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More than rewards: insights into a hospital infection prevention and control gamification strategy

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SUMMARY

Background: Traditional infection prevention and control (IPC) education and training of healthcare workers (HCWs) is expensive and rarely sustainable. Gamification strategies support behavioural change by capitalizing on psychological drivers such as intrinsic and extrinsic motivation. However, little is known about which type of reward presentation best supports the engagement of HCWs.

Aim: To examine which reward strategy can best facilitate engagement and acquisition of IPC knowledge.

Methods: This study was performed in three gastroenterology wards, and a palliative care ward served as the control. Data on bed occupancy and consumption of alcohol-based hand sanitizer (ABHS) were collected over a 2-month baseline period, and the number of correct answers was gathered during the intervention phases. Surveys on expectation and satisfaction were conducted pre and post intervention. Twice-weekly knowledge quizzes used loss aversion, standard reward and in-game reward strategies. Multi-variate analysis was used to analyse data on ABHS consumption and IPC knowledge.

Findings: In total, 105 HCWs participated in this study. A 170% increase in mean ABHS consumption was observed between baseline and the last phase of gamification. This represents a significant effect of gamification ($P<0.05$). However, no significant difference in ABHS consumption was observed between the gamified wards ($P>0.05$). Furthermore, gamified strategies showed higher engagement than the control strategy, but strategies of loss aversion and standard rewards did not display higher ABHS consumption or game engagement compared with gamification alone.

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Conclusion: The intervention effectively engaged medical and non-medical staff in IPC topics, positively influencing HCW work flow and increasing ABHS consumption. These findings highlight gamification as a promising approach for IPC education.

Introduction

In the hospital context, infection prevention and control (IPC) has been described by the World Health Organization (WHO) as an evidence-based approach to protect patients and healthcare workers (HCWs) from avoidable infections [1]. Despite the overarching concern for patient safety in healthcare institutions, experts face formidable challenges in promoting robust compliance with IPC measures such as hand hygiene [2,3], adherence to specific hygiene guidelines [4], and the correct use of antibiotic therapies [5]. The prevalence of nosocomial infections is estimated to be approximately 0.11% among hospitalized patients in Europe, compared with a global prevalence of approximately 0.14% [6]. The 2022 report of the European Centre for Disease Prevention and Control (ECDC) estimated that 4.3 million patients have at least one nosocomial infection per year in Europe [7].

Over the past decade, there have been many efforts to motivate and improve compliance with IPC guidelines through training, education programmes, certifications, workshops, etc. with mixed results. Recent approaches from the fields of psychology and behavioural economics, which utilize behavioural techniques, have been shown to enhance compliance with IPC practices using various strategies [8,9]. Within these behavioural approaches, there are two game-related concepts: (i) serious games, which are defined as games designed with objectives beyond entertainment; and (ii) gamification, which applies classic game design elements (e.g. goal setting, rewards, competition and progress tracking) to non-game contexts [10]. Both approaches support behavioural change by capitalizing on psychological drivers such as intrinsic and extrinsic motivation, social influence and perceived usefulness [11,12].

Gamification interventions in health care have used a wide range of strategies and goals [9]. The use of rewards has been shown to be particularly effective in the context of learning and teaching new materials to students in medical [13] and health-related fields [14]. However, while reward strategies such as loss aversion have been used successfully in other contexts, the different types of reward presentations have not been explored thoroughly in HCWs. GAST-Hygiene (from the German acronym 'GAmification zur STeigerung der händeHYGIENE') proposes a gamification strategy based on competition between wards, with a tangible reward and multiple reward presentation strategies to test and motivate engagement in the players.

In terms of motivation, IPC is not typically a popular topic among students and HCWs [15]. This affects compliance with IPC guidelines and therefore reduces patient safety [16]. In addition, both the multi-factorial cause of nosocomial infections [17] and the delay between the lack of proper IPC behaviours and the consequences tend to influence and generate the perception of a preparedness paradox, which states that when prevention is effective, the risk of infection may be perceived as unlikely. Together, these factors influence motivation to engage in IPC interventions [18]. However, gamification allows a wide range of professional roles to engage in specific subjects which could maintain IPC awareness, boosting both HCW motivation [19] and perception of IPC [18].

This study aimed to examine which reward strategy could best facilitate engagement and acquisition of IPC knowledge.

Methods

GAST-Hygiene was funded by the B.Braun fundation and was designed to engange a wide range of HCWs (nurses, physicians, nurse assistants, volunteers, housekeeping services, etc.) in the topic of IPC. The study was planned as a single-centre, quasi-randomized, pre—post intervention study with three intervention groups and one control group. Baseline measures were conducted between 15th August and 15th October 2023, and the intervention was carried out between 16th October 2023 and 15th May 2024 in three wards of the Department of Gastroenterology, Gastrointestinal Oncology and Endocrinology. All three specialities are located within a single department in the hospital. The palliative care ward served as a control. Ward selection was guided by procedural and staffing similarities to the gamified wards, along with moderate-to-low staff-sharing rates. The control ward was chosen to ensure personnel and physical separation from the gamified wards.

The project comprised three distinct phases. The initial phase, designated as baseline, aimed to establish a reference point by measuring data on bed occupancy and consumption of alcohol-based hand sanitizer (ABHS) in the absence of any intervention. The subsequent two phases were designed to introduce gamification elements, whereby the wards were introduced to different reward systems, with the presentation of these rotated once between the wards (Table I). For the reward structure, when the gamification frame was applied alone without additional incentives, participants could

Table I
Reward allocation throughout the intervention phases

Ward	Phase 1	Phase 2
A	Loss aversion[a]	Standard reward
B	Standard reward[b]	Game
C	Game[c]	Loss aversion

[a] Loss aversion is one of the principles of behavioural economics, and was first described by Kahneman and Tversky (1979) as changes for the worse are perceived as more influential than equivalent changes for the better [20]. In other words, losing the already named massage voucher was perceived as more meaningful than gaining the same item.

[b] Standard reward was defined by the authors as a gain framed strategy where participants earned an economic reward (in the form of a massage voucher) after achieving a certain number of points on the board game.

[c] The game strategy solely used gamified rewards such as points system, a leaderboard and competition to motivate participants.

compare the progress of their ward with other wards on a game board, allowing them to visualize their ward's progress and compete with other wards. Under the loss aversion approach, participants had the same gamification conditions but needed to score at least 24 points (correct answers) within 2 weeks to retain four massage vouchers. In the standard reward frame, participants followed the gamification structure but were required to score at least 24 points to earn the vouchers.

Each measurement was conducted four times per week in four patient rooms (all rooms had up to two beds) selected at random by the nursing staff, with no measurements taken in rooms where the patients were in a critical condition. This decision was made to avoid disturbing patients and families during measurement. Bed occupancy was operationalized as the number of occupants within the room at the time when ABHS consumption was measured, and varied between 0 (if all patients in the room had been discharged between measurements) and 2 (maximum room occupancy). ABHS consumption was measured by weighing the ABHS container to establish a baseline and then reweighing it 24 h later. The difference in weight was converted into millilitres using a conversion formula [volume (mL) = weight (g)/density (g/mL)]. ABHS consumption was only measured for ABHS dispensers in patient rooms (between the beds), which was closely linked by our IPC experts to the WHO hand hygiene moments 1, 3 and 4.

Two surveys were conducted: one at the start to assess motivation, knowledge and perceived usefulness of gamification; and another anonymously at the winner's ceremony 2 weeks later. Participants were briefed on the rules of the study in October 2023. Gamification participants received a massage voucher at enrolment, and could win more vouchers biweekly and at the end of the project. The intervention included twice-weekly quizzes (five questions each), of increasing difficulty, which focused on hand disinfection. These were led by an IPC 'game master'. Quiz points were updated biweekly on a game board in the nursing lounge. Quizzes were held at various times, including weekends, to cover all shifts. The control group answered the same questions without gamification.

Data and statistical analysis, as well as visualizations, were performed using R Version 4.2.2. The game visualizations (Supplementary Appendix 1) were created by a graphic designer.

Results

In total, 105 participants engaged in the gamification, collectively completing 129 quizzes. Three participants were part of a pool of HCWs that rotated between wards, competing for different wards. As a result, the total number of participants and quizzes per ward was distributed as follows: Ward A had 28 participants, completed 36 quizzes and had 132 correct answers. Ward B had 37 participants, completed 39 quizzes and had 132 correct answers. Ward C had 27 participants, completed 33 quizzes and had 99 correct answers. The control ward had 19 participants, completed 21 quizzes and had 71 correct answers.

