**Patient and psychological safety: a mixed methods study on aspects of teamwork in the operating room**

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**ABSTRACT**

**Objectives:** To predict the amount of teamwork throughout a surgery and to explore factors affecting patient and psychological safety during a surgery, based on performing a preoperative check-in and interprofessional teamwork.

**Methods:** This mixed methods study included quantitative and qualitative analyses. Quantitative data included 2,184 observations of performing safety standards during surgeries in 29 hospitals, analyzed using multivariate binary logistic regressions. Qualitative data were obtained from an analysis of 25 semi-structured interviews with operating room (OR) clinicians and risk managers, using a thematic analysis approach.

**Results:** Analysis of the OR observations revealed that alack of teamwork in the preoperative “sign in” phase doubled the odds of there being a lack of teamwork during surgery (odds ratio = 1.972, 95% confidence interval (CI) 1.741, 2.233, p<0.001) and during the “time out” phase (odds ratio = 2.142, 95% CI 1.879, 2.441, p<0.001). Consistent staff presence during surgery increased teamwork, by 21% for physicians and 24% for nurses (p<0.05), but turnover decreased teamwork by 73% for physicians (p<0.05).

Interview data indicated that patient and psychological safety are related to a perception of a collaborative team role, with mutual commitment and effective interprofessional communication.

**Conclusions:** Healthcare organizations should consider the key items identified in this study when trying to identify factors that affect teamwork during a surgery. Effective preoperative teamwork positively affects intraoperative teamwork, as does more clinicians participating in a surgery, with no turnover. Other factors include working in a designated team led by a surgeon and effective interprofessional communication.

**INTRODUCTION**

Patient safety is an ongoing concern in operating rooms (OR), and teamwork is a major component of safety. Surgical teams work in complex environments, characterized by a high level of stress and vulnerable patients (1,2). Standard safety checks are sometimes omitted (3). Most surgical teams include clinicians from various disciplines, with differing priorities, roles, backgrounds, and expertise (4). Although they share the goal of providing safe and successful surgical care (5,6), they are susceptible to errors (2). Surgical Never Events (NE) are preventable, unjustifiable adverse events that should be reduced to zero through quality improvement (7).

Effective teamwork is an essential component of safe surgery (8). Xyrichis and Ream defined teamwork as a “dynamic process involving two or more healthcare professionals with complementary backgrounds and skills, sharing common health goals” (9). Surgical outcomes depend strongly on communication and cooperation (10-13). Ineffective teamwork is linked to poorer patient outcomes and adverse events (14).

The psychological safety theory can explain some of the factors that inhibit teamwork. Psychological safety represents a shared belief among a team that it is safe to engage in interpersonal risk-taking, which is necessary for team learning and working toward a common goal (15). Generally, poorly defined tasks and a lack of resources lead to poor psychological safety, whereas leadership, trust among team members, and an ability to solve problems (16) engender an environment that fosters empowerment (17).

Bates and Singh described the importance of policies to prevent previous and emerging risks (18). Surgical safety standards promote and enable psychological safety during a surgery (19). The World Health Organization’s surgical safety checklist (SSC) and surgical counts encourage intra- and inter-disciplinary teamwork through collaboration between nurses and physicians (20).

In this study, we analyzed the interprofessional teamwork between physicians and nurses during surgery in relation to following safety standards, turnover, and role definition, to identify factors that might predict teamwork throughout a surgery. We used a mixed methods design, because quantitative data can provide only a partial understanding of effective teamwork, while an analysis of qualitative data enabled us to refine and explain the quantitative results by exploring participants’ views regarding teamwork (21).

**METHODS**

The current study used a triangulation, mixed methods convergence design to analyze teamwork in the OR (22). It included a retrospective cohort study that used data captured from observations of safety standards in the OR, to predict teamwork throughout a surgery; we also conducted purposive recruitment of individuals to participate in semi-structured interviews regarding their perceptions of safety in the OR (23).

