



Task-based training to prevent surgical site infection: A formative evaluation

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SUMMARY

Background: Lack of evidence-based training constitutes a serious impediment to preventing surgical site infections in low-middle income countries (LMIC). The purpose of this study was to design and implement an infection prevention training programme and investigate how it might work in an LMIC. Intended for healthcare professionals working in operating rooms, the programme was based on current instructional design principles of interprofessional, task-based learning. The second aim was to carry out a formative evaluation exploring participants' and facilitators' perceptions and experiences of the training.

Methods: In undertaking this design-based research, we used a mixed-methods approach. The four session training was attended by anaesthesia and surgical trainees, registered nurses, technologists and included a video showing best practices, role plays, and peer-group reflection. We evaluated the programme through questionnaires, focus-group interviews with participants, written reflections by participants, and individual interviews with facilitators. Quantitative analysis was complemented by thematic analysis of focus-group and interview transcripts, reflections, and observer notes.

Results: Our analysis revealed that participants had positive attitudes towards the training. They felt they had learned a lot from each other and the facilitators offered them the opportunity to interact with each other. Trainees especially valued the video presentation as it inspired them to revise old concepts and presented an excellent practical example of infection prevention in their specific setting.

Conclusion: The training seemed to bridge the gap between knowledge and practice. However, direct observation of procedural skills and peer feedback could further reduce the gap, by enhancing the transfer of knowledge to practice.

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Introduction

A lack of evidence-based education and training constitutes a serious impediment to preventing surgical site infections (SSI) in low-middle-income countries (LMICs). Various initiatives have however been taken to reduce such infections in other countries, including educational awareness programmes, blended educational programmes, lectures, and videotaped presentations and educational meetings [1–6]. These initiatives, however, used educational strategies that were essentially aimed at teaching knowledge, skills, and attitudes in a rather fragmented way. Contemporary instructional design theories have recommended that learners engage in meaningful learning by performing whole, authentic learning tasks from real clinical practice that are ordered from simple to complex. More specifically, these theories have emphasised five principles that are vital when designing instruction. The first principle is that authentic professional tasks should be used as a starting point for learning [7–10]. Such tasks can take different forms, for instance, a video or role play shown to the learner. They should closely resemble a professional job in real practice. Second, learners should be confronted with a variety of learning tasks so that they learn about the different varieties and situations in which a problem may present in practice. The third principle is, as mentioned, that learning tasks should be ordered from simple to complex; the simplest task should still be authentic and representative of a professional's task in real practice. Fourth, the learner must receive support and guidance while working on learning tasks, for instance in the form of reading materials or feedback from a teacher. This support should be substantial in the beginning and gradually be reduced as learners become competent (scaffolding). As soon as learners demonstrate that they can adequately complete a specific task without guidance, the next set of tasks may be offered at a higher level of complexity [7–9]. Finally, the fifth instructional design principle is about interprofessional learning, which occurs when participants from two or more healthcare professions (e.g. doctors, nurses, and technologists) learn to effectively collaborate, for instance, to prevent SSIs in the operating rooms (ORs) in a specific training programme [10,11]. This process is marked by active learning from and with each other.

The first four of these instructional design principles recall Merrill's first principles of instruction that emphasise the importance of engaging learners in solving real-world problems, activating their existing knowledge, presenting them

with new knowledge, and encouraging them to apply and integrate this new knowledge [12]. In addition, Merrill stressed that new learning contents can be presented most efficiently by visualizing processes, demonstrating procedures, or modelling behaviours [12]. When all these principles are effectively applied in training, learners will acquire competencies as an integrated set of knowledge, skills, and attitudes and be able to transfer these to professional practice.

With this knowledge in mind, we set out to design a training programme on SSI prevention that was based on the said instructional design principles of interprofessional, task-based learning (TBL). Our assumption is that this educational intervention will lead to increased knowledge, skills and attitudes regarding SSI prevention, and eventually to a decrease in SSI incidence. Table 1 presents an overview of the main design principles on which the training was based. Intended for healthcare professionals (HCPs) working in the ORs, the programme was implemented in Pakistan, to see how it might work in a LIC. Finally, we formatively evaluated the programme by exploring participants' and facilitators' perceptions and experiences. We aimed to design, implement and evaluate a training programme on SSI prevention that was based on instructional design principles using mixed methods.

Research question

What are participants' and facilitators' perceptions and experiences of an interprofessional TBL programme aimed at supporting healthcare professionals in learning to prevent SSIs in LMIC?

Methods

Study design

We conducted this design-based study in an authentic educational environment. We first developed a training programme on SSI prevention, implemented it in a LMIC, and then investigated the outcome using mixed methods [13]. This investigation consisted of a formative evaluation by relevant stakeholders, in this case, participants (HCPs) and facilitators. As explained in the Introduction and shown in Table 1, we designed the training programme in line with current instructional design principles or theories. We aimed to collect evidence about how the training might work in the specific context of a LMIC, in this

Table 1

The instructional design principles on which the SSI prevention programme was based

Serial no.	Instructional design principle
1	Interprofessional learning: learners from two or more healthcare professions, in this case, doctors, nurses, and technologists, interactively learn from and with each other to collaborate effectively to prevent surgical site infection in the operating rooms.
2	Task-based training based on whole, realistic tasks: learning tasks are derived from professional practice and ordered from simple to complex, starting e.g. with a video demonstrating best practices, through practising simplified but practical tasks, to practising a variety of more and more challenging tasks from the daily routine of SSIs.
3	Guidance and feedback provided by the facilitators: the amount of guidance offered decreases from one task to another until the learners can perform the tasks independently. The facilitators stimulate discussion rather than spoon-feeding by lecturing.

case, Shifa International Hospital, the teaching hospital of Shifa Tameer-e-Millat University in Islamabad, Pakistan.

Intervention

The intervention was designed to bridge the gap between knowledge and practice in SSI prevention. The training comprised four sessions spanning two months. Every two weeks, participants gathered in a five-person interprofessional group for a two-hour session. The three sections into which the training was divided will be further discussed below.

Part I

In part I, participants viewed a 10-minute video demonstrating an expert model of best practices in SSI prevention SSIs. The purpose of the expert video, is to give participants an example or a situation they readily recognize as authentic in their own work setting as a starting point for discussing good practice habits. Participants compare this practice to their current practice and discuss ways to improve their current practice.

Part II

Part II consisted of two role-play exercises (20 minutes each) for which participants played the role of a doctor, nurse, or patient. Role-plays were based on five case scenarios that covered the following topics: antibiotic prophylaxis, hand hygiene, use of clippers, and maintenance of normothermia. [Appendix B](#) presents an overview of the learning tasks used.

Part III

Part III consisted of two facilitated peer-group reflection sessions that lasted 1.5 hours. During these sessions, participants discussed their experiences in applying what they had learned in daily practice and formulated the actions they planned to implement in their daily routine to improve site infection control.

Participants

Participants were 20 conveniently selected HCPs who played a crucial role in improving patient safety and quality of care: anaesthesia and surgical trainees, registered nurses, and technologists (six to seven from each group). [Box 1](#) provides more detailed information about these participants. The training was facilitated by two moderators: a nurse educator and an anaesthesia trainee with experience in conducting undergraduate-level problem-based learning at Shifa Tameer-e-Millat University.

Data collection instruments

Survey

To evaluate participants' perceptions of the training programme, we used a questionnaire, which was administered to participants at the end of the last training session. The questionnaire consisted of 16 items to be rated on a 5-point Likert scale ranging from 4) strongly agree to 0) disagree (see [Table II](#) for the full questionnaire). Participants were directly approached by the researcher.

Focus groups and individual interviews

The principal researcher (MNA) conducted four focus-group interviews with participants (five members per group) to explore their perspectives and perceptions of the training

Box 1

Background of the participants

Doctors: the doctors were anaesthesia and surgical trainees who had passed their preliminary fellowship exam of the college of physicians and surgeons in anaesthesia and surgery. The anaesthesiologist influences most of the prophylactic measures to prevent surgical site infection at the beginning in the operating room. The medical literature has identified many areas where the anaesthesiologist plays an influential role in preventing surgical site infection, including antibiotic administration, peri-operative normothermia, hyperoxia, normoglycemia, smoking cessation, and hand washing.

Nurses: The nurses had completed a 4-year bachelor's degree in nursing and were registered with the nursing council of Pakistan. In the operating theatre, they were responsible for observing and enforcing strict standards of aseptic technique and infection control protocols, such as ensuring compliance with hand hygiene. They also participated in quality improvement and assurance.