In total, 67 participants reported their occupation during registration. Ward A had the highest participant diversity with five professions, followed by Ward B with four professions, and Ward C with three professions. In the control ward, only two professions were reported (Table II).

Table II
Diversity of reported participant occupation across wards

	Physician	Nurse	Nursing assistant	Housekeeping services	Other	Total
Ward A	13	11	1	1	2	28
Ward B	2	8	1	0	2	13
Ward C	2	10	2	2	0	16
Control	1	9	0	0	0	10
Total	18	38	4	3	4	67

The standard reward strategy led to the most correct answers [N=142, mean 3.38, standard deviation (SD) 0.88), followed by loss aversion (N=115, mean 3.59, SD 1.32), game-based rewards (N=106, mean 3.12, SD 1.15) and the control strategy (N=71, mean 3.38, SD 0.86; Figure 1). A multi-variate analysis of variance (MANOVA) found no significant differences in the numbers of correct answers between strategies, but a generalized linear model showed a significant negative effect of the control ward on HCW participation (P=0.01), suggesting lower motivation. Pairwise comparison (Supplementary Appendix 2) indicated that the HCWs allocated to reward strategies participated in the game significantly more than HCW on the control ward. Nevertheless, no significant difference was found between external rewards and game strategies without rewards.

In addition, bedroom-specific ABHS consumption and bed occupancy were compared within and between wards, as well as between gamification phases. Mean ABHS consumption of the gamified wards was 3.12 mL/patient-day for baseline, 5.84 mL/patient-day for the first gamification phase and 8.60 mL/patient-day for the second gamification phase. MANOVA (Supplementary Appendix 3) revealed a significant effect of gamification phase on ABHS consumption (P<0.05). A closer look at the means revealed an overall increase of 72% in ABHS consumption between baseline and the first gamification phase, and a 56% increase between the first and second gamification phases, with an overall increase of 170% in ABHS consumption compared with baseline (Figure 2). Furthermore, similar statistical significance was found when analysing each phase within the wards (Figure 3). However, no significant differences in ABHS consumption were found between the phases within the control ward (Figure 3) nor between the participant wards (Supplementary Appendix 3). A generalized linear model found a significant difference in ABHS consumption between the control ward and the participant wards. On the control ward, ABHS consumption was 73.5% higher during the first phase and 46% higher after the second phase compared with the gamified wards.

Bed occupancy varied significantly between phases (P=0.044), decreasing by 7.7% from baseline to the first gamification phase, then increasing by 6.7% in the second gamification phase, resulting in a net 1.4% decrease.

Of the 77 survey participants who were recruited and gave their consent to participate at the beginning of gamification, only 15 (19%) responded to the first survey. When asked about their motivation to participate in the game, 3/15 participants had low motivation, 3/15 had high motivation, and 9/15 had moderate motivation. When asked to compare their knowledge level with their peers, one participant believed that they had slightly less knowledge, three participants thought they had slightly more knowledge, 10 participants felt that their

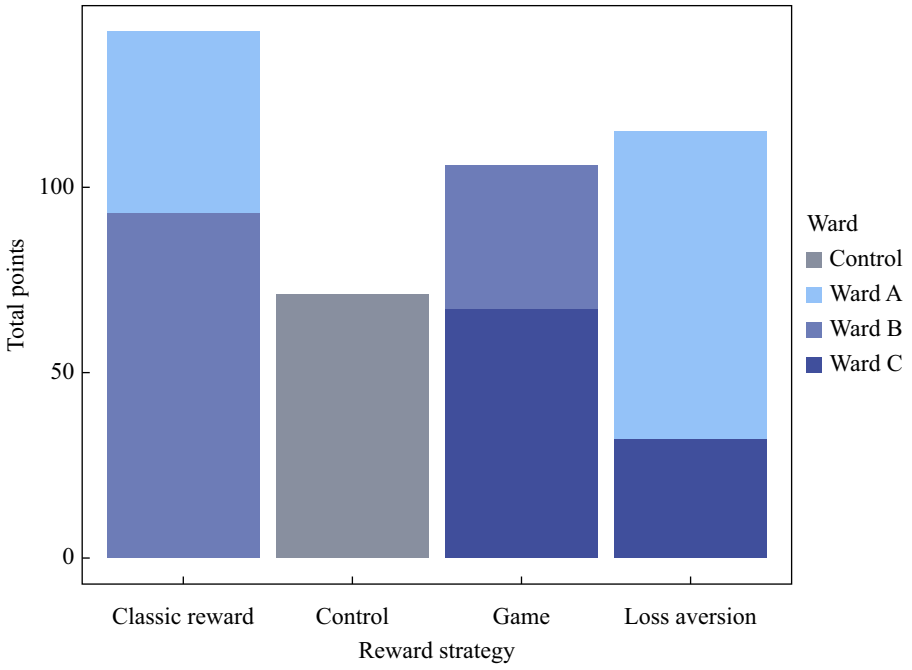

Figure 1. Points per ward and reward strategy. This stacked bar chart displays total points earned (y-axis) by reward strategy (x-axis) for various hospital wards, with the control ward in gray. The classic reward and loss aversion strategies generated the highest scores, while the control condition showed the lowest performance. Variations between wards indicate differential responses to gamified interventions.

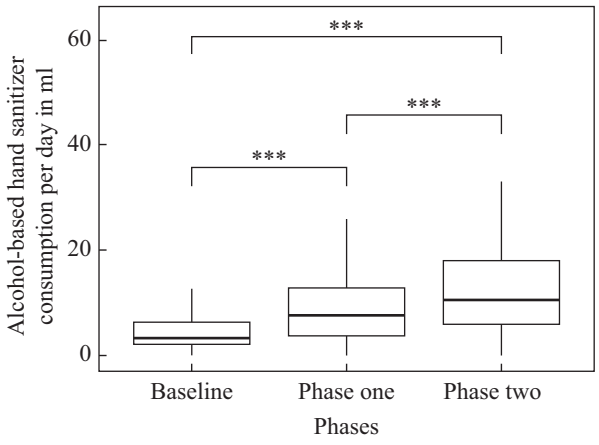

Figure 2. Consumption of alcohol-based hand sanitizer (ABHS) over time. This boxplot displays daily ABHS consumption (y-axis) across three study phases (x-axis). Consumption increased significantly from baseline to the first gamification phase, and further in the second gamification phase, as indicated by statistical significance markers (*$P<0.05$, **$P<0.01$, ***$P<0.001$).

knowledge was about the same, and one participant considered themselves to have significantly more knowledge on IPC compared with their peers. However, 12/15 participants saw a need to improve IPC measures on the ward, and all saw gamification as the correct way to improve it. At the beginning of the gamification intervention, 14/15 participants believed that this would help them to gain knowledge on infection prevention and this would be the right approach. In the second survey ($N=20$), 16 participants were willing to join a similar intervention, although only 12 of them saw gamification as effective for hygiene improvement. However, 17 participants reported gaining hygiene knowledge. Perceptions of the IPC department remained unchanged for 14 participants, while four participants viewed it more favourably. Regarding the difficulty of the quizzes, 15 participants found them moderate, four found them easy, and one found them too easy. Overall, 19/20 participants became more attentive to IPC, and 16 participants found gamification helpful. The full results are given in Supplementary Appendix 4.

An ad-hoc evaluation with the Department of Physiotherapy revealed that, of the 105 vouchers distributed during the game, only 12 (11%) were used within the first 3 months of the intervention.

Discussion

This study tested the usability of different rewards systems on a hospital-based IPC gamification intervention. GAST-Hygiene showed a high participation rate within the gamified wards, as well as a positive impact on ABHS consumption. Frequent IPC quizzes and result displays may enhance knowledge retention and increase the use of ABHS. These results are in line with recent literature. Alhumaid *et al.* (2021) identified a possible influence of educational opportunities of health care on compliance, as well as a positive relationship between adequate knowledge and HCW compliance with IPC guidelines [16].

With 86 participants (excluding the control group), the intervention was well received and successfully motivated medical and non-medical staff to engage with IPC-related topics. Combined with positive survey feedback on motivation (12/15) and high interest in re-enrolment in similar initiatives (16/20), it appears that gamification approaches have

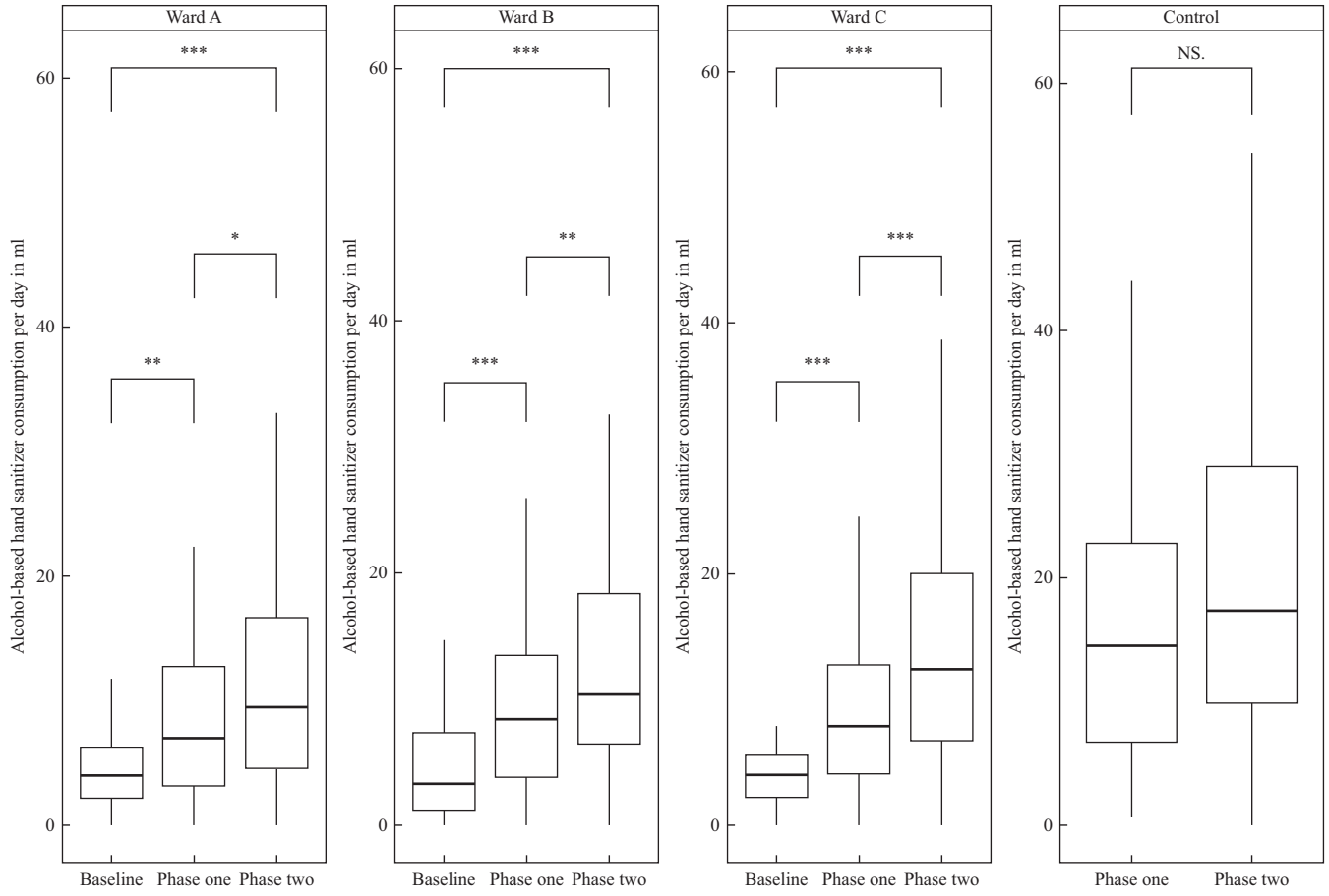

Figure 3. Consumption of alcohol-based hand sanitizer (ABHS) by ward. These boxplots show daily ABHS consumption across intervention phases for four hospital wards. Significant differences (*$P<0.05$, **$P<0.01$, ***$P<0.001$) are indicated, while 'NS' indicates non-significance. Wards A, B and C showed significant increases in ABHS consumption, whereas consumption on the control ward remained unchanged.

strong acceptance among HCWs [21]. Furthermore, the intervention proved effective in motivating a wide range of HCWs such as nurses, physicians and housekeeping services. The high motivation and participation rates may also be attributed to the high perceived need to enhance IPC compliance (12/15) within the gamified wards.