**Participants**

*Quantitative Dataset*

Staff from the Israeli Ministry of Health (MOH) observed the performance of surgical safety standards during surgical cases, for quality control and patient safety assessments, in 29 hospitals in Israel between December 2018 and May 2021. Five had >400 beds, 10 had 400–800 beds, and 14 had <400 beds. Seven of the hospitals were in rural areas and 22 in urban areas.

*Qualitative Dataset*

We interviewed 25 individuals, comprising OR clinicians (anesthesiologists, surgeons, and nurses with management positions who currently practice in the OR) and risk managers from general hospitals and the MOH, based on what we anticipated to be sufficient to achieve data saturation. Five risk managers were from the MOH, and 20 interviewees were clinicians and risk managers from 8 hospitals (4 with >400 beds, 2 with 400 to 800 beds, and 3 with <400 beds; 5 were in urban areas and 3 in rural areas).

**Data Collection**

*Quantitative Observations*

We used data from 2,184 surgical cases in which direct observations were made of SSCs and surgical counts throughout the surgery. The surgical cases were selected at random by the observers. The observations were performed by physicians, medical students, nurses, or nursing students. All observers underwent simulation training for 8 hours. To ensure observers were competent, observers with >5% discordance between their observation entries and the expected entries in the simulation were not allowed to perform the observations. For the purposes of our study, we chose items in the SSC and surgical counts that represent teamwork throughout a surgery (Appendix 1). In the surgical cases observed there were no observations involving the occurrence of Never Events.

*Qualitative Semi-structured Interviews*

The 25 interviews were conducted between September and December 2019 by one of the authors (DA). Participants were approached based on their position and the size and location of their OR (Appendix 2). The interviews were recorded and the recordings were transcribed verbatim. Participants provided verbal consent to participate and received no compensation. The interviews were conducted in person at the participants’ offices and lasted an average of 20 minutes.

Field notes were taken during and immediately after each interview, in which the interviewers described factors contributing to OR Never Events and recorded any nonverbal reactions, such as anger or discomfort, during the interview.

**Analysis**

*Quantitative Analysis*

The statistical software package SPSS-25 was used to analyze the data captured during the observations. A multivariate logistic regression model was used to predict teamwork during a surgery based on two measures: the level of preoperative teamwork as a predictor of teamwork during surgery and the effect of staff presence and turnover on teamwork.

*Preoperative Teamwork*

The variable representing a lack of preoperative teamwork included seven items (Appendix 1), expressing team collaboration when performing an SSC during sign-in and time-out. A lack of teamwork was defined as the number of items in which the team did not work together on each item. We ranked the variable from 0 to 7 (where 0 represents the most teamwork and 7 represents the least).

*Intraoperative Teamwork*

The variable representing intraoperative teamwork was created from four items performed during the second SSC (Appendix 1). At that point, two nurses perform the surgical count together and include the surgeon in the process. A lack of teamwork was defined as the number of items on which the team did not work together. The variable was ranked from 0 to 4 (where 0 represents the most teamwork and 4 represents the least).

*Staff Presence and Turnover*

To evaluate the effect of staff turnover throughout a surgery on teamwork, we created two variables. The first evaluated the mean number of physicians (anesthesiologists and surgeons) and nurses participating in sign-in, time-out, and second SSC throughout the surgery. The second evaluated the standard deviation (SD) of the number of physicians and nurses present during a surgery, to represent staff entering and leaving the OR. For this measure, the higher the number, the higher the turnover (0 represents no change).

**Qualitative Analysis**

The interviews evaluated factors that contribute to surgical Never Events in the OR. The interview guide (Appendix 2) was developed based on opinions from clinicians and risk management experts. To test the interview guide, two pilot interviews were conducted, after which one question was omitted. The data from the pilot study were added to the final analysis.

