Archives of Surgical Research| Narrative Literature Review

Exploring Operating Room-Based Student Learning Experience: Perils & Pitfalls? A Narrative Literature Review

Talat Waseem; Hadia Munir Baig; Rahila Yasmeen; Rehan Ahmad Khan

IMPORTANCE Operating Room (OR) is a high-pressure setting where multiple complex surgical, educational, and administrative facets interplay. While considered an essential aspect of the undergraduate curriculum and a valuable tool for cultivating an unparalleled interest and enthusiasm in the young minds of medical students, the real-life experience of the operating theatre can pose a number of challenges to be dealt with. OR-based student learning has traditionally been suboptimal owing to many reasons. Exploring such perils and pitfalls remains a high research priority in order to design structured clinical encounters within the OR setting in future.

METHODS A literature search was done through PubMed, ERIC, and Google Scholar. Keywords used were "operating room", OR "operating theater", AND "student learning" OR "medical students". Following PRISMA guidelines, 1580 articles were identified, out of which 68 pertinent articles were initially selected for the literature review, and 52 articles were used for thematic analysis. The article evidence was thoroughly evaluated and analyzed, and various themes were identified.

DISCUSSION Operating theater-based student learning is influenced by a number of factors that likely include organizational, socio-environmental, and emotional factors and factors related to educational relevance and surgical educator. Conflicting roles of medical educators in this setting, their availability to students, confused learning objectives, the theatre environment, poor visibility of the procedure, and various emotional aspects of medical students are amongst other reasons. Although a number of studies have individually examined the role of various factors in 'OR' based student learning, their relative importance and influence remain partially explored. Moreover, the quality of evidence to substantiate these aspects still remains contextual with low external validity and generalizability.

CONCLUSION& RELEVANCE The reasons of suboptimal student learning within OR setting are multifactorial. In depth analysis of these factors influencing OR-based student learning remains a high research priority in order to design future structured clinical encounters within OR for a more meaningful and enriched learning experience.

KEYWORDS Learning experience; Operating Room; Operation Theater; Student Learning;

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Surgical training being the most important part of the medical school curriculum, has remained a traditional focus of attention [1–5]. Operating room is the most versatile and unique learning environment that focuses almost all of the learning forms, such as spatial, aural, verbal, physical, logical, interpersonal, and intrapersonal[7]. The Operating Room (OR) offers students an opportunity to experience real-life cases that they once only used to read in textbooks. Most importantly, this setting enhances the learning experience, promotes independent thinking and learning, and facilitates retaining clinical knowledge for improved exam performance. Student learning in OR not only provides undergraduates with exposure to working with real patients but also enables them to adapt to the challenges and stressors related to OR[6]. Moreover, the surgeon's responsibility additionally transforms into an educator and leader in the OR, which requires significant organizational skills and professional expertise[5].

Operation theater-based student learning is influenced by a number of factors that likely include organizational, socio-environmental, and emotional factors apart from factors related to educational relevance and surgical educator[8]. Although a number of studies have individually examined the role of various factors in OR-based student learning, their relative importance and influence remain partially explored1. Moreover, the quality of evidence to substantiate these aspects still remains contextual with low external validity and generalizability[9]. Similarly, the students' and faculty's perspectives regarding these factors are still relatively unexplored.

Identification and analysis of the factors influencing OR-based student learning remains a high research priority in order to design future structured clinical encounters within the OR for a more meaningful and enriched learning experience[4].

METHODS

In order to review the literature, a narrative approach was used to have a comprehensive, critical, and objective analysis of the data available related to the factors affecting student learning experience in the operating room.

2.1. Literature Search Process

Following PRISMA guidelines, literature search strategies were formulated for the databases (PubMed, ERIC, and Google Scholar) using search terms "operating room", 'operation theater", "medical students", "learning". A review of all search papers was conducted according to the selected search strategy from 1990-2020. Additionally, the reference research papers were also included for a comprehensive literature review.

2.2. Inclusion of Articles

1580 papers were identified in the literature search, 342 were excluded for duplication, and 1238 articles were assessed for pertinence. 68 articles were initially selected for review, of which 52 were included in the literature review. Only Full-text English language papers were selected. Studies that were not related to the topic were not included. The critical analysis of the searched literature was done using Harden's framework. The article selection process is presented in a flow diagram in Figure 1.

2.3. Data Synthesis and Analysis

The data was analyzed by thematic analysis of each paper's results. The outcomes of each paper were physically coded. Those codes were categorized as themes. The findings of all the papers were recorded according to categorized themes. The intermittent themes identified through data analysis are described in the table below.

DISCUSSION

Operating room learning is an important phase in medical students' training; however, it still remains unstructured[4, 5, 10]. Students learn surgical skills, real case pathologies, and techniques to manage the patients. The medical students' learning in the OR is affected adversely by several factors in which organizational, educational, and emotional factors are included[4,5]. Lack of clarity regarding learning objectives, lack of basic introductory sessions on OR etiquettes, syncope, a biased attitude of the faculty, poor teaching strategies, anxiety, fear, lack of motivation are some of the factors frequently reported by medical students[4].

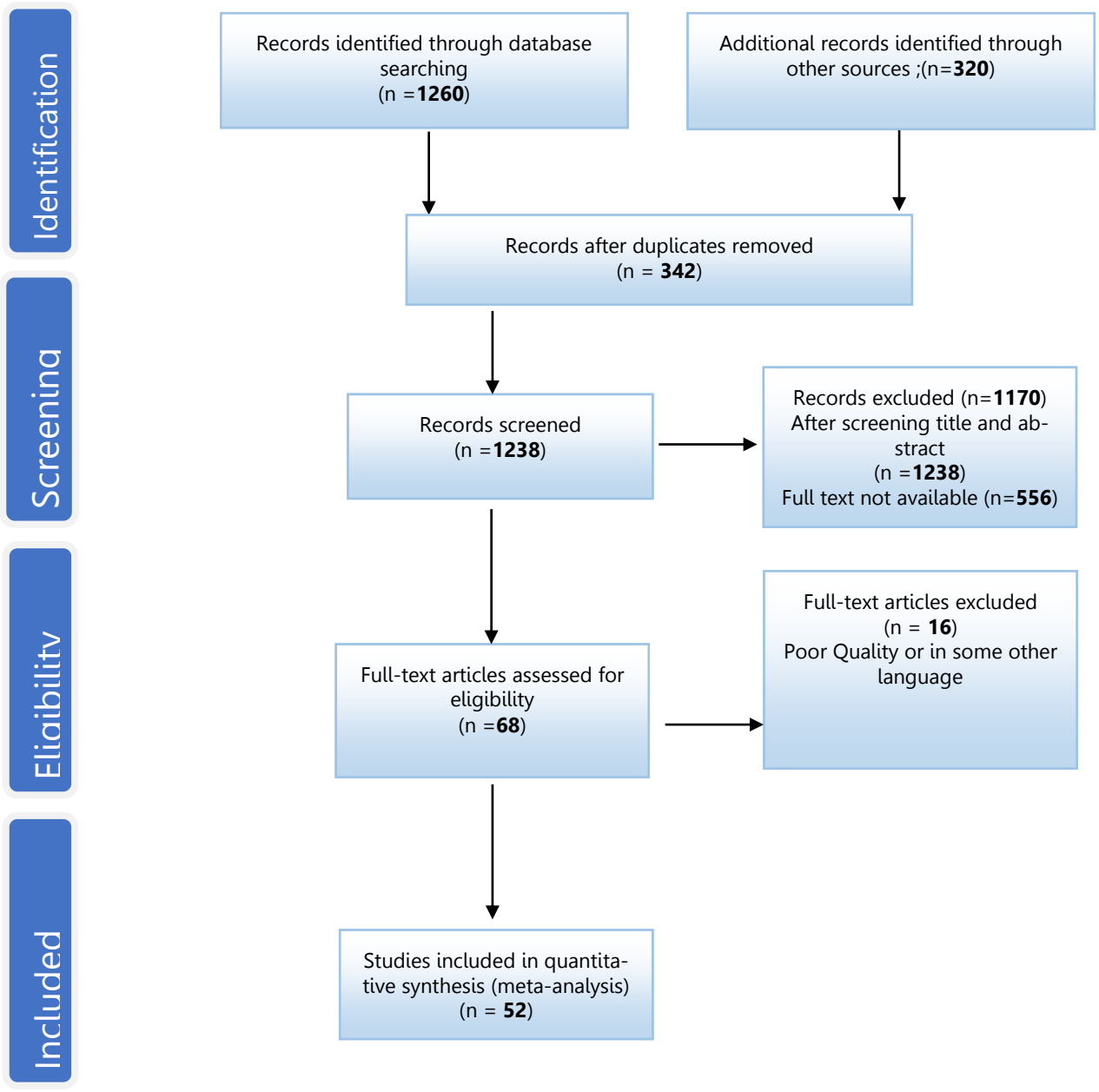
A total of 1580 articles were identified by the literature search strategy. 52 papers were included after the screening process by removing duplicates. These papers were analyzed thoroughly. The detailed analysis of the selected papers showed some recurrent themes affecting students learning in OR. These themes are described in Table 1. These themes were further divided into sub-themes to cover each theme in detail and make the literature analysis more comprehensive.

3.1. Educational relevance/Learning objectives

Clarity about learning objectives is very important for the students' OR learning [4,5]. When the learning objectives are not practical, they result in frustration, confusion, and hamper learning. It is also observed that students develop unrealistic goals when they are not educated about them[4]. For medical students to understand the purpose of their theatre placement, the senior faculty's active role in the mentorship and supervision of students cannot be overstated. This intervention can provide a sense of direction for students and is crucial for building a surgical competency and the ability

to sustain clinical knowledge. Previously, it has been identified that learning plans within the OR setting have remained suboptimal, and learning objectives for lesson plans have been unstructured and ill-defined[5]. Ravindra and colleagues found that almost 47% of the students were not clear about the learning objectives when they were asked about them. The ratio of the students with planned learning objectives was as low as 13%[11]. In order to achieve this goal, the importance of a comprehensive OR orientation session is pivotal. When the students were formally educated about learning objectives, it increased their confidence, and they performed better in the OR[11].

Figure 1: PRISMA Flow Chart for literature search



The other issue is the relevance of learning objectives about OR-based student learning and its place in the overall curricular picture[5]. There is frequently a disparity in what surgeons and medical students believe to be learning objectives. Faculty members have a tendency to suggest the student concentrate more on the disease process and cognitive portion of the operative procedure. The students, however, have a different perspective about OR learning, which does not correspond to the surgical teacher's thought process. The students want to learn more about the surgical procedure and surgical instruments and want to focus on the psychomotor component[4]. O'Neill and colleagues explored this issue further in their questionnaire-based study and found that 84% of students chose surgical skill acquisition to be their primary objective of the OR-based learning, to which only 11% of the surgeons agreed[12]. Most of the surgeons in the same survey envisioned that learning disease processes, pathology and developing decision-making skills were far more important than learning surgical techniques.

It remains imperative to sort this dichotomy of thought with the ultimate objective to synchronize student and faculty vision about the OR-based learning process and content selection[4]. It remains of substantial importance that learning objectives are clear and comprehensive[5]. Pragmatism is another important element that should reflect in learning objectives.

3.2. Educator-related Factors

The surgeon, as an educator, plays an over-riding role in students' OR-based learning. The students perceived educators as the most influential factor in OR learning when they were asked to rate 27 different factors (unpublished evidence). The educator's positive attitude, interest, and competency are the factors that positively correlated with improved student learning and theater attendance[4]. But when the teacher is over critical and does not give feedback to students, it makes them feel burdened and not being welcomed[4]. It was observed that students found junior doctors to be more competent teachers within this setting and were able to come down to the level of students and address common queries they had. It is very crucial for the educator to prepare and educate the students for the OR session by preoperative teaching sessions and discussions and keeping them involved during a surgical procedure by live commentary and asking structured questions[4]. An established style of teaching is when surgical educators give a narration of the findings and make a constant commentary, which helps students gain an insight into procedures and cases in an unfamiliar setting. Often information that surgeons consider to be obvious is of immense importance for theatre-naïve students. It is found that when students are instructed to study up on topics and develop baseline knowledge on the anatomical regions that they are going to encounter, it can result in an improved quality of the theatre experience. Preoperative briefing and active participation in question-answer sessions can encourage undergraduate students to develop critical thinking skills and apply the information to new case scenarios[13]. The use of effective teaching strategies is as important as are pre and intraoperative teaching sessions in making teaching sessions productive. Students frequently associate the quality of their theatre experience with the effectiveness of the surgeon's teaching style. The teaching style of the educator has been considered to be an important factor influencing students' learning reported in various studies[3].

Surgeons' formal training before working as educators can enable them to improve their teaching skills and as a result facilitates student learning[14]. There is also often a lack of communication within the surgical team as to who takes up the teaching role and a degree of confusion amongst students regarding who's in charge of teaching within the theatre. Rosters made to assign teaching roles to staff on a regular basis can help amend this issue[15].

3.3. Organizational Factors

The institutes are required to provide all resources that students need to facilitate their OR-based learning. Previously, students have reported inadequate organizational support for OR-based learning[16]. When asked about attending OR orientation sessions, students denied any formal arrangement in this regard. This lack of orientation about the OR environment induces stress and confusion[4, 17]. Besides conducting an orientation session, the institute can improve students' OR experience by fostering surgical skills in a simulated setting before exposing them to real-life scenarios[18, 19]. Students who receive structured training in simulated settings prior to their OR rotation perform better than those who do not[13]. Simulations provide undergraduates a safe environment to practice in prior to their theatre placement. With adequate facilities, didactic lectures, web conferencing, online seminars, pre-theatre workshops, virtual training and simulated operation suites (SOS) can all significantly enhance the OR experience.

Another important limiting factor is the narrow surgical view as complained by many students previously[20]. Poor visibility can be due to a confined working space, surgeries at a miniature scale, limited accommodation, or large batches of students. This problem can be managed through the use of head cameras worn by surgeons[20]. This equipment allows the surgeon to teach students intraoperatively while highlighting regional anatomical structures. A new device called 'Video Glass' by Landry may improve visualization and enhance OR learning[20]. Satisfactory organizational support has a substantial impact on the overall experience of the students and can improve theater-based learning.

Table 1- Qualitative thematic analysis of the literature evidence

Year	Author	Country	Research method	Themes identified
1996	Hubbell [23]	US	Questionnaire; Medical students = n-48 Response rate =98 %	Clarity of learning goals facilitates OR learning, Teaching styles; The effect of visual reinforcement
1996	Hong [24]	Canada	Questionnaire; Medical students = n-8; Some other faculty members	Being welcomed; Being part of the team important to medical students; Feeling burdensome; Teaching strategies – advantages of surgical skills workshop; Importance of active interaction for students
2002	Broderick [25]	US	Variety of medical background including medical students (n=11)	Cannot observe the surgical procedure affect students OR learning
2003	Lyon [26]	Australia	Group interviews of medical students, detailed semi structured interviews. Questionnaire (n=197, response rate 87%); (surgeons=n 10, students = n15)	Fear affecting OR learning negatively; Ambiguity related to learning goals Embarrassment not being competent; Long OR sessions and their educational benefits
2003	Stark [27]	UK	Semi- structured interview of consultants (n= 13) Focus groups of medical students (n=20)	Effect of teaching strategies on OR learning long OR sessions affecting student's attendance;Educational benefits of long learning sessions
2004	Pettitt [28]	US	Questionnaire; n= 84; response rate =83 %	Fear affecting OR learning negatively; Medical students not treated well by the faculty
2004	Lyon [29]	Australia	Questionnaire;(n =197); Response rate = 83 % Detailed semi-structured interviews;Medical students (n=15); Surgeons (n=10); Group interview of medical students	Feeling being welcomed; Part of the team being important to the students Active interaction and participation; Teaching strategies affecting OR learning
2004	Callcut[30]	US	Evaluation; Medical students (n= 70 +/- 7); Surgeons (n = 74)	Teaching strategies affecting students OR learning
2005	Lee[31]	Scotland	Questionnaire; (n=52); Response rate = 100 %	Ambiguity related to learning goals/ discordant; Lack of visualization
2006	Thomas [32]	UK	Personal reflection	Teaching strategies affecting OR learning; Benefits of orientation session; Humiliation
2007	Fernando [33]	Scotland	Questionnaire; Medical students (n=54); Response rate = 90 %	Feeling being welcomed; Ambiguity related to learning goals
2007	Fernando [34]	Scotland	Questionnaire; Medical students (n=46); Response rate = 100 %; Consultants (n=42); Response rate 46	Ambiguity related to learning goals /discordant; Lack of visualization
2008	Cloyd [35]	US	Questionnaire; (n=55); Response rate = 88.7%	Feeling being welcomed; Feeling being part of the team; Feeling burdensome Teaching styles – benefits of surgical skills workshop; Active participation
2008	Berman [36]	US	Questionnaire; (n=116); Response rate= 89%structured mentorship program	Teaching strategies – benefits of preparatory course; Active participation Teaching strategies affecting OR learning
2008	McIntyre [37]	US	Questionnaire (n=78)	Teaching strategies affecting students OR learning; Long OR sessions affecting student's attendance and their educational importance
2010	Irani [38]	US	Field observation; Satisfaction ratings; Medical students (n=11)	Learning objectives not clear/ discordant; Active participation
2011	Hampton [39]	US	Focus groups; Medical student (n= 13); Faculty members (n=5)	Importance of learning objective to students and faculty; Feeling being welcomed; Feeling part of the team
2012	Patel [40]	UK	Questionnaire; (n= 60)	Teaching styles – advantages of preparatory workshop
2012	Martin [41]	UK	Questionnaire; Medical students (n=36); Consultants (n=8)	Teaching style – advantages of preparatory workshop; Lack of confidence in students
2013	Chapman [42]	UK	Questionnaire; Medical students;(n=292); Response rate= 20.8%	Feeling being welcomed; Feeling being part of the team; Active participation
2013	Coveney [43]	Ireland	Free recall experimenting model	Effect of short-term free recall on students learning
2013	Patel [44]	US	Questionnaire; (n=33)	Teaching styles – advantages of preparatory workshop
2013	Ravindra [11]	UK	Questionnaire; (n=209); Response rate 87%	Learning objective not clear; Victimization; Humiliation; Active participation Long OR sessions affecting students learning and their educational benefits
2014	Flannery [45]	Northern Ireland	Questionnaire; Medical students; (n=22); Response rate = 8%	Importance of learning objectives; Teaching strategies affecting students learning
2014	Hampton [46]	US	Questionnaire; (n=68)	Advantages of setting learning objectives; Effective teaching strategies results in higher satisfaction
2014	Bowrey[47]	UK	Semi-structured interview; (n=9 of 83 invited students)	Fear associated with OR; Intimidation; Feeling being welcomed; Feeling being part of the team
2014	Drolet[48]	US	Questionnaire; (n=24); Response rate =100%	Teaching strategies – advantages of preparatory course; Lack of confidence in students

2014	Bauer [49]	Germany	Objective structured clinical examination; Written tests; Medical students (n=20)	Preoperative training for medical students; Teaching strategy affecting students learning; Students confidence
2015	Stone [50]	Canada	Questionnaire; (n=72); Response rate= 21%	Fear associated with OR; Intimidation; Teaching strategies – advantages of preparatory course
2015	Bakhshialibad[7]	Iran	Medical students; (n=493)	Feeling being part of the team; Effective teaching strategy affecting students learning
2015	Piromchai[51]	Australia	(n=210)	Teaching strategy affecting students learning
2015	Rothenberger[52]	Switzerland	Questionnaire; Medical students; (n=15)	Importance of preoperative training
2015	Zundel [16]	Germany	Series of focus groups; Medical students(n=17); Surgeons (n=10)	Importance of learning objectives; Fear associated with OR; teaching strategies affecting students learning
2016	Flinn [6]	US	Medical students; (n=40)	Stress; Criticism by surgeons
2016	Miandob	Iran	Questionnaire; (n=62)	Feeling being part of the team; Feeling being welcomed
2016	Morzycki[53]	Canada	Questionnaire; (n=180); Response rate =40%	Fear associated with OR; Intimidation; Feeling being welcomed; Feeling being part of the team
2017	O'Neill [54]	US	Questionnaire; Medical students(n=39); Surgical residents(n=9); Surgeons (n=9)	Importance of learning objectives; Feeling burdensome
2017	Butler [55]	US	Multiple choice questions; Medical students; (n=21)	Teaching strategy affecting students learning
2017	Labadie [56]	US	Questionnaire; Medical students; (n=119)	Clarity of learning objectives; Students confidence; Preoperative surgical training affecting students learning
2017	Knight [57]	UK	Questionnaire; (n=201); Response rate= 81.4%	Feeling being part of the team; Feeling being welcomed; Considering OR learning useful
2018	Shipper [58]	US	Semi- structured interviews; Medical students(n=8) Instructors (n=5)	Teaching strategies – advantages of preparatory course; Fear associated with OR Intimidation
2018	Jensen [59]	Denmark	Ethnographic observation; (n=7); 70 hours of observation	Importance of learning objectives; Lack of confidence in students; Teaching strategies; Importance of intra-operative teaching; Teaching strategies affecting students learning
2018	Pilieci[60]	Canada	Questionnaire; Multiple choice questions; Medical students;(n=29)	Preparedness; Teaching strategy affecting students learning; Confidence
2018	Lee [42]	US	Objective structured clinical examination; Medical students ;(n=34)	Effective teaching strategy; Preparedness; Orientation session
2018	Leithead[2]	US	Questionnaire Response rate = 80%	Effective Teaching strategy; affecting student learning
2018	Torbjörnsson[61]	Sweden	Questionnaire; Medical students;(n=42); Nurses (n=4) ; Response rate=59%	Preparedness; Time pressure; Surgeon's behavior; Interprofessional learning
2019	Gallagher [62]	US	Peer assisted learning; Medical students; (n=100)	Teaching strategy affecting students learning; Satisfaction; helpfulness
2019	Rosen [63]	US	Questionnaire; (n=28)	Teaching strategy affecting students learning
2019	Z. Chaudhry [64]	Canada	Questionnaire (n=143)	Lack of confidence; Learning objectives not clear; Importance of preoperative teaching; Positive environment; Role of feedback
2019	Landry [20]	Canada	Questionnaire;(n=23)	Effective teaching strategy improved visualization
2019	Shore [65]	Canada	Questionnaire; Medical students;(n=88)	Effective teaching strategy affecting students learning
2019	Ng [66]	Canada		Fatigue, stress, surgeon's attitude affecting students learning

3.4. Emotional / Psychological Factors

Emotional or psychological factors also affect student learning in the OR setting. Various educational, organizational, and educator-related factors may trigger certain emotional responses in students in the challenging theater environment. Students have previously reported that being in an unfamiliar environment was fearsome, and they felt intimidated[4]. The OR setting greets students with an unspoken code of conduct that is expected to be adhered to strictly. A common sentiment amongst students is fear of not acting in accordance with the rules, looking like a fool in front of the staff, and not being able to live up to their teachers' expectations. Students report that trainees and residents often had a hostile attitude towards them which created feelings of anxiety and stress. It has been demonstrated that stress levels, beyond a certain extent, proved to be detrimental to student learning and performance and made retaining information difficult. Students also report that they felt their presence was undesired, constantly fearing of getting in the way or being told off for not maintaining a distance from the sterile field. Fear of syncope is also very common among the students as they try not to make any mistake and feel embarrassed[21]. Chapman and colleagues found that students were victimized by the faculty and seniors and received negative put-downs, which is quite stressful for students. Negative ethical environment results in low motivation, lack of confidence and poor self-esteem[5, 22]. Not addressing these factors can lead to students being unnecessarily mentally drained, not being able to show their true potential, reducing their attention span and learning capacity.

3.5. Limitations of the Study

Although there is a reasonable amount of data available related to the factors that influence medical students' learning in the OR, the data is contextual. The data is based on opinions without sound scientific evidence and may not be generalizable. Some studies have a low response rate signifying non-response bias that limits both reliability and validity of the studies.

3.6. Recommendations

The in-depth literature analysis has identified various factors influencing OR-based student learning. Based on the collective wisdom attained through this data, the following steps may be incorporated in future structured clinical encounters within the OR- setting:

1. Operating Room-based learning process in its entirety should be structured with well-planned lessons, defined instructional and assessment strategies which encompass all dimensions of learning e.g. cognitive, motor and affective skills.

2. Establishing and implementing structured learning process within the OR setting is an uphill task. Organizational commitment and support to enforce and improve quality of learning process within the OR setting remains pivotal.

3. A structured OR preparatory orientation session explaining various aspects of OR sections and clearly defined learning objectives can be of substantial importance. This would generate clarity and reduce frustration among the students.

4. Prior intimation about operative procedures to be done in the OR can add to students' clarity about learning objectives and may be instrumental for students' preparation for the expected lesson.

5. The provision of student-centered learning objectives for the OR-based sessions would reduce confusion among students and would reinforce student preparedness about the expected lesson.

6. Intraoperative lessons should be structured, well prepared, and comprehensive. Effective teaching strategies should be utilized. There should be an ongoing commentary about the surgical procedure with questions to keep students involved in the session.

7. Faculty training remains the central cornerstone for an effective learning process within the OR setting. The surgeons should also receive training sessions, attend preparatory workshops and courses to improve and enhance their teaching skills especially within the OR setting.

8. The positive attitude of the faculty would increase students' participation, OR attendance, interest, and motivation. This will improve their confidence and self-esteem, and students will no longer feel victimized and intimidated.

9. Peer-assisted learning can be very effective as students can learn in a non-threatening environment and this can lessen the surgeon's workload too.

10. The surgeons and students should fill feedback forms at the end of each OR rotation to evaluate the process and highlight the concerns.

CONCLUSION

In conclusion, OR learning trains students professionally. They learn skills, techniques and patients' management. During this process, they learn how to cope with stress and anxiety, how to handle time pressure and remain calm when situations become challenging. Different variables play an important role during the learning process that affect the

overall quality of learning in the OR. These issues can be managed by acknowledging them and making positive changes to resolve them.

