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Cinemeducation to teach patient safety: an experience in medical students

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From early in medical school, students need to learn about patient safety, and how to prevent and reduce risks, errors and harm that occur to patients during health care provision. Cinemeducation is a teaching methodology that uses fragments of feature films or TV series in medical education. We hypothesized that cinemeducation could help simplify the comprehension of complex situations for students, aiding in the learning of patient safety and the understanding of human behaviors that impact it. This concept stands as an integral component within a comprehensive medical humanities approach. The study population was the 70 medical students of the second course of a six-year undergraduate program. In a 2-h class, after learning objectives were established, students watched a fragment from TV series The Resident centered on adverse events, and discussed them afterward. To measure learning achievements, we administered a 10-question multiple-choice pre and post-test and a 2-question open-essay post-test. Given the complexity of the concepts related to patient safety, we used a mixed quali-quantitative approach. An exploratory descriptive and content analysis was performed. Sixty-eight students participated and completed the questionnaires. Despite high pre-intervention scores, post-intervention scores improved (mean difference 0.779, 95% CI: 0.475–1.083, $p < 0.001$). The open-essay questions provided more information about the learning points, mostly related to the understanding of system error and preventive measures against adverse events. Classical teaching methods may be insufficient for learning how to deal with complex situations in hospital contexts. Our results show that cinemeducation may significantly improve learning on patient safety. Cinemeducation methodology can be effective in teaching some complex concepts in medical education. The integration of cinemeducation within medical education, through the lens of medical humanities, offers a dynamic approach to teaching patient safety. By using cinematic narratives to explore intricate medical scenarios, students engage with real-world complexities and the influence of human factor, enhancing their understanding.

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Introduction

Traditional medical education has often prioritized the acquisition of scientific knowledge and clinical skills, leaving limited room for the exploration of the human and emotional dimensions of healthcare. Projecting and discussing clips, full movies or episodes of TV series can help the learning of health sciences students (Goodman 2007; Darbyshire and Baker 2012; Law et al. 2015; Hoffman et al. 2018). Cinemeducation methodology uses these audiovisual methods for specific purposes in medical education (Alexander et al. 2005; Alexander 2012). As cinema and television series portrays medical cases, ethical dilemmas, and cultural contexts, students are afforded the opportunity to cultivate heightened empathy, cultural acumen, and a nuanced grasp of the intricate interplay between medical science and human lives. Several studies have shown its usefulness in teaching of transversal skills such as communication, which is important in doctor-patient relationship (Wong et al. 2009; Shevell et al. 2015a), offering models of behavior and professionalism (Lumlertgul et al. 2009; Czarny et al. 2010; Pavlov and Dahlquist 2010a), and showing patients' experience, diagnosis, and treatment from different perspectives (Williams et al. 2015; Jerrentrup et al. 2018). Also, these audiovisuals have been used in specific disciplines such as pharmacology (Cambra-Badii et al. 2020), psychology (Michel Fariña 2009), social work (Jonathan 2023) or bioethics (Arawi 2010; Pereira Rates et al. 2014; Blasco et al. 2018).

Even though the majority of these experiences are from the United States (Mandel 1983; McNeilly and Steven Wengel 2001; Welsh 2003; Lenahan and Shapiro 2005; Aboul-Fotouh et al. 2010; Pavlov and Dahlquist 2010b; Darbyshire and Baker 2012; Retamero et al. 2014), there are also relevant studies from different parts of the world: Canada (Østbye et al. 1997; Wong et al. 2009; Shevell et al. 2015b), Argentina (Quadrelli et al. 2009; Michel Fariña 2009), Brazil (Blasco et al. 2018; Picanço et al. 2019), Spain (Farré et al. 2004; Pérez et al. 2014; Baños et al. 2019; Cambra-Badii et al. 2020), Slovenia (Klemenc-Ketis and Kersnik 2011), Germany (Kuhnigk et al. 2012; Jerrentrup et al. 2018), The Caribbean (Shankar 2019), Turkey (Ozcakir and Bilgel 2014), India (Patel et al. 2022; Soni et al. 2023), Thailand (Lumlertgul et al. 2009), and Australia (Walter et al. 2002).

Although several of these reports describe experiences using cinemeducation, there is scarce information on the systematization of their use in teaching activities and their assessments (Darbyshire and Baker 2012; Law et al. 2015; Hoffman et al. 2018; Cambra Badii and Baños 2020; Rueb et al. 2022a; Cambra-Badii et al. 2023).

With the change of the TV format to online platforms such as Netflix, HBO or Amazon Prime over the last 15 years (Lotz 2014, 2018; Lobato 2018; Neira et al. 2021), series are now the most-consumed type of audiovisuals. In particular, medical series like *Emergency Room* (1994–2009), *House MD* (2004–2012), *Grey's Anatomy* (2005-), and *The good doctor* (2017-) are one of the most successful formats since the beginning of TV series, and many health sciences students watch this shows every week (Czarny et al. 2008; Weaver and Wilson 2011; Williams et al. 2014; Cambra-Badii et al. 2021). There are only few reports using cinemeducation with medical series (Hoffman et al. 2018), and most of them analyzed its use in teaching professionalism, ethics and communication through student satisfaction surveys. None of them considered the teaching of patient safety.

Patient safety (PS) is a complex discipline aiming to prevent and reduce risks, errors and harm that occur to patients during provision of health care. A cornerstone of the discipline is continuous improvement based on learning from errors and adverse events (World Health Organization 2019). It is based on the premise that errors are unavoidable in health care as it is performed by human beings. Originally intended for air navigation, the concept of human error includes also prevention and error management (Donaldson et al. 2000). Besides, an adverse event can't be seen only as an individual error, and multiple factors should be analyzed (Reason 2000).

One of the most common used error analysis methods is the Ishikawa's diagram or Ishikawa's fishbone (Ishikawa and Loftus 1990). This diagram can help to determine the root causes of a problem in the case of an adverse event. Firstly, it is needed to identify and define the effect or the adverse event itself; then, to identify the main causes contributing to that effect; and lastly, to identify factors that may contribute to the main causes, adding factors and details while more factors are identified (Albrecht 2015).

Ensuring PS is one of the main goals in health sciences education. Early in their studies, students must become familiar with the basic concepts and terminology related to PS. This initiation should also help them appreciate the complexity on patient care, the importance of understanding and learning from medical errors, the management of clinical risk, and the relationship of PS with invasive procedures (World Health Organization 2009a; Bohomol et al. 2016), among other important clinical issues.

PS is a vital component of medical degree programs (World Health Organization 2009b). Aligned with various transversal competencies (abilities, attitudes and values) such as communication and teamwork, PS skills are often informally acquired through diverse teaching activities in the curriculum. In our Faculty of Medicine, PS is taught in specific courses.

Our curriculum extends beyond scientific knowledge, emphasizing the application of this knowledge in personalized and community-oriented medical care. The first two years of medical school focus on fundamental training, covering the structure and function of the human body (anatomy, physiology, and histology), as well as the principles of diagnostic and therapeutic procedures in human clinical practice. From the third year onward, students engage in clinical practice within the public healthcare system. The essential aspect emphasized from the first course is the humanistic and patient-centered nature of medical practice, that is, providing holistic care that considers the complete well-being of the individual instead of concentrating solely on treating the disease (Osler 1899). This is underscored by different methodologies starting in the first year, providing practical exposure two years before encountering the first real patient, including Problem-Based Learning (PBL) and simulation.

Classical teaching methods such as lectures, and innovative approaches such as simulation, are often used to address topics of PS (Argani et al. 2012; Schmidt et al. 2013; Arora et al. 2015; Escher et al. 2017). However, it can be challenging to develop and implement a curriculum for teaching PS in complex situations such as surgical scenarios (Salas et al. 2005; Nie et al. 2011; Bohomol et al. 2016; Kutaimy et al. 2018; Abbott et al. 2020). Learning about PS should also involve understanding of complex situations in hospital contexts (World Health Organization 2009a) that can be difficult to explain and recreate using only those teaching methods.

We aimed to assess the effect of cinemeducation in learning outcomes related to PS in medical students. The underlying hypothesis was that cinemeducation may improve students' learning about PS in complex situations.

Materials and methods

Study population. This prospective study aimed to use a qualitative perspective. In the research context, a qualitative perspective typically entails exploring data such as opinions or experiences, to gain a deeper understanding of a phenomenon,

even when using basic statistics for an initial approximation to the phenomenon (Groth, 2010).

The population consisted of 70 medical students recruited from the course "Foundations of Human Medicine" in the undergraduate medical program during the second semester of the second year.

Participants were informed of the background, aims, and procedures of the study, of the confidentiality of the study data, and of their right to decline to participate in or to drop out of the study at any time without fear of consequences. Participants were asked to give their consent to participate. The study was performed in accordance with the principles of the Declaration of Helsinki. Data confidentiality was ensured according to local laws on the protection of personal data.

Study design. We designed a study to analyze the improvement of students' learning about PS in the hospital environment using cinemeducation methodology.

We chose the episode "None the wiser" (episode 1 × 05) of the TV medical series *The Resident* because it is focused on adverse events during hospitalization and error managements, and provides a complex problem scenario that fits our teaching objectives. We selected different scenes (combined length, 30 min) according to their relevance to the teaching objectives about PS and surgical procedures (World Health Organization 2009a, 2009b) and omitted those related to the regular characters' dramatic backstory.

The episode's central story involves a patient who requires a scheduled surgical intervention to remove one testicle. The chief of surgery schedules him for surgery concurrently with operations on two other patients. When the patient is prepared for surgery in the operating room (OR), the intervention is interrupted because there is an emergency in another OR and no other doctor is available at that moment. Multiple factors concur at the same time: a surgical resident is forced to participate in the surgery even when he has just finished a 30-hour shift; a patient needs an emergency surgery because an aneurism suddenly ruptured, and another patient dies in the OR from an undetected bleeding disorder. When the surgery of the main patient restarts, the surgical resident refuses to identify him and removes the wrong testicle by error. Later, the chief of surgery deceptively apologizes with the patient for the mistake, and the surgical resident is confronted by her colleagues at a conference in the hospital.

The teaching activity. One week before to the teaching activity, students received a teaching guide containing all information to review the relevant literature of the topics and prepare for the activity.

The teaching activity occurred in March 2020 at our Faculty of Medicine, where the same instructors conducted the session for all students. The TV series clip was presented in English with Spanish subtitles, while classroom instruction and discussion were conducted in the local languages (Catalan and Spanish). To ensure that all students had understood the video clip, we conducted a *Timeline debriefing* immediately after its viewing. The discussion phase focused on adverse events and error management in the video clip. Students, guided by PS and cinemeducation experts, employed an Ishikawa diagram to identify factors contributing to the adverse event (Ishikawa and Loftus 1990). This diagram facilitated a root cause analysis, aiding students in interpreting these factors and analyzing the roles of medical doctors represented in the plot. All the proposed sequence by stages, time elapse, and objectives of the teaching activity for PS is shown in Table 1. The entire activity took about 2 h.

Study questionnaires. To assess students' pre- and post-activity knowledge, we developed a multiple-choice questionnaire with 10 questions on PS. Each question had four possible answers, of which only one was correct. The questions covered content aligned with the pedagogical objectives of the session, following the topics outlined in the WHO guide for teaching PS to medical students (World Health Organization 2009a): understanding human factors and their importance to PS; comprehending systems and the impact of complexity on patient care; learning from errors; managing clinical risk; and the relation between PS and invasive procedures.

Participating students filled out an identical questionnaire to evaluate their understanding of PS before (pre-activity assessment) and after (post-activity assessment) the instructional session. Additionally, they were required to answer to a 2-question open-essay post-test regarding the content of the video clip. They were asked about how the adverse event is addressed in the hospital portrayed in the series, whether the institutional response to the error can prevent its recurrence, and why. Additionally, students were prompted to suggest modifications in the hospital to prevent a similar incident, providing concrete examples illustrating these changes and linking them to Ishikawa factors.

The questionnaires were pre-tested with 5 members of our teaching and research team, along with 2 voluntary students from another class group. Suggestions for changes were incorporated into the questionnaire to ensure its comprehension.

Table 1 Sequence of development of the teaching activity.