The gamified wards had a higher participation rate than the control ward, which is consistent with the existing literature [14,19], and allows the authors to conclude that the gamified intervention was able to motivate HCWs and enhance engagement with IPC learning material. No differences in participation rates were found between the gamified situations with external rewards and those with internal rewards (points and competition), nor between the standard reward frame and the loss aversion frame. It could be argued that the control ward was the smallest ward; however, it had the lowest rate of repeated participation as well as the lowest occupational diversity, which underlines the effectiveness of the gamified conditions to motivate a wide range of HCWs. In addition, the modest use of the vouchers suggests that the rewards alone were not the main motivation for participation in the gamification. The gameboard, the competition and the possibility of rewards could have contributed to a increase in players' self-efficacy and expectancy [22]. Nevertheless, further analysis may provide insight into the influence of rewards and incentives on the motivation of HCWs.

A recent study conducted on a surgical ward found that ABHS dispensers located between patient beds had low to very low consumption [23]. Similarly, baseline ABHS use (3.12 mL/patient-day) was far below the 49 mL/patient-day ward annual average. Furthermore, gamified wards showed a significant increase in consumption despite lower bed occupancy, while the control ward did not, highlighting the effectiveness of gamification. These results suggest that the implementation of gamification strategies had a significant impact on the work flow and use of ABHS by HCWs. Further analysis should be carried out to determine whether the higher consumption in the aforementioned dispensers can be related to more precise adherence to the Five Moments for Hand Hygiene, as suggested in the literature [23].

Despite high acceptance of gamification (16/20), increased ABHS consumption and initial support for IPC awareness (15/15), nearly half (40%, 8/20) of the participants later questioned its effectiveness for hand hygiene. This contrasts with most participants (19/20) reporting increased IPC attentiveness. The discrepancy may stem from the measurement method, which tracked dispenser use rather than direct hand hygiene behaviour. Moreover, the initial survey indicated considerable anticipation of acquiring knowledge through the gamification (14/15),

a sentiment that was validated as the majority of participants reported an increase in their knowledge base through the game (17/20). These outcomes highlight the positive results of continuous gamified education interventions in an IPC context [21], and suggest that gamification interventions are good alternative approaches to traditional education (e.g. mandatory compliance training, workshops, seminar, certificate programmes, etc.) in the IPC context [22,24].

This study has various limitations, starting with difficulty transmitting the different game strategies and reward systems. Furthermore, the complexity of the reward systems, an overworked population and the 'present time bias' [25] could have played a role in understanding and acceptance of the loss aversion reward group. Therefore, in the context of this study, the implementation of vouchers did not align with the time and complexity requirements of a rewards system that incorporates loss aversion strategies. Furthermore, it was noted that Ward C accrued the lowest number of points during the intervention. This may be attributed to the sequence in which the gamified frames were presented, with the first frame lacking any form of reward and the second frame utilizing a loss aversion strategy. The succession of these frames may have resulted in a less motivated response from HCWs on Ward C. Consequently, the order of presentation of the reward systems should be investigated as a potential factor influencing motivation.

Participation of HCWs on gamified wards was limited, with only 16% playing more than once. While this broadened the participant pool, it could be explained by a higher incentive for new players, possibly contributing to fewer active participants. A follow-up study could not be undertaken due to funding limitations, and long-term effects require further study.

In conclusion, the gamified intervention was well received, and successfully motivated medical and non-medical staff to engage with IPC-related topics. Gamification strategies with and without external rewards offer a potential solution for frequently overworked HCWs, allowing minimal time investment and seamless integration into work hours, tailored to fit employees' schedules. Together, these results add to the notion that integrating knowledge-based gamification interventions into the field of IPC can provide an alternative approach to traditional education (e.g. mandatory compliance training, seminars, certificate programmes, etc.).

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Conflict of interest statement

None declared.

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Ethical approval

Ethical approval for this study was obtained from Medical Centre Göttingen (Approval No. 25/8/23). All participants provided informed consent before participation, and the study was conducted in accordance with the Declaration of Helsinki.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jhin.2025.02.019.

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