We used the six-phase inductive thematic analysis approach described by Braun and Clarke (24): (1) data familiarization, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. Two investigators (DA and AF) read the entire dataset, independently and systematically coded the transcripts, and entered them into Microsoft Excel, version 16.0. Any disagreements about the codes used were discussed between all four investigators (DA, AF, RM, and RR). Codes were grouped into emergent themes following the discussions among all investigators.

We followed Tracy’s (2010) criteria for qualitative best practices. Transparency was maintained throughout the process of sorting, choosing, and organizing data. The rigor of data analysis was achieved through the development of a rational framework to transform and organize raw data into the research report. Two investigators (DA and AF) analyzed the data and shared it with the rest of the research team to ensure triangulation. Finally, the information was continuously shared with team members during the analysis, with their input based on their various types of professional expertise strengthening the credibility of the analysis.

**Results**

*Observations*

We used data from 2,184 surgeries. Most were general surgeries (37.5%), and most lasted for 1 to 2 hours (53.3%). At the three surgical phases observed, three physicians (SD 0.9–1.02) and two nurses (SD 0.52–0.58) were present (Table 1).

*Preoperative and Intraoperative Teamwork*

Table 2 shows the effects of the preoperative variables on intraoperative teamwork in a multivariate binary logistic regression model. The variables tested (amount of preoperative teamwork and the effect of staff presence and turnover on teamwork) predicted a lack of teamwork (χ2(6) = 408.110, p<0.0001, Nagelkerke’s r2 = 0.236). The findings did not differ significantly based on hospital location or size.

Regarding preoperative variables, the effect of each incidence of not performing a sign-in almost doubled the odds for a lack of teamwork at the SSC performed during surgery (odds ratio = 1.972, p<0.001, 95% confidence interval [CI] 1.741, 2.233). A similar effect was found for not performing the preoperative time-out (odds ratio = 2.142, p<0.001, 95% CI 1.879, 2.441).

The variable of consistent staff presence in the OR revealed a “protective” effect of mean absolute number of staff and a “harmful” effect of turnover during the surgery. Each increase in the number of physicians or nurses decreased the chance of a lack of teamwork by 21% and 24%, respectively (p<0.05). However, each increase in the turnover of physicians reduced the chance of teamwork by 73%. A similar but non-significant trend was seen with the turnover of nurses (p = 0.068).

*Semi-structured Interviews*

We interviewed 25 clinicians and risk managers who were in administrative roles (Table 3). Most were female with more than 30 years of experience.

We identified four main themes regarding the relationship between teamwork and patient and psychological safety: 1) perception of individual versus collaborative team role, 2) team leadership, 3) team characteristics (designated team and team communication), and 4) recommendations to improve teamwork. These themes are expanded upon below.

1) Individual versus collaborative role: most physicians and nurses viewed patient safety as their individual responsibility and not that of the team. Most nurses with more than 10 years of experience perceived themselves to be the safety supervisor during a surgery. For example, they said that: “We are in charge of implementing the standards in the OR. We supervise how they are performed.” and “Nurses, have a huge responsibility. They stop dangerous work processes before harming the patient.”

A surgeon, however, thought that nurses’ supervisory role negatively affected their relationship with a surgeon and thus affected the safety and success of a surgery: “Nurses are not nurses anymore. They are a control system that controls and criticizes physicians. They check us all the time. Instead of focusing on their nursing role, they sit and write what the physicians are doing instead of helping them”.

Anesthesiologists’ opinions differed. Most viewed themselves as individual safety supervisors: “This is the essence of our role. To assess and evaluate the work environment all the time and make sure everything is working properly.”; “Often, I inform the surgeon about relevant background diseases that his patient has. I don’t think this is my role, but I see myself as a gatekeeper”. Only a few thought of their role as collaborative: “The safety standards define specific roles for each clinician, but also define our role as a team”.