Stage	Time (minutes)	Objectives
Introduction	10 min	To introduce learning objectives of the session, its development and limitations.
Pre intervention assessment	10 min	To assess students' previous knowledge and preparation by responding a 10 multiple choice questions (MCQ) test about PS in surgical procedures, management of clinical risk, and the care process, following WHO guidelines (World Health Organization 2009a). Each question had four answers, of which only one was correct.
Film viewing	30 min	To critically visualize the purposes of the episode fragment, focusing on error and PS.
Timeline debriefing	10 min	To center the aim of the discussion, a summary and a review of the relevant aspects of the plot was done.
Debate	40 min	To guide a root cause analysis by using Ishikawa diagram and to discuss the main topics related to PS.
Post intervention assessment	10 min	To assess students' subsequent knowledge by responding a 10 MCQ test (the same as before).
Qualitative questionnaire	10 min	To know the opinion of the students on the institutional response to the adverse event in *The Resident*: can it prevent from happening again, and why? Students were also required to give specific examples to illustrate these details and factors, and link them to the factors in the Ishikawa diagram.

Data analysis. To compare the results on the pre intervention and post intervention tests, we used the Wilcoxon signed-rank test analyzing the entire sample. All analyses were done with SPSS (SPSS Inc. SPSS for Windows, Version 15.0. Chicago, SPSS Inc.).

To analyze the open-essays questionnaires we followed an approach based on content analysis (Berelson 1952; Weber 1990). On one side, we systematically integrated, interpreted, and synthesized qualitative findings (Finfgeld-Connett 2014). We considered both content and formal aspects, and followed Bardin's key stages (Bardin 1996):

1. *Pre-analysis*, which involves developing the corpus through material selection, that is, student's answers to our questionnaire. We read all the responses from all the students multiple times to find recurrent aspects or topics.
2. *Encoding and categorization*, that is, entailing the transformation of raw data from the corpus. We coded the most recurrent aspects or topics, and we categorized, organizing, and classifying it, based on PS specific criteria and the WHO curriculum for medical students (World Health Organization 2009a; Slater et al. 2012; Bohomol et al. 2016; Cooper et al. 2019). We coded from the most general to the most specific aspects, named the categories, and we verified the coding with all students' responses.
3. *Interpretation*, highlighting the inferential process. We selected the most useful texts or fragments of student's responses to exemplify the analysis. Finally, we compared the information with the PS and pedagogical theoretical framework. We focused on subjects and contexts and emphasized variations within and between texts (Graneheim et al. 2017).

On the other hand, we used a quantitative description of the student's responses as "manifest content of communication" (Berelson 1952). This approach allowed the identification of elements in the texts that indicated similar or discrepant views. We identified correct and incorrect answers according to the pedagogical objectives (Rourke and Anderson 2004).

Validity and reliability in both stages were guaranteed by successive reviews by different researchers. Two researchers who had completed a content analysis research method course coded the students' responses. Coders received two training sessions specifically for this material. They independently read the responses, coded the first 10 responses together, discussed the initial code and categorization to ensure objectivity, and defined the final categories under the supervision of the first author.

Results

Study sample. All medical students enrolled in the program ($n = 70$) participated in the teaching activity; 51 (72.9%) students were women. 68 students (97.1%) completed the questionnaires.

Teaching activity evaluation. Regarding pre and post-intervention assessments, the mean score significantly higher after the intervention (9.24, SD = 0.88) when compared with baseline values (8.46, SD = 1.38); mean difference, 0.779 (95% CI: 0.475–1.083, $p < 0.001$).

Regarding open-essays questions, most students (84.3%) gave correct answers in the understanding about how hospital management of the adverse event in the TV series episode cannot prevent such an event from happening again because it was not centered on PS. These answers focused on understanding error as systemic, highlighting that the hospital management only sought to assign individual blame and that the error should be understood as systemic. Additionally, they emphasized that error is always systemic rather than attributable to random 'bad luck,'

and finally, underscored the need to prioritize PS over other concerns, such as economic profits.

No student wrote a completely incorrect answer. However, 8 students (11.7%) gave mixed responses including correct elements of PS and also incorrect ones (see Table 2).

The incorrect elements mainly revolve around the notion that the error is ultimately the responsibility of an individual (the boss) rather than the system, or that the error is the responsibility of a global system without specifying individual responsibilities. Lastly, there is the belief that errors are inevitable and therefore they can be repeated, whereas PS is primarily about understanding the cumulative impact of individual responsibilities that shape the overall system's response and, precisely, the need to prevent errors.

On the other hand, 35.7% of the responses mention that the institution should have analyzed the error and taken different measures, for example:

- ".. if, in this meeting that was held to talk about what happened, they had observed the critical points where there was an error and proposed options for improvement, the chances of it happening again would decrease" (Answer #14)
- "… in this case, a committee should be convened to analyze the errors and look for strategies to prevent their recurrence. Institutions should understand that mistakes are not bad as long as we take action and learn from them" (Answer #29)

In relation to the question about what could be changed to prevent the adverse event from recurring, 100% of the students identified specific examples from the TV series episode and 30.9% linked these aspects to factors in the Ishikawa diagram. Narrative aspects of the episode were mentioned 263 times in the answers, mentioning plot details, character names, and dialogue lines indicating responsibilities regarding the adverse event and elements of PS.

The students specifically focused on the resident who had been on call for an extended period, performing surgery (8.74%), the need to ensure an adequate number of healthcare workers (7.60%), and the caution against residents conducting unsupervised surgery (3.80%). In terms of surgical procedures, they emphasized the significance of using a checklist for control before beginning surgical procedure (12.92%) and the availability of appropriate resource materials (2.66%).

The Ishikawa factors were mentioned by students 251 times, regarding: communication issues (7.8%), team factors (7.1%), working conditions (4.7%), training and coaching factors (3.8%), labor factors (3.8%), organizational factors (2.1%), and individual factors modified to prevent the adverse event (1.4%). In all cases, these factors were linked to the idea that they could be changed to prevent the adverse event.

Discussion

Some scientific studies have analyzed the effect of cinemeducation on learning of medical students (Goodman 2007; Lumlertgul et al. 2009; Darbyshire and Baker 2012; Wilson et al. 2013; Law et al. 2015; Klemenc-Ketiš and Švab 2017; Hoffman et al. 2018; Rueb et al. 2022b), but the majority of them assessed student's satisfaction with the teaching activity, and none of them was about PS.

Given the complexity of the concepts related to PS, such as the identification of an adverse event, the wrong site of surgery, its conceptualization as a system error and not as an individual one, and the importance of taking actions to prevent its recurrence rather than punishing individuals involved, we considered it necessary to plan a specific teaching activity and analyze its

Table 2 Qualitative analysis of the answers on the open-essay questionnaire.

	Statements on the questionnaire	Examples of comments highlighting the most representative ideas
Correct responses	The hospital management only sought to assign individual blame, without analyzing the systemic error	"… because they were looking for a culprit of the situation to be judged individually instead of analyzing it as an error of the system" (Answer #5)
		"… because **they are trying to find a person to blame**. In such cases, this attitude should not be considered a solution as grief and guilt are useless" (Answer #13)
	The hospital used excuses related to chance or bad luck, so the error is considered random	"No, since culprits are sought and **the adverse event is attributed to bad luck**. This way, no possible system errors are identified that should be rectified to prevent it from happening again" (Answer #26)
		"**The chief of surgery only said that it was because of bad luck, Murphy's law** and that surely his resident was not prepared enough (like blaming her), when in fact except for the death of the patient due to a clotting problem, it could have been avoided" (Answer #34)
	The hospital prioritized profits over patient safety	"I consider that the institutional response is inadequate since **they tried to minimize the economic damage of the hospital** in the face of possible patient lawsuits" (Answer #51)
		"**The answer they give focuses more on not having legal problems and above all revolves around money**. Taking into account that probably an important factor in what happened is the hospital's desire to earn money, it seems to me that nothing is solved" (Answer #69)
Mixed responses with elements of PS and contradictions in the comments	Indicating that the responsibility is ultimately the team's chief, and not the team	"…yes, **it can be prevented by taking measures to improve the system**. Analyzing the mistakes made at the team level and also at the individual level, **especially the chief of surgery, who in the end is the one who is responsible for the residents and who is in charge of making these surgeons competent enough to carry out a successful risk prevention plan**. Unfortunately, in the series, senior doctors prioritize financial gains over public health, and simply apologize for the mistake in the face of the possibility of a negligence suit" (Answer #25)
	Indicating that, since the error is inherent in the system, the chances of making the same mistake again are the same as before the adverse event.	"No, because the human factor is involved in the adverse effects, that is, even though the resident could be expelled, **there will always be exactly the same chances that another person will commit such an erroneous act**" (Answer #21)
	Indicating that the problem is "the system" as a generality without specifying which issues of the system need to be addressed.	"… In reality, knowing who the culprit is would not solve the problem, since (as said in the classroom) replacing that person would not automatically solve the problem. This means that, on the contrary, there really is a set of culprits: the situations that have led to this outcome. **The problem here is really the system, not the doctor or the director of surgery or anyone in particular**" (Answer #3)

impact qualitatively and quantitatively. Thereby, we carried out and assessed an educational experience using cinemeducation methodology for teaching PS.

Our results showed that the teaching activity was effective in improving students' understanding of strategies for PS. The high scores in the pre-intervention assessment might have been due to students' preparation for the activity, as students were provided with a learning guide with recommendations and suggested readings prior to the session. Given the difficulties involved in assessing learning about PS in complex scenarios, we devised an additional two-question open-essay test to better understand students' experiences. The first question aimed to collect information about students' learning about the institutional response to the adverse event in the sequence. Most students answered this question correctly. Students consistently mentioned that blaming

an individual, making excuses involving chance, and prioritizing profits were inadequate reactions to the adverse event.

Another very interesting finding emerged. Some students' responses mixed elements showing a correct understanding of concepts related to PS with others showing that they had not fully understood these concepts, such as suggesting that an individual subject should be in charge of the whole process, the vague idea that adverse events will be always inevitable, and the lack of responsibilities when the system as a whole is the problem. These "mixed" responses could reflect progress in learning, showing that, although these students had incorporated basic notions of PS and applied them critically to the plot in the episode, some of their previous misconceptions persisted. These findings underline the importance of reinforcing this initial experience with new practical activities and theoretical readings and that teaching PS

should be a multidisciplinary endeavor, from conception to implementation (Armitage et al. 2011).

The second question on the qualitative assessment aimed to articulate the elements of the narrative that could be changed to prevent the adverse event, linking them with the Ishikawa diagram. Our findings indicate that this question was more difficult to manage than the first one. The most frequently identified elements were related to the team, including communication among team members and the organizational structure of the team (the approach to surgery and the surgical procedure, as well as working conditions). Similarly, the Ishikawa factors that students mentioned most often were communication and team factors. Interestingly, many students noted aspects that were directly related to the characters of the surgical residents in the series, and these aspects were connected to the working conditions. Given that movies and TV series foster students' emotional engagement and identification with characters (Volandes 2007; Cambra Badii and Baños 2020), it seems reasonable to assume that students would identify themselves with the residents, who are in a position that they hope to be in when they begin their professional life.

The fact that students can identify themselves with the TV series main protagonists has two fundamental implications. On one side, they can feeling empathy for patients, relatives and healthcare workers (Blasco et al. 2010; McConnell and Eva 2022); on the other hand, this emotional implication is achieved without the need to burden themselves with clinical responsibility, which they still don't have when they are second-year medical students (Oh et al. 2012).

In cinemeducation, choosing appropriate material is as important as defining the learning objectives –and for this reason, it is important to include specialists from cinemeducation and PS in the teaching team. The choice of an American series, which shows a health system very different from ours, might have confused some students, who found it difficult to understand financial barriers to accessing care; however, these issues were dealt with in the group discussion.

The complexity of the situations in hospital practice portrayed in the television series requires the teacher's guidance. Guided discussion can encourage constructive interchange between teachers and students (Ramani et al. 2019) that can improve

students' understanding. These improvements are reflected in students' performance on the open-essay test. Teachers need a list of educational objectives and items to be completed, and it is crucial to actively and rigorously plan the viewing activity and the following discussion (Cambra Badii and Baños 2020).

In this regard, it can be helpful to work with Bloom's taxonomy for learning objectives (Bloom 1956). Using Bloom's taxonomy encourages teachers to think about learning objectives in behavioral terms (Bloom et al. 2001; Adams 2015).

The effectiveness of the activity and resulting gains in knowledge can be assessed at several levels, from the description of the most basic concepts in PS (level 1) to the top of the pyramid, which entails an understanding of how to prevent an adverse event by making decisions from an organizational perspective (level 5). The teaching guide helped students to complete levels 1 and 2, which were assessed through the multiple-choice questionnaire, and viewing the audiovisual material and discussing helped them progress through levels 3, 4, and 5, which, together with the previous two levels, were assessed in the open-essay questions (Fig. 1).

To improve and enhance learning in future applications, the activity can be expanded to reach level 6, which involves applying decision-making skills in other, specific situations. However, it would probably be too ambitious to expect to incorporate this level of complexity in which students would have to find new solutions in new situations into an initial two-hour activity especially considering that this group of students was from a pre-clinical course.

Regarding the assessment of the effectiveness of the training, it could be beneficial to analyze it in the context of Kirkpatrick's evaluation framework (Kirkpatrick and Craig 1970; Kirkpatrick and Kirkpatrick 2006). Some previous studies proposed that the Kirkpatrick model is especially well-suited for implementation in higher education and healthcare training initiatives, including PS (Slater et al. 2012), and also used this evaluation method for the measurement of the impact of training in a cinemeducation experience (Lumlertgul et al. 2009; Law et al. 2015).

Kirkpatrick's evaluation structure includes four levels: reaction, learning, behavior, and results. The initial level, known as reaction, typically entails participants completing a post-course survey reflecting their impressions of the program. This evaluation
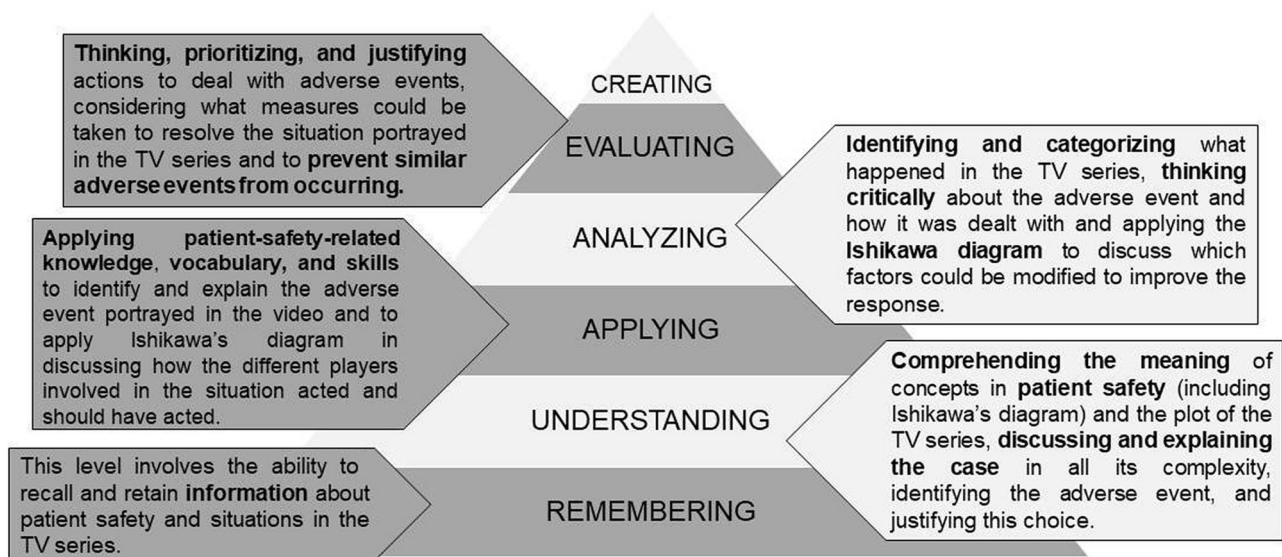
Fig. 1 Bloom's taxonomy of learning objectives applied to our experience. This figure illustrates the application of Bloom's taxonomy of learning objectives to our experience. Each panel represents a different level of learning, as defined by Bloom's taxonomy (remembering, understanding, applying, analyzing, evaluating, and creating), with the outcomes observed in our study filled in for each level.

doesn't measure the acquired knowledge but assesses the participants' interest, motivation, and attention levels. Since most prior research on cinemeducation (Darbyshire and Baker 2012; Law et al. 2015) assesses satisfaction rather than knowledge, and health science students commonly exhibit a positive disposition towards these innovative activities (Nicolaides 2012; Kowitlawakul et al. 2022), we decided to proceed directly to the second level. This level, learning, involves assessing participants' knowledge or skills acquired during the training (Smidt et al. 2009), encompassing not only the analysis of pre-post test knowledge but also the qualitative integration of responses and learning approaches pertinent to SP.

Previous studies pointed out that these experiences leave lasting educational impressions and serve as pathways to cultivate attitudes that shape behavior (Blasco et al. 2005, 2018). However, the evaluation of the third and fourth levels of Kirkpatrick's model typically involves an in-depth, long-term assessment, measuring how the acquisition of knowledge and skills translates into behavioral changes (clinical application) and, consequently, leads to improved outcomes in patient care (Smidt et al. 2009). The third level, focusing on behavior evaluation, entails assessing participants' capacity to apply their newly acquired knowledge or skills in their workplace; meanwhile, the fourth level, results, gauges the overall impact of the training. As second-year medical students have not yet participated in clinical practices in real environments, they can only showcase their knowledge through role-playing scenarios.

Regarding the limitations of our study, our analysis was limited to immediate gains in knowledge; further investigations will also assess long-term gains. Furthermore, the high baseline scores in the pre-intervention assessment suggest the possible need for a more complex instrument (Rourke and Anderson 2004). However, this aspect connects with one of the strengths of our study: the qualitative analysis of student's responses regarding PS learning, and not only a pre-post test.

Future research could use another movie or another TV series episode to work about PS, or comparing cinemeducation with other methodologies, like simulation (Arora et al. 2015; Escher et al. 2017), gamification (Backhouse and Malik 2019), or animated videos developed to accompany audio recordings of junior doctors describing their experiences of a serious incident or near-miss event (Cooper et al. 2019). However, as we pointed out, specific and complex scenarios can be difficult to replicate, and TV series offers a good opportunity to work with. This approach can easily be reproduced in other universities and studies, and the full value of the activity can be established after further validation in future studies.

Conclusions

The teaching activity described here performed cinemeducation methodology to enhance learning about PS. Students showed significant gains in knowledge. A high percentage of the students managed to interpret a wrong-site surgery as a complex situation, an adverse event as a system error, and the management of the adverse event as an institutional problem. By analyzing the situation and putting these concepts in other contexts, they progressed through five of the six levels of Bloom's taxonomy of learning objectives. This approach can easily be reproduced in other universities and studies.

The integration of cinematic narratives and visual storytelling techniques into medical education offers a multifaceted approach to enhance students' understanding of complex situations and the interplay between each team member's behaviors, which collectively influences patient outcomes. Cinemeducation encourages critical thinking by inviting learners to analyze complex scenarios

from different perspectives, fostering a holistic approach to patient care. This discourse further highlights how cinemeducation stimulates introspection among future healthcare professionals, prompting them to explore their own values, biases, and emotional responses. Since medical practice is inherently intertwined with the human condition, embracing cinemeducation as a pedagogical tool has the potential to cultivate well-rounded, compassionate, and socially conscious physicians capable of navigating the intricacies of healthcare with heightened humanistic insight.

Data availability

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

References

Abbott JF, Pradhan A, Buery-Joyner S et al. (2020) To the point: integrating patient safety education into the obstetrics and gynecology undergraduate curriculum. J. Patient Saf. 16:e39–e45. https://doi.org/10.1097/PTS.0000000000000250

Aboul-Fotouh F, Ali MD, Asghar-Ali A (2010) Therapy 101: A Psychotherapy Curriculum for Medical Students

Adams NE (2015) Bloom's taxonomy of cognitive learning objectives. J. Med Libr Assoc. 103:152–153. https://doi.org/10.3163/1536-5050.103.3.010

Albrecht RM (2015) Patient safety: the what, how, and when. Am. J. Surg. 210:978–982. https://doi.org/10.1016/j.amjsurg.2015.09.003

Alexander M (2012) Let's look at the data: a review of the literature. In Cinemeducation: Using Film and Other Visual Media in Graduate and Medical Education. Oxford: Radcliffe Publishing, Oxford 2:3–9

Alexander M, Lenahan P, Pavlov A et al. (2005) Cinemeducation: Using Film and Other Visual Media in Graduate and Medical Education. Oxford: Radcliffe Publishing, Oxford

Arawi T (2010) Using medical drama to teach biomedical ethics to medical students. Med Teach 32:. https://doi.org/10.3109/01421591003697457

Argani CH, Eichelberger M, Deering S, Satin AJ (2012) The case for simulation as part of a comprehensive patient safety program. Am. J. Obstet. Gynecol. 206:451–455. https://doi.org/10.1016/j.ajog.2011.09.012

Armitage G, Cracknell A, Forrest K, Sandars J (2011) Twelve tips for implementing a patient safety curriculum in an undergraduate programme in medicine. Med Teach. 33:535–540. https://doi.org/10.3109/0142159X.2010.546449

Arora S, Hull L, Fitzpatrick M et al. (2015) Crisis Management on Surgical Wards: A Simulation-based Approach to Enhancing Technical, Teamwork, and Patient Interaction Skills. Ann Surg 261:

Backhouse A, Malik M (2019) Escape into patient safety: bringing human factors to life for medical students. BMJ Open Qual. 8:e000548. https://doi.org/10.1136/bmjoq-2018-000548

Baños JE, Lucena MI, Farré M et al. (2019) The usefulness of TV medical dramas for teaching clinical pharmacology: A content analysis of House, M.D. Educacion Med. 20:295–303. https://doi.org/10.1016/j.edumed.2018.07.011

Bardin L (1996) Análisis de contenido (César Suárez, trad.). Madrid: Ed Akal

Berelson B (1952) Content analysis in communication research. Free press, Glencoe

Blasco P, Roncoletta AFT, Moreto G et al. (2005) Family medicine and cinema: a humanist resource for educating affectivity? Aten. Primaria 36:566–572. https://doi.org/10.1016/s0212-6567(05)70568-0

Blasco PG, Mônaco CF, De Benedetto MAC et al. (2010) Teaching through movies in a multicultural scenario: Overcoming cultural barriers through emotions and reflection. Fam. Med 42:22–24

Blasco PG, Moreto G, Pessini L (2018) Using Movie Clips to Promote Reflective Practice: a Creative Approach for Teaching Ethics. Asian Bioeth. Rev. 10:75–85. https://doi.org/10.1007/s41649-018-0046-z

Bloom BS (1956) Taxonomy of educational objectives: the classification of educational goals. Longmans Green, New York

Bloom BS, Airasian P, Cruikshank K et al. (2001) A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. Longman, New York

Bohomol E, Freitas MAdeO, Cunha ICKO (2016) Patient safety teaching in undergraduate health programs: Reflections on knowledge and practice. Interface.: Commun., Health, Educ. 20:727–741. https://doi.org/10.1590/1807-57622015.0699

Cambra Badii I, Baños JE (2020) The university goes to the movies: our experience using feature films and TV series in teaching health sciences students. In: Kim S (ed) Medical Schools: Past, Present and Future Perspectives. Nova Publishers, New York, pp 105–148

Cambra-Badii I, Francés MdeL, Videla S et al. (2020) Cinemeducation in clinical pharmacology: using cinema to help students learn about pharmacovigilance and adverse drug reactions. Eur. J. Clin. Pharm. 76:1653–1658. https://doi.org/10.1007/s00228-020-02985-y

Cambra-Badii I, González-Caminal G, Gomar-Sancho C et al. (2023) The Value of Cinemeducation in Health Sciences Education. In: Varsou O (ed.) Teaching, Research, Innovation and Public Engagement. Springer, pp 29–40

Cambra-Badii I, Moyano E, Ortega I et al. (2021) TV medical dramas: health sciences students ' viewing habits and potential for teaching issues related to bioethics and professionalism. BMC Med Educ. 7:1–11. https://doi.org/10.1186/s12909-021-02947-7

Cooper K, Hatfield E, Yeomans J (2019) Animated stories of medical error as a means of teaching undergraduates patient safety: an evaluation study. Perspect. Med Educ. 8:118–122. https://doi.org/10.1007/s40037-019-0498-1

Czarny MJ, Faden RR, Nolan MT et al. (2008) Medical and nursing students' television viewing habits: Potential implications for bioethics. Am. J. Bioeth. 8:1–8. https://doi.org/10.1080/15265160802559153

Czarny MJ, Faden RR, Sugarman J (2010) Bioethics and professionalism in popular television medical dramas. J. Med Ethics 36:203–206. https://doi.org/10.1136/jme.2009.033621

Darbyshire D, Baker P (2012) A systematic review and thematic analysis of cinema in medical education. Med Humanit 38:28–33. https://doi.org/10.1136/medhum-2011-010026

Donaldson MS, Corrigan JM, Kohn LT (2000) To err is human: building a safer health system. National Academies Press, Washington

Escher C, Creutzfeldt J, Meurling L et al. (2017) Medical students ' situational motivation to participate in simulation based team training is predicted by attitudes to patient safety. BMC Med Educ. 17:1–7. https://doi.org/10.1186/s12909-017-0876-5

Farré M, Bosch F, Roset PN, Baños JE (2004) Putting Clinical Pharmacology in Context: The Use of Popular Movies. J. Clin. Pharm. 44:30–36

Finfgeld-Connett D (2014) Use of content analysis to conduct knowledge-building and theory-generating qualitative systematic reviews. Qualitative Res. 14:341–352. https://doi.org/10.1177/1468794113481790

Goodman K (2007) Imagining Doctors: Medical Students and the TV Medical Drama. AMA J. Ethics 9:182–187. https://doi.org/10.1001/virtualmentor.2007.9.3.medu1-0703

Graneheim UH, Lindgren B-M, Lundman B (2017) Methodological challenges in qualitative content analysis: A discussion paper. Nurse Educ. Today 56:29–34. https://doi.org/10.1016/j.nedt.2017.06.002

Groth RE (2010) Situating qualitative modes of inquiry within the discipline of statistics education research. https://doi.org/10.52041/serj.v9i2.372

Hoffman BL, Hoffman R, Wessel CB et al. (2018) Use of fictional medical television in health sciences education: a systematic review. Adv. Health Sci. Educ. 23:201–216

Ishikawa K, Loftus JH (1990) Introduction to quality control. Springer

Jerrentrup A, Mueller T, Glowalla U et al. (2018) Teaching medicine with the help of "Dr. House." PLoS One 13:. https://doi.org/10.1371/journal.pone.0193972

Jonathan K (2023) Teaching Note—Using Cinemeducation in Teaching Practice Readiness in Social Work Education. J Soc Work Educ

Kirkpatrick DL, Craig RL (1970) Evaluation of Training. In: Craig RL, Bittel LR (eds.) McGraw-Hill, New York

Kirkpatrick DL, Kirkpatrick JD (2006) Evaluating training programs: The four levels. Berrett-Koehler Publishers, Oakland

Klemenc-Ketis Z, Kersnik J (2011) Using movies to teach professionalism to medical students. BMC Med Educ 11:. https://doi.org/10.1186/1472-6920-11-60

Klemenc-Ketiš ZK, Švab I (2017) Using movies in family medicine teaching: a reference to EURACT educational agenda. Slovenian J. Public Health 56:99–106

Kowitlawakul Y, Tan JJM, Suebnukarn S et al. (2022) Utilizing educational technology in enhancing undergraduate nursing students' engagement and motivation: A scoping review. J. Professional Nurs. 42:262–275. https://doi.org/10.1016/J.PROFNURS.2022.07.015

Kuhnigk O, Schreiner J, Reimer J et al. (2012) Cinemeducation in psychiatry: a seminar in undergraduate medical education combining a movie, lecture, and patient interview. Acad. Psychiatry 36:205–210. https://doi.org/10.1176/appi.ap.10070106

Kutaimy R, Zhang L, Blok D et al. (2018) Integrating patient safety education into early medical education utilizing cadaver, sponges, and an inter-professional team. BMC Med Educ. 18:215. https://doi.org/10.1186/s12909-018-1325-9

Law M, Kwong W, Friesen F et al. (2015) The current landscape of television and movies in medical education. Perspect. Med Educ. 4:218–224

Lenahan P, Shapiro J (2005) Facilitating the emotional education of medical students: using literature and film in training about intimate partner violence. 37:543–545

Lobato R (2018) Rethinking International TV Flows Research in the Age of Netflix. Television N. Media 19:241–256. https://doi.org/10.1177/1527476417708245

Lotz AD (2014) The television will be revolutionized. NYU Press, New York

Lotz AD (2018) We now disrupt this broadcast: How cable transformed television and the internet revolutionized it all. MIT press, Cambridge

Lumlertgul N, Kijpaisalratana N, Pityaratstian N, Wangsaturaka D (2009) Cinemeducation: A pilot student project using movies to help students learn medical professionalism. Med Teach 31. https://doi.org/10.1080/01421590802637941

Mandel J (1983) Medical education about human sexuality: the impact of film in the workshop setting. Med Educ. 17:305–310. https://doi.org/10.1111/j.1365-2923.1983.tb00963.x

McConnell M, Eva KW (2022) Emotions and learning: cognitive theoretical and methodological approaches to studying the influence of emotions on learning. In: Researching Medical Education. pp 279–290

McNeilly DP, Steven Wengel PP (2001) New Idea The "ER" Seminar Teaching Psychotherapeutic Techniques to Medical Students

Michel Fariña JJ (2009) A model for teaching bioethics and human rights through cinema and popular TV series: a methodological approach. Couns. Psychol. Q 22:105–117. https://doi.org/10.1080/09515070902853946

Neira E, Clares-Gavilán J, Sánchez-Navarro J (2021) New audience dimensions in streaming platforms: The second life of money heist on netflix as a case study. Profesional de. la Inf. 30:1–17. https://doi.org/10.3145/epi.2021.ene.13

Nicolaides A (2012) Innovative teaching and learning methodologies for higher education Institutions

Nie Y, Li L, Duan Y et al. (2011) Patient safety education for undergraduate medical students: a systematic review. BMC Med Educ. 11:33. https://doi.org/10.1186/1472-6920-11-33

Oh J, Kang J, De Gagne JC (2012) Learning concepts of cinenurducation: An integrative review. Nurse Educ. Today 32:914–919. https://doi.org/10.1016/j.nedt.2012.03.021

Osler W (1899) Address. Albany Med. Ann. 20:308

Østbye T, Miller B, Keller H (1997) Throw that epidemiologist out of the Emergency Room! Using the television series ER as a vehicle for teaching methodologists about medical issues. Clin. Epidemiol. 50:1183–1186

Ozcakir A, Bilgel N (2014) Educating medical students about the personal meaning of terminal illness using the film "Wit. J. Palliat. Med 17:913–917. https://doi.org/10.1089/jpm.2013.0462

Patel PP, Gandhi AM, Desai CK (2022) Cinemeducation: a teaching-learning tool to teach professionalism and ethics in medical undergraduates. Int J. Basic Clin. Pharm. 11:91. https://doi.org/10.18203/2319-2003.ijbcp20220405

Pavlov A, Dahlquist GE (2010a) Teaching communication and professionalism using a popular medical drama. Fam. Med 42:25–27

Pavlov A, Dahlquist GE (2010b) Teaching communication and professionalism using a popular medical drama. Fam. Med 42:25–32

Pereira Rates CM, Maciel Silva L, Moura Pereira L, Reis Pessalacia JD (2014) The use of films as a teaching tool for the teaching-learning process in bioethics. Invest Educ. Enferm. 32:421–429. https://doi.org/10.1590/S0120-53072014000300007

Pérez J, Aramburu J, Baños JE et al. (2014) The use of popular movies in the teaching of health sciences students. A multidisciplinary experience

Picanço TSdaC, Nazima MTST, Santos BEFdos et al. (2019) Films as an Educational Resource in the Teaching of Humanistic Attitudes to Medicine Students. Rev. Bras. Educ. Med 43:57–68. https://doi.org/10.1590/1981-5271v43suplemento1-20180164.ing

Quadrelli S, Colt HG, Semeniuk G (2009) Appreciation of the aesthetic: a new dimension for a medicine and movies program. Fam. Med 41:316–324

Ramani S, Könings KD, Ginsburg S, van der Vleuten CPM (2019) Meaningful feedback through a sociocultural lens. Med Teach. 41:1342–1352. https://doi.org/10.1080/0142159X.2019.1656804

Reason J (2000) Human error: models and management. BMJ 320:768–770. https://doi.org/10.1136/bmj.320.7237.768

Retamero C, Walsh L, Otero-Perez G (2014) Use of the film the bridge to augment the suicide curriculum in undergraduate medical education. Academic Psychiatry 38:605–610. https://doi.org/10.1007/s40596-014-0086-y

Rourke L, Anderson T (2004) Validity in quantitative content analysis. Educ. Technol. Res. Dev. 52:5–18. https://doi.org/10.1007/BF02504769

Rueb M, Siebeck M, Rehfuess EA, Pfadenhauer LM (2022a) Cinemeducation in medicine: a mixed methods study on students' motivations and benefits. BMC Med Educ 22:. https://doi.org/10.1186/s12909-022-03240-x

Rueb M, Siebeck M, Rehfuess EA, Pfadenhauer LM (2022b) Cinemeducation in medicine: a mixed methods study on students' motivations and benefits. BMC Med Educ. 22:1–19. https://doi.org/10.1186/s12909-022-03240-x

Salas E, Wilson KA, Burke CS, Priest HA (2005) Using Simulation-Based Training to Improve Patient Safety: What Does It Take? Jt. Comm. J. Qual. Patient Saf. 31:363–371. https://doi.org/10.1016/S1553-7250(05)31049-X

Schmidt E, Goldhaber-Fiebert SN, Ho LA, McDonald KM (2013) Simulation Exercises as a Patient Safety Strategy. Ann. Intern Med 158:426–432. https://doi.org/10.7326/0003-4819-158-5-201303051-00010

Shankar PR (2019) Cinemeducation: Facilitating educational sessions for medical students using the power of movies. Arch. Med. Health Sci. 7:96. https://doi.org/10.4103/amhs.amhs_30_19

Shevell AH, Thomas A, Fuks A (2015a) Teaching professionalism to first year medical students using video clips. Med Teach. 37:935–942. https://doi.org/10.3109/0142159X.2014.970620

Shevell AH, Thomas A, Fuks A (2015b) Teaching professionalism to first year medical students using video clips. Med Teach. 37:935–942. https://doi.org/10.3109/0142159X.2014.970620

Slater BL, Lawton R, Armitage G et al. (2012) Training and action for patient safety: Embedding interprofessional education for patient safety within an improvement methodology. J. Continuing Educ. Health Prof. 32:80–89. https://doi.org/10.1002/chp.21130

Smidt A, Balandin S, Sigafoos J, Reed VA (2009) The Kirkpatrick model: A useful tool for evaluating training outcomes. J. Intellect. Dev. Disabil. 34:266–274. https://doi.org/10.1080/13668250903093125

Soni RK, Kumar A, Singh Meena M, Enugala S (2023) Cinemeducation: An auxiliary tool to traditional teaching learning methods for teaching Forensic Medicine to undergraduates. Future Med. Educ. J. 13:14–19

Volandes A (2007) Medical ethics on film: Towards a reconstruction of the teaching of healthcare professionals. J. Med Ethics 33:678–680. https://doi.org/10.1136/jme.2006.017665

Walter G, McDonald A, Rey JM, Rosen A (2002) Medical student knowledge and attitudes regarding ECT prior to and after viewing ECT scenes from movies. J. ECT 18:43–46

Weaver R, Wilson I (2011) Australian medical students' perceptions of professionalism and ethics in medical television programs. BMC Med Educ. 11:7–12. https://doi.org/10.1186/1472-6920-11-50

Weber RP (1990) Basic content analysis. Sage

Welsh CJ (2003) OD's and DT's: Using Movies to Teach Intoxication and Withdrawal Syndromes to Medical Students

Williams DJ, Re D, Ozakinci G (2014) Television viewing habits of preclinical UK medical undergraduates: Further potential implications for bioethics. AJOB Empir. Bioeth. 5:55–67. https://doi.org/10.1080/21507716.2013.826297

Williams R, Evans L, Alshareef NT (2015) Using TV dramas in medical education. Educ. Prim. Care 26:48–49. https://doi.org/10.1080/14739879.2015.11494308

Wilson AH, Blake BJ, Taylor GA, Hannings G (2013) Cinemeducation: Teaching family assessment skills using full-length movies. Public Health Nurs. 30:239–245. https://doi.org/10.1111/phn.12025

Wong RY, Saber SS, Ma I, Roberts JM (2009) Using television shows to teach communication skills in internal medicine residency. BMC Med Educ 9:. https://doi.org/10.1186/1472-6920-9-9

World Health Organization (2019) Patient safety. Global action on patient safety. Geneva

World Health Organization (2009a) WHO Patient Safety Curriculum Guide for Medical Schools. Geneva

World Health Organization (2009b) WHO guidelines for safe surgery 2009: safe surgery saves lives. Geneva

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Competing interests

The authors declare no competing interests.

Ethical approval

The study was carried out in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments, the General Regulation (EU) 2016/679, of April 27, and the Spanish Organic Law 3/2018, of December 5, on the protection of personal data and guarantee of digital rights. Ethical approval was obtained from the institutional Ethics Committee.

Informed consent

Participation was voluntary and anonymous, and each participant was informed about the objectives of the project and the option to abandon the study at any time. Informed consent was obtained from all the participants.

Additional information

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