Technologists: The technologists were registered diploma holders from the faculty of health sciences who had been certified after completion of a 2-year accredited training course. As critical members of the team, surgical technologists ensured safe surgical care by preventing surgical site infection. Before surgery, they prepared patients for surgery by washing, shaving and disinfecting the surgical incision site.

programme. We held these focus groups for their explanatory and exploratory potential as they are commonly used to clarify, elaborate or salvage topics that are poorly understood or ill-defined in medical education. As such, they allowed us to obtain the views of various HCPs during the group discussions [14]. In addition to this, the principal researcher held 20-minute semi-structured individual interviews with facilitators to probe their perceptions and experiences of the training. The six questions for facilitators are presented in the interview guide in [Appendix A](#), as are the questions for participants. We obtained verbal informed consent before the start of the interviews; all interviews were digitally recorded.

Reflection

We asked participants to write a brief reflection (of 150 words maximum) in which they contemplated the past weeks, whether the programme's intended learning goals were achieved and how the programme did or did not prepare them for SSI prevention.

Analysis

Quantitative analysis

We used Statistical Package for the Social Sciences (SPSS) software (IBM Corp, Released 2013. IBM SPSS Statistics for Windows, Version 22.0 Armonk, NY: IBM CORP) to analyse the quantitative data, which will be reported in the form of Means (M) and Standard Deviations (SD) for each item. We flagged perceptions as 'positive' when the respective score exceeded 3.

Qualitative analysis

After verbatim transcription of the focus group and facilitator's interviews. The researchers inductively analysed all transcripts, reflections, and observer notes, using the generally

Table II
Participants' perceptions and experiences of the interprofessional TBL programme aimed to prevent SSIs

Items	Mean score	Standard deviation of scores
The learning environment for interprofessional TBL was friendly	3.45	0.51
The content was appropriate to prevent SSIs in the ORs	3.40	0.51
The training helped to bridge the gap between knowledge and practice to prevent SSIs in the OR	3.50	0.51
The organisation of training was good for interprofessional TBL	3.40	0.68
The training provided me with a strong practical orientation to prevent SSIs in the OR	3.35	0.67
Learners were allowed to make connections between old and new knowledge about the subject	3.45	0.51
Facilitators encouraged and motivated learners to participate actively in training	3.45	0.60
During the training, the subject matter was discussed among the group members	3.55	0.51
The facilitator provided support in learning when needed	3.45	0.60
It was easy to initiate communication with a facilitator	3.55	0.51
The facilitator showed an interest in what participants had to say	3.45	0.51
The self-study was a central part of this TBL programme	3.40	0.50
Tasks used in the TBL programme were relevant to day-to-day clinical practice to prevent SSIs in the OR	3.45	0.51
I was allowed to reflect and discuss tasks with other participants	3.60	0.60
Learners were provided with clear information about the goals and outcomes of the TBL programme	3.55	0.51
It was clear what was expected of me during this interprofessional TBL programme	3.40	0.51

accepted principles of primary (open), secondary and tertiary coding. First, we identified response segments that were related to the research question (open coding). We subsequently labelled these segments to create categories (secondary coding). To reduce overlap among the categories, we read the categories that were associated with each other. In the final stage, we developed a framework to report results. Data analysis commenced when data gathering was still in progress, in an iterative process of constant comparison. The findings were discussed with participants to check for accuracy.

Ethical approval

We obtained approval from the ethics committee of Shifa Tameer-e-Millat University (reference number IRB# 1169-445-2018). The participants could withdraw at any time for any reason. Only the researchers had access to the data, which were stored in electronic format, secured by a password, at Maastricht University.

Results

Quantitative results

The results presented in Table II show that participants had positive perceptions and experiences of the interprofessional TBL training. They indicated that the programme's learning environment, content, organisation, and facilitators helped them bridge the gap between knowledge and practice in SSI prevention in the ORs. The item with the highest score was 'I was allowed to reflect and discuss tasks with other participants' ($M=3.60$ $SD+0.60$). The item with the lowest score was

'The training provided me with a strong practical orientation to prevent SSIs in the OR' ($M=3.35$ and $SD+0.67$).

Qualitative results

Based on qualitative data analysis, we constructed the following four themes, which will be further discussed below: 1) different HCPs learn from each other, 2) the use of professional tasks enhances learning, 3) the facilitators provided scaffolding, and 4) the programme set-up could be improved. In the next paragraphs, each theme will be illustrated with quotes or reflections from participants (P) and facilitators (F).

Theme 1: different HCPs learn from each other

Participants' experiences of the interprofessional TBL programme were generally positive. They especially valued interacting with colleagues who had various years' experience and felt they learned from discussing and giving expertise views:

Not only doctors, nurses, and technologists were involved in learning together, but also people with different levels of experience were found in the same course. For instance, there were people with experience of ten years or more and some with relatively lesser experience. The point is, that everyone was learning the same thing. (P1)

Working in teams in the ORs was central to their work, which required a firm understanding of each other's professional identity and role. Participants, therefore, deemed it beneficial if the training were offered as early as possible, as this would prepare the HCPs for their team role:

Interprofessional learning is effective in ORs as we work in a team. This training improves the understanding of each other's roles. Training should be provided to everyone working in the

ORs at the time of the start of his job so that everyone becomes a team player. (P1)

Theme 2: the use of authentic tasks enhances the application in practice

All participants valued the video showing best practices in SSI prevention because they saw their colleagues applying the evidence-based knowledge in their specific setting: *'The learning format of the video was informative and captivating as per popular feedback. We saw our people practising the best evidence-based to prevent SSIs. All the sessions were admirable, but nothing could match the video session'*. (F1)

Participants also noted that the tasks used in training were simple, complex, and valuable as they activated their thinking process and motivated them to understand the logic and scientific evidence behind every measure used to prevent SSIs:

Nothing ornamental or elaborate was imparted, but we learned the prevention of SSIs through simple tasks. This training challenged our thought process and conventional practices through challenging tasks. (P3)

Furthermore, many participants appreciated the training for its potential to support them in applying knowledge with their colleagues, which is essential to SSI prevention:

This training has prepared me to practise safe and high-quality prevention of SSIs in the ORs in my country. It allows me to understand why guidelines are important and how, along with my colleagues, I can implement them. (Reflection of P4)

Theme 3: facilitators provided scaffolding and support

According to participants, the facilitators acted like guides, coaching them effectively while managing group discussions and dynamics. They created friendly learning environments that encouraged participants to discuss and actively learn from each other. Participants knew that the facilitators were there to guide them throughout the learning process when needed:

Facilitators provided us with reading materials and aided us during discussion sessions. They were highly unconventional and directed us at every step, yet they did not even over-indulge us at all. They made sure we solved the tasks ourselves and at the same time fully assisted us. (P4)

Interacting with an individual from a different level was often perceived as challenging in real clinical practice, however, it was not during this training. Owing to its amicable learning environment and educational climate, this inter-professional TBL programme afforded participants an excellent opportunity to interact with each other. The training not only enhanced learning but also clarified the perspectives and roles of others in the prevention of SSIs:

We had enough time to interact with facilitators and within the group. We brainstormed and discussed potential barriers within the group to solve tasks that not only made learning easy but also enhanced it. (P1)

Theme 4: the training setup could be improved by adding a workplace-based assessment and feedback

Although perceptions were generally positive, some participants felt that the training could be improved by direct observations of procedural skills in the OR, followed by peer feedback. Such addition could further enhance participants' learning of SSI prevention in the ORs:

I suggest that one more thing should be added to this course, "the practical demonstration". We tend to forget what we see, but if we do it practically within the peer groups, I think it will become a habit. (P4)

A facilitator pointed out that the training might best be taught in a single-day workshop with protected educational time:

I would like to keep the training as a one-time learning experience because a clash between the timings of different healthcare professionals was observed. If the training is provided as a full day within the protective learning day, we think it will be more helpful. (F2)

Finally, a few participants suggested that the learning materials and tasks be supplied in advance of the training, rather than on-site, to allow for preparation: *'I would like to suggest that learning materials and tasks should be provided at least a week before the start of the training so that we read it before coming to the training, which will save us more time'*. (F2)

Discussion

In this study, we designed an interprofessional TBL programme aimed at SSI prevention in the OR and implemented it in HCPs' real context in Pakistan to see how it might work in LMIC. We subsequently evaluated the programme by exploring participants' and facilitators' perceptions and experiences. The programme combined a video showing best practices with case-based role plays. In the following paragraphs, we will discuss the quantitative and qualitative results of the existing literature and give suggestions on how the training might be improved.