2) Team leadership: most interviewees suggested that surgeons should function as team leaders, thereby directing the safety of the surgery. An anesthesiologist stated that “If the surgeons understand that they in charge of all aspects of the surgery, it will improve safety”. The nurses agreed and added that one meaning of leadership is taking responsibility. “Surgeons don’t understand their responsibility. They are supposed to call for time-out process, but they do not, so the nurses take charge and do it instead”. “When we (nurses) do the surgical count, we know the surgeon needs to be involved and it seems like we bother him”. On the other hand, an anesthesiologist did not think they should be as involved as the nurses: “It is the surgeon’s business if he skips the standards and takes shortcuts, I don’t deal with it”.

Only a few surgeons, from small rural hospitals, viewed their role to be that of a leader in prioritizing safety standards. “We are performing the surgery and we know what is important and how to prevent errors. Nurses are stricter in following the standards and rules”. “Most of the standards do not focus on risk reduction and can lead to more errors; we know what to focus on”. A risk manager explained that it evolves from their training: “Surgeons trust shortcuts because they learned in medical school to diagnose the quickest way and then to provide solutions to errors without basing them on standards and checklists”.

A few risk managers explained that surgeons lead a surgery in clinical terms, but not as team leaders. “Their weak point is their hubris. They don’t think they should review what others (nurses and anesthesiologists) did. It is like wearing a seat belt when you drive, wearing eyeglasses when you are nearsighted”. For example, “when there is a discrepancy in the count, the surgeon prefers to finish the surgery without waiting for the nurses to recount”.

3) Team characteristics: two main team characteristics related to safe teamwork were described, working in a designated team and interprofessional communication.

A designated team was perceived as increasing the team’s commitment to the surgery. A few surgeons thought that this type of team would increase nurses’ commitment. “We never leave the surgery in the middle, but stay beyond our shift because this is the right thing to do for the safety of the surgery and the patient. Nurses, however, leave for their lunch break or go home. We have a substitute nurse, but she comes in the middle and does not know what happened before. If the nurses were committed like us and stayed from the beginning to the end, the teamwork would be better and there would be fewer errors”. On the other hand, a nurse described the turnover of surgeons as a factor affecting patient safety. “The surgeon says the surgery is urgent, but leaves for his private clinic in the middle and gets replaced, or he tells me: if you don’t prepare the patient to start the surgery before 3 pm we will not operate”.

Most anesthesiologists agreed that working in a designated team would benefit the quality and safety of a surgery. “Working in the same team all the time, without turnover, will promote the safety and success of the surgery. When you work with the same people, you know what they think and how they operate”. “If we all work together on the same mission from the beginning of the surgery until the end, we will be able to provide quick responses to urgent issues and consult with each other”.

Communication was mentioned as an essential aspect of teamwork and safe surgery. Most anesthesiologists and nurses emphasized the importance of communication: “the physician and the nurse should communicate well and be involved in each other’s work because they work together on a big mission”. “During the sign-in and the time-out, the communication between all staff involved is much better than expected and prevents errors”. “In the OR, we are a multidisciplinary team that works closely together, physically and emotionally, and we have to find a way to interact and communicate effectively”.

An anesthesiologist noted that poor communication between surgeons and anesthesiologists can affect patient safety: “It is very rare that there are errors in machines and equipment, the main errors are related to decision-making and lack of communication between us. For example, something went wrong in the surgery but the surgeon did not think to call the anesthesiologist who was around and could assist”. Interestingly, one surgeon noted that “there should be communication between the patient, anesthesiologist, and surgeon during the surgery”.

Inappropriate communication can be hurtful and may even progress to bullying. Some nurses described situations in which they were bullied by physicians: “I tell the surgeon that I am missing a sponge in the count, who screams that I should go to school and learn how to count. So, I insist on stopping the surgery and refuse to give him the stitches to close the fascia…In the X-ray, the sponge was found behind the heart… I feel like I am in a warzone”. “There was a discrepancy in the surgