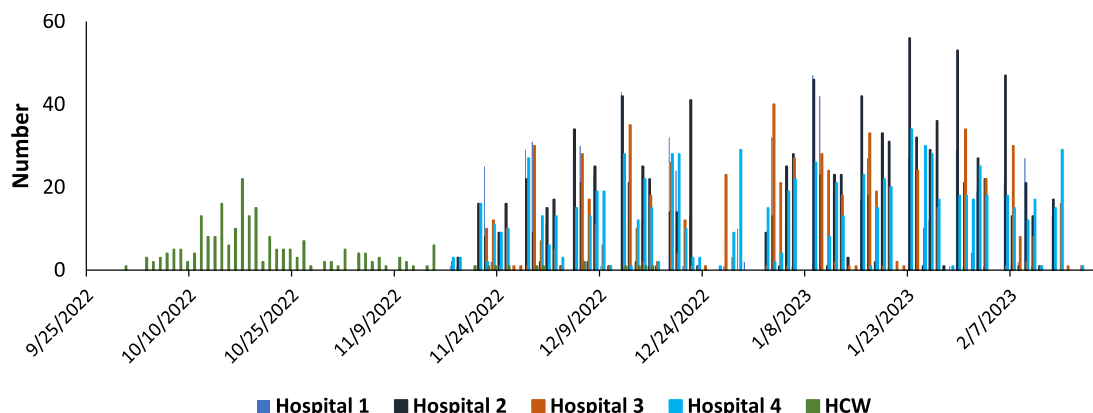


Fig. 1. Daily number of scans made by patients, their companions and HCWs during the study period.

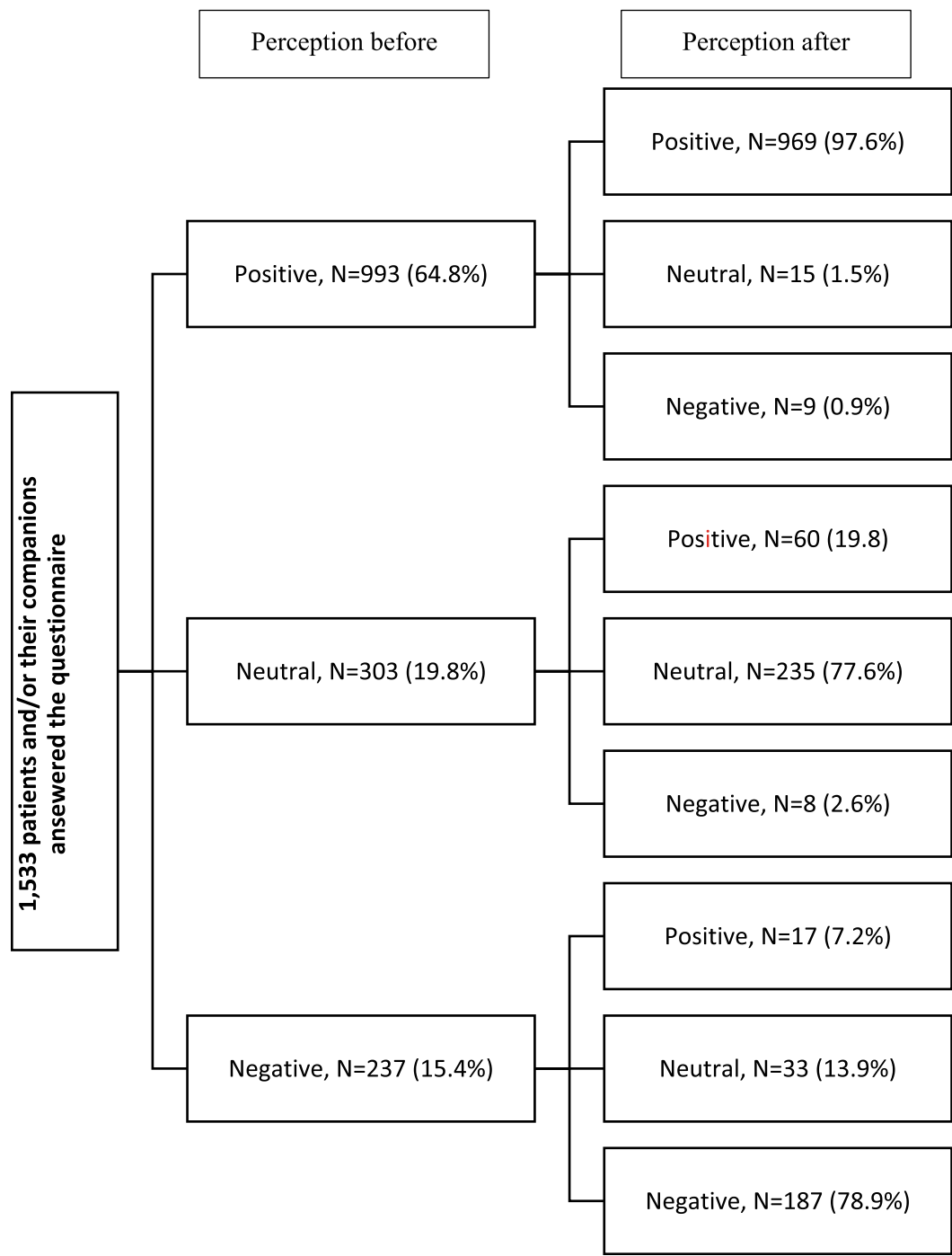


Fig. 2. Impact regarding influenza vaccination before/after consultation of ELEFIGHT®.

Table 1
Perception of influenza vaccination by participating patients/companions before and after consultation of ELEFIGHT®.

Opinion of patients (and/or their companions) regarding influenza vaccination	Absolute variation	Relative variation (level of evolution)
Unfavorable then favorable	+1,1	+7,2%
Neutral then favorable	+3,9%	+19,8%
Favorable then unfavorable	-0,6%	-0,9%
Favorable then neutral	-0,5%	-0,8%

short questionnaire to assess the impact of our action regarding their perception of influenza vaccination before and after reading the provided medical information.

The main finding of our study was the positive impact of an electronic nudge to improve the perception of influenza vaccination among patients and/or their families during outpatient consultation. This was considered as non-intrusive and acceptable motivation to target both patients and HCWs. Moreover, the access to medical information through the app will enhance participants' sense of autonomy. In addition, with ageing of the population and increase of pressure on health cost, the health care system continues to face challenges and must find ways to enhance the partnership with patients in the management of their diseases [9]. In a recent study, interviews with nursing home staff

identify that strategies including education, building trust, use of vaccine champions, and incentives, as well as taking individualized approaches can be useful to promote influenza vaccination [10].

Annual influenza vaccination can effectively decrease the morbidity and mortality associated with influenza, especially in elderly individuals and in high-risk patients. Despite the proven effectiveness, the availability of safe vaccines and policy recommendations, influenza vaccine uptake rates fail to reach the recommended vaccination coverage target of 75% in recommended population, in almost all OECD (Organization for Economic Co-operation and Development) states [11,12].

Vaccine hesitancy, considered by the WHO as a motivational state of being conflicted about, or opposed to being vaccinated, was listed as one of the top ten health threats [13]. Psychosocial factors (e.g., vaccination beliefs) seemed better to explain influenza vaccination behavior than demographic or economic factors [14]. A Cochrane review identified that low (e.g., postcards), medium (e.g. personalized phone calls), and high (e.g., home visits, facilitators) intensity intervention had significant positive effects on influenza vaccination in people 60 years and older [15]. Although its focus was specific people in community, key elements may be transferable. The most frequent reasons given by vulnerable patients for not getting the influenza vaccine are beliefs that this vaccine is not essential or effective, worries about potential side effects, or missing or unclear recommendations [16]. In addition, a recent study found that the source of information is an important factor in deciding to vaccinate or not [17].

The intervention of the CRA to encourage patients to scan the QR code was often necessary for many reasons. In our pilot study conducted in 2021, the QR codes were well accepted by the patients and showed that the number of scans were higher when the CRA was present [8]. The role of the CRA to encourage patients to scan the QR code was also confirmed in this study. The interaction with patient performed by non-physician might act as communication facilitators between patient and physician [16]. Some patients declared a low interest in the topic. As the use of Elefight® digital solution is entirely anonymous, a survey could be conducted outside to identify the underlying reasons (social, cultural...) for the lower interest in influenza vaccination. By doing so, future interventions or policy development could be guided towards achieving vaccination goals [18]. The suitability of elderly people for reading QR codes appeared to be limited due to the lack of smartphones in general, and/or unfamiliarity with this technology. Also, we confirmed that perception of QR code technology and its usage could be affected by certain demographic factors like age [19]. In an exploratory subgroup analysis of the NUDGE-FLU, a randomized Danish national trial, it appears that electronic nudges were linked to increased acceptance of influenza vaccination in participants without diabetes; however there was no evidence of an positive effect in those with diabetes [20]. Then, efforts are needed to facilitate access to the webapp, regardless of the age or other patient determinants.

Some limitations need to be addressed. The data regarding the perception on influenza vaccine was not collected among HCWs. There is evidence that HCWs attitudes towards vaccination are among the most important factor in boosting the decision to vaccinate [21]. In a recent systematic review, tailored reminders and multicomponent interventions appear to be effective in improving the ability of HCWs to engage in a dialogue on vaccines with their older patients [22]. A review study among patients with inflammatory bowel diseases; showed that interventions-targeted at gastroenterologists (eg., education, electronic medical records tools, and audit feedback), patients (eg., education, questionnaires, and improved access to vaccines), or both-were effective in improving the uptake of preventive health measures, including influenza vaccination [23]. Considering that no personal data were collected, analysis according to users' baseline characteristics and past medical history was not possible in this study. The present investigation was undertaken during the autumn-winter periods when the administration of simultaneous vaccines, including pneumococcal, influenza, and COVID-19 vaccines, is recommended for individuals at risk. While

certain individuals may be hesitant to comply with these recommendations due to concerns about potential side effects and safety issues associated with the vaccination schedule, it is essential to enhance the public's understanding of the safety of concurrently administered vaccines [24,25]. Furthermore, there were no data collected to identify the factors that contribute to the negative perception and/or hesitancy of influenza vaccination. Finally, no data were collected regarding the influenza vaccine uptake to evaluate the impact on vaccination. Future research to explore perspectives regarding vaccination by directly engaging with patients and HCWs themselves could be interesting. However, despite these limitations, results obtained in this multicentric study provide some insight to those developing policies to improve vaccination coverage.

5. Conclusions

In conclusion, this study suggests that a facilitated direct access to medical information through QR codes disseminated in health settings can help nudging people to raise their awareness on influenza and its prevention. The challenge remained how target populations for the appropriation of the tools and the analysis of the topic/substantive information. Global policies and actions including a clear global roadmap are still needed to achieve influenza control objectives [26]. Future investigations to explore in depth any reasons (concerns about the vaccine safety, risk balance, efficacy, religious, social and cultural norms, ...) about vaccine hesitancy are necessary to purpose to adapt communication by decision-makers [16]. The added value of the use of numeric tools for prevention needs to be evaluated including the report of a risk of numerical saturation of population related to the over exposure to such tools.

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Institutional review board statement

According to French Law, such study does not require Ethical review.

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Data Availability Statement: Not applicable.

CRedit authorship contribution statement

Naghm Khanafer: Writing – original draft, Visualization, Validation, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Sylvain Oudot:** Writing – review & editing, Validation, Software, Methodology, Conceptualization. **Margot Maligeay:** Methodology, Conceptualization. **Catherine Planckaert:** Investigation. **Camille Mena:** Investigation. **Nadège Trehet Mandel:** Investigation. **Rym Bouhalila:** Investigation. **Florence Ader:** Writing – review & editing. **Frédéric Berard:** Writing – review & editing. **Françoise Bouhour:** Writing – review & editing. **Roland Chapurlat:** Writing – review & editing. **Sybil Charriere:** Writing – review & editing. **Cyrille Confavreux:** Writing – review & editing. **Gilles Devouassoux:** Writing – review & editing. **Emmanuel Disse:** Writing – review & editing. **Denis Fouque:** Writing – review & editing. **Herve Ghesquieres:** Writing – review & editing. **Sophie Hyvert:** Writing – review & editing. **Anne Jolivot:** Writing – review & editing. **Alice Durand:** Writing – review & editing. **Géraldine Martin-Gaujard:** Writing – review & editing. **Jean-Francois Mornex:** Writing – review & editing. **Marc Nicolino:** Writing – review & editing. **Nathalie André-Obadia:** Writing – review & editing. **Gérald Raverot:** Writing – review & editing. **Alain Ruffion:** Writing – review & editing. **Pascal Seve:** Writing – review & editing. **Ruben Hermann:** Writing – review & editing. **Fabien Zoulim:** Writing – review & editing. **Joséphine Clamens:** Writing – review & editing.

Marie-Pierre Ayala: Writing – review & editing, Software, Conceptualization. **Philippe Vanhems:** Writing – review & editing, Validation, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Nagham Khanafer, Florence Ader, Frédéric Berard, Françoise Bouhour, Roland Chapurlat, Sybil Charriere, Cyrille Confavreux, Gilles Devouas-soux, Emmanuel Disse, Jean-Pierre Fauvel, Denis Fouque, Herve Ghesqueres, Sophie Hyvert, Anne Jolivot, Gilles Leboucher, Catherine Lombard, Géraldine Martin-Gaujard, Jean-Francois Mornex, Marc Nicolino, Nathalie Obadia, Gérald Raverot, Philippe Reix, Alain Ruffion, Pascal Seve, Eric Truy, Fabien Zoulim and Philippe Vanhems have no conflicts of interest related to this study to declare.

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Data availability

Data will be made available on request.

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