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REFERENCES

1. Stone JP, Charette JH, McPhalen DF, Temple-Oberle C. Under the Knife: Medical Student Perceptions of Intimidation and Mistreatment. J Surg Educ. 2015;72(4):749-753. doi:10.1016/j.jsurg.2015.02.003

2. Leithead J, Garbee DD, Yu Q, et al. Examining interprofessional learning perceptions among students in a simulation-based operating room team training experience. J Interprof Care. 2019. doi:10.1080/13561820.2018.1513464

3. Lyon P. A model of teaching learning in the operating theatre. Med Educ. 2004;38(12):1278-1287. doi:10.1111/j.1365-2929.2004.02020.x

4. Croghan SM, Phillips C, Howson W. The operating theatre as a classroom: a literature review of medical student learning in the theatre environment. Int J Med Educ. 2019. doi:10.5116/ijme.5ca7.afd1

5. Hexter AT, O'Dowd-Booth C, Hunter A. Factors that influence medical student learning in the operating room. Med Teach. 2018. doi:10.1080/0142159X.2018.1504163

6. Börjeson L, Höjer M, Dreborg K-H, Ekvall T, Finnveden G. Scenario types and techniques: Towards a user's guide. Futures. 2006;38(7):723-739. doi:10.1016/j.futures.2005.12.002

7. Bakhshialiabad H, Bakhshi M, Hassanshahi G. Students’ perceptions of the academic learning environment in seven medical sciences courses based on DREEM. Adv Med EducPract. 2015. doi:10.2147/amep.s60570

8. McIntyre TP, Monahan TS, Villegas L, Doyle J, Jones DB. Teleconferencing surgery enhances effective communication and enriches medical education. SurgLaparoscEndosc Percutaneous Tech. 2008. doi:10.1097/SLE.0b013e31815746a8

9. Hexter A, Hunter A. Response to: Factors that influence medical student learning in the operating room: Medical students' perspective. Med Teach. 2019. doi:10.1080/0142159X.2018.1548419

10. Galway UA. Designing an Optimally Educational Anesthesia Clerkship for Medical Students - Survey Results of a New Curriculum. J EducPerioper Med JEPM.

11. Ravindra P, Fitzgerald JEF, Bhangu A, Maxwell-Armstrong CA. Quantifying factors influencing operating theater teaching, participation, and learning opportunities for medical students in surgery. J Surg Educ. 2013. doi:10.1016/j.jsurg.2013.02.011

12. O'Neill R, Shapiro M, Merchant A. The Role of the Operating Room in Medical Student Education: Differing Perspectives of Learners and Educators. J Surg Educ. 2018;75(1):14-28. doi:10.1016/j.jsurg.2017.06.013

13. Roberts NK, Williams RG, Kim MJ, Dunnington GL. The Briefing, Intraoperative Teaching, Debriefing Model for Teaching in the Operating Room. J Am Coll Surg. 2009;208(2):299-303. doi:10.1016/j.jamcollsurg.2008.10.024

14. Ibrahim A, Delia IZ, Edaigbini SA, Abubakar A, Dahiru IL, Lawal ZY. Teaching the surgical craft: surgery residents perception of the operating theater educational environment in a tertiary institution in Nigeria. Niger J Surg Off Publ Niger Surg Res Soc. 2013. doi:10.4103/1117-6806.119240

15. Lingard L, Reznick R, Espin S, Regehr G, DeVito I. Team communications in the operating room: Talk patterns, sites of tension, and implications for novices. Acad Med. 2002;77(3):232-237. doi:10.1097/00001888-200203000-00013

16. Zundel S, Wolf I, Christen HJ, Huwendiek S. What supports students' education in the operating room? A focus group study including students' and surgeons' views. Am J Surg. 2015. doi:10.1016/j.amjsurg.2015.03.011

17. Böckers A, Mayer C, Böckers TM. Does learning in clinical context in anatomical sciences improve examination results, learning motivation, or learning orientation? AnatSci Educ. 2014. doi:10.1002/ase.1375

18. Nasiri M, Amirmohseni L, Mofidi A, PiresPadilhaPaim C, BigdeliShamloo MB, Asadi M. Educational games developed for students in perioperative nursing: A systematic review and appraisal of the evidence. Nurse EducPract. 2019. doi:10.1016/j.nepr.2019.05.002

19. Butler A, Olson T, Koehler R, Nicandri G. Topics in training: Do the skills acquired by novice surgeons using anatomic dry models transfer effectively to the task of diagnostic knee arthroscopy performed on cadaveric specimens? J Bone JtSurg - Ser A. 2013. doi:10.2106/JBJS.L.00491

20. Landry EC, Yong M, Pauwels J, Chadha NK. The use of video glasses improved learning of tonsillectomy and adenoidectomy surgery: A randomized controlled trial. Int J PediatrOtorhinolaryngol. 2019. doi:10.1016/j.ijporl.2018.10.039

21. Morzycki A, Hudson A, Williams J. Medical Student Presyncope and Syncope in the Operating Room: A Mixed Methods Analysis. J Surg Educ. 2016;73(6):1004-1013. doi:10.1016/j.jsurg.2016.05.003

22. Chapman SJ, Hakeem AR, Marangoni G, Raj Prasad K. How can we Enhance Undergraduate Medical Training in the Operating Room? A Survey of Student Attitudes and Opinions. J Surg Educ. 2013;70(3):326-333. doi:10.1016/j.jsurg.2013.01.008

23. Hubbell DS, Byers PH, McKeown PP. Clinical anatomy instruction in the operating room. Clin Anat. 1996;9(6):405-407. doi:10.1002/(SICI)1098-2353(1996)9:6<405::AID-CA9>3.0.CO;2-9

24. Hong D, Regehr G, Reznick RK. The efficacy of a computer-assisted preoperative tutorial for clinical clerks. Can J Surg. 1996;39(3):221-224. http://www.ncbi.nlm.nih.gov/pubmed/8640621. Accessed August 4, 2019.

25. Broderick TJ, Russell KM, Doarn CR, Merrell RC. A Novel Telemedicine Method for Viewing the Open Surgical Field. J LaparoendoscAdvSurg Tech. 2002;12(4):293-298. doi:10.1089/109264202760268113

26. Lyon PMA. Making the most of learning in the operating theatre: student strategies and curricular initiatives. Med Educ. 2003;37(8):680-688. http://www.ncbi.nlm.nih.gov/pubmed/12895247. Accessed July 21, 2019.

27. Stark P. No Title. Med Educ. 2003;37(11):975.

28. Pettitt BJ. Medical student concerns and fears before their third-year surgical clerkship. Am J Surg. 2005. doi:10.1016/j.amjsurg.2004.09.017

29. Lyon P. A model of teaching learning in the operating theatre. Med Educ. 2004. doi:10.1111/j.1365-2929.2004.02020.x

30. Callcut RA, Rikkers L, Lewis B, Chen H. Does academic advancement impact teaching performance of surgical faculty? Surgery. 2004. doi:10.1016/j.surg.2004.03.015

31. Lee MS, Montague ML, Hussain SS. No Title. J Laryngol Otol. 2005;119(4):293.

32. Markman JD, Soeprono TM, Combs HL, Cosgrove EM. Medical student mistreatment: understanding 'public humiliation.' Med Educ Online. 2019. doi:10.1080/10872981.2019.1615367

33. Fernando N, McAdam T, Cleland J, Yule S, McKenzie H, Youngson G. How can we prepare medical students for theatre-based learning? Med Educ. 2007. doi:10.1111/j.1365-2923.2007.02839.x

34. Fernando N, McAdam T, Cleland J, Yule S, McKenzie H, Youngson G. How can we prepare medical students for theatre-based learning? Med Educ. 2007;41(10):968-974. doi:10.1111/j.1365-2923.2007.02839.x

35. Cloyd J, Holtzman D, O'Sullivan P, Sammann A, Tendick F, Ascher N. Operating Room Assist: Surgical Mentorship and Operating Room Experience for Preclerkship Medical Students. J Surg Educ. 2008;65(4):275-282. doi:10.1016/j.jsurg.2008.04.002

36. Berman L, Rosenthal MS, Curry LA, Evans L V., Gusberg RJ. Attracting Surgical Clerks to Surgical Careers: Role Models, Mentoring, and Engagement in the Operating Room. J Am Coll Surg. 2008. doi:10.1016/j.jamcollsurg.2008.08.003

37. McIntyre TP, Monahan TS, Villegas L, Doyle J, Jones DB. Teleconferencing Surgery Enhances Effective Communication and Enriches Medical Education. SurgLaparoscEndoscPercutan Tech. 2008;18(1):45-48. doi:10.1097/SLE.0b013e31815746a8

38. Irani JL, Greenberg JA, Blanco MA, et al. Educational value of the operating room experience during a core surgical clerkship. Am J Surg. 2010;200(1):167-172. doi:10.1016/j.amjsurg.2009.06.023

39. Hampton BS, Magrane D, Sung V. Perceptions of operating room learning experiences during the obstetrics and gynecology clerkship. J Surg Educ. 2011. doi:10.1016/j.jsurg.2011.03.006

40. Patel V, Aggarwal R, Osinibi E, Taylor D, Arora S, Darzi A. Operating room introduction for the novice. Am J Surg. 2012. doi:10.1016/j.amjsurg.2011.03.003

41. Martin TG, Clarke DR, Bowrey DJ. Medical students in theatre: Setting the scene. Med Teach. 2012. doi:10.3109/0142159X.2012.661892

42. Chapman SJ, Hakeem AR, Marangoni G, Raj Prasad K. How can we enhance undergraduate medical training in the operating room? A survey of student attitudes and opinions. J Surg Educ. 2013. doi:10.1016/j.jsurg.2013.01.008

43. Coveney AP, Switzer T, Corrigan MA, Redmond HP. Context dependent memory in two learning environments: The tutorial room and the operating theatre. BMC Med Educ. 2013. doi:10.1186/1472-6920-13-118

44. Kind T, Patel PD, Lie D, Chretien KC. Twelve tips for using social media as a medical educator. Med Teach. 2014;36(4):284-290. doi:10.3109/0142159X.2013.852167

45. Flannery T, Gormley G. Evaluation of the contribution of theatre attendance to medical undergraduate neuroscience teaching-A pilot study. Br J Neurosurg. 2014. doi:10.3109/02688697.2014.896873

46. Hampton BS, Raker CA, Sung VW. Implementation and evaluation of a novel operating room curriculum for the obstetrics and gynecology clerkship. J Surg Educ. 2014. doi:10.1016/j.jsurg.2013.12.008

47. Bowrey DJ, Kidd JM. How Do Early Emotional Experiences in the Operating Theatre Influence Medical Student Learning in This Environment? Teach Learn Med. 2014. doi:10.1080/10401334.2014.883986

48. Drolet BC, Sangisetty S, Mulvaney PM, Ryder BA, Cioffi WG. A mentorship-based preclinical elective increases exposure, confidence, and interest in surgery. Am J Surg. 2014;207(2):179-186. doi:10.1016/j.amjsurg.2013.07.031

49. Bauer F, Rommel N, Kreutzer K, et al. A novel approach to teaching surgical skills to medical students using an ex vivo animal training model. J Surg Educ. 2014. doi:10.1016/j.jsurg.2014.01.017

50. Stone JP, Charette JH, McPhalen DF, Temple-Oberle C. Under the knife: Medical student perceptions of intimidation and mistreatment. J Surg Educ. 2015. doi:10.1016/j.jsurg.2015.02.003

51. Piromchai P, Avery A, Laopaiboon M, Kennedy G, O'Leary S. Virtual reality training for improving the skills needed for performing surgery of the ear, nose or throat. Cochrane Database Syst Rev. 2015. doi:10.1002/14651858.CD010198.pub2

52. Rothenberger J, SeyedJafari SM, Schnabel KP, Tschumi C, Angermeier S, Shafighi M. Evaluation of medical students' attitudes and performance of basic surgery skills in a training program using fresh human skin, excised during body contouring surgeries. J Surg Educ. 2015. doi:10.1016/j.jsurg.2015.03.004

53. Morzycki A, Hudson A, Williams J. Medical Student Presyncope and Syncope in the Operating Room: A Mixed Methods Analysis. J Surg Educ. 2016. doi:10.1016/j.jsurg.2016.05.003

54. O'Neill R, Shapiro M, Merchant A. The Role of the Operating Room in Medical Student Education: Differing Perspectives of Learners and Educators. J Surg Educ. 2018. doi:10.1016/j.jsurg.2017.06.013

55. Butler BA, Lawton CD, Burgess J, Balderama ES, Barsness KA, Sarwark JF. Simulation-Based educational module improves intern and medical student performance of closed reduction and percutaneous pinning of pediatric supracondylar humeral fractures. J Bone JtSurg - Am Vol. 2017. doi:10.2106/JBJS.17.00425

56. Labadie B, Patel RM, Gandy Labadie J, Hwang C, Okhunov Z, Landman J. Assessing the Effect of an Intensive 2-Week Surgical Training and Innovation Program for High-School Students. J Surg Educ. 2017. doi:10.1016/j.jsurg.2017.05.023

57. Knight J, Stroud L, Geyton T, Stead A, Cock HR. Medical student perceptions of clinical neurosurgery teaching in an undergraduate medical school curriculum. Br J Neurosurg. 2017;31(6):727-730. doi:10.1080/02688697.2017.1335856

58. Shipper ES, Miller SE, Hasty BN, et al. Determining the educational value of a technical and nontechnical skills medical student curriculum. J Surg Res. 2018. doi:10.1016/j.jss.2018.01.002

59. Jensen M, Hussong AM, Baik J. Text Messaging and Social Network Site Use to Facilitate Alcohol Involvement: A Comparison of U.S. and Korean College Students. Cyberpsychology, BehavSocNetw. 2018;21(5):311-317. doi:10.1089/cyber.2017.0616

60. Pilieci SN, Salim SY, Heffernan DS, Itani KMF, Khadaroo RG. A Randomized Controlled Trial of Video Education versus Skill Demonstration: Which Is More Effective in Teaching Sterile Surgical Technique? Surg Infect (Larchmt). 2018. doi:10.1089/sur.2017.231

61. Torbjörnsson E, Olivecrona C, Sonden A. An interprofessional initiative aimed at creating a common learning resource for the operating room ward. J Interprof Care. 2018. doi:10.1080/13561820.2018.1435516

62. Gallagher KC, Matevish LE, Neuzil K, et al. Peer-led Surgical Clerkship Programming Support Through the General Surgery Interest Group at the Vanderbilt University School of Medicine. J Surg Educ. 2019. doi:10.1016/j.jsurg.2019.04.012

63. Rosen DA, Criser AL, Petrone AB, Jackson E, Bowers J. Utilization of a Role-Based Head Covering System to Decrease Misidentification in the Operating Room. J Patient Saf. May 2019. doi:10.1097/PTS.0000000000000608

64. Chaudhry Z, Campagna-Vaillancourt M, Husein M, et al. Perioperative Teaching and Feedback: How are we doing in Canadian OTL-HNS programs? J Otolaryngol - Head Neck Surg. 2019. doi:10.1186/s40463-019-0330-2

65. Shore EM, Davidson A, Arnason M, Kara H, Shah A, Shah R. Bridging the Gap: Incorporating Simulation into Obstetrics and Gynaecology Undergraduate Medical Education. J ObstetGynaecol Canada. 2019. doi:10.1016/j.jogc.2018.03.016

66. Ng R, Chahine S, Lanting B, Howard J. Unpacking the Literature on Stress and Resiliency: A Narrative Review Focused on Learners in the Operating Room. J Surg Educ. 2019. doi:10.1016/j.jsurg.2018.07.025.