The *quantitative results* of this study provided evidence that participants, facilitators, and observers' perceptions and experiences of the training under scrutiny were generally positive. The *qualitative results* explained why this was so: the tasks used for learning were realistic, relevant, interesting, engaging, and meaningful. Moreover, they were derived from participants' daily practice and were varied, which facilitated the transfer of learning [7,8]. Participants especially valued the video session showing best practices in SSI prevention; it allowed them to discuss their current SSI prevention practices and compare them with the evidence-based best practice presented during the training. Participants also felt that the training had helped them develop the communication and speaking skills they needed when collaborating to prevent SSIs in practice [11,12]. Certain training parts were dedicated especially to the practising of these skills. From an educational viewpoint, this is desirable, as it may enhance transfer to practice even further. We concluded, however, that the training could gain from the addition of a fifth session where trainees discuss their experiences and ways to overcome any barriers encountered.

The previous educational interventions used to prevent surgical site infection neither utilized instructional design principles nor involved HCPs in the preparation of the planning, design, and evaluation of training to prevent SSI in the OR. Moreover, previous studies have not considered the context within which education and training were provided, as well as teaching strategies that actively engage the healthcare professionals in their learning and stimulate behavioral changes. Our educational intervention, on the other hand, utilized these

principles and involved the healthcare professionals in the planning, design, and evaluation of training.

In summary, the results of this study show that the design principles used to develop this interprofessional TBL programme based on whole tasks and guidance and feedback from facilitators produced the desired effect. They also show that the training need not be expensive, for no expensive simulator facilities were required: an educational video, case-based discussions, and role-play proved sufficient. Practising in context with colleagues, their protocols, and standards also contributed to the development of a community of practice, while it improved understanding of the various other healthcare professionals' roles and responsibilities [15–17].

Strengths and limitations

The study's strength is the triangulation of data collected, using a survey among programme participants, focus-group interviews with participants, and semi-structured interviews with facilitators. Limitations include that the training was evaluated in the ORs of one hospital in one country (with a convenience sample of 20 participants) and only addressed participants' and facilitators' perceptions. Furthermore the actual impact on SSI incidence was not investigated.

Implications for research

Future research should investigate not only educational outcomes but also outcomes related to SSI incidence after this TBL training in settings with more participants. We also welcome investigations into whether the training leads to behaviour changes in the workplace.

Implications for practice

Based on this study, we recommend that all OR staff receive similar training, preferably interprofessional and task-based, with colleagues in their hospital. The training should be task-based and led by trained facilitators who act as coaches rather than teachers. Previous studies have shown that no institution is currently offering such training [10]. To ensure that everyone gets trained in SSI prevention, it is therefore imperative that medical institutions and governments take responsibility for organising this training.

Conclusion

The participants and facilitators had positive views about the tasks used in this interprofessional TBL training programme. The video presentation was valued highly because it stimulated participants, who were HCPs from different professional backgrounds (i.e. doctors, nurses, and technologists), to revise old concepts and it offered them an excellent working example of how to prevent SSI in their specific setting. Moreover, the facilitators offered participants the opportunity to interact with each other. As such, the programme seemed to bridge the gap between knowledge and SSI prevention practices in the OR. To further enhance this transfer of knowledge to practice, however, it might be beneficial to include direct observations of procedural skills performed in the OR, as well as peer feedback.

Data availability

The datasets generated during and/or analysed during the current study are not publicly available due to risks of confidentiality, privacy breaches and legitimate private interests but are available from the corresponding author on reasonable request.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institutional review Board & Ethics committee of Shifa Tameer e Millat University Islamabad reference number IRB# 1169-445-2018).

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Written informed consent was obtained from the parents.

Consent to publish

Not applicable

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Author contributions

MNA, DV, SI, DD, and WvM participated and approved the study design. MNA has written the main manuscript text. It was multiple times read corrected and reviewed by MNA, DV, DD, and WvM. SI helped in collecting and analyzing data. All authors read and approved the final manuscript

Conflict of interest statement

The authors declare that they have no relevant competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.infpip.2022.100235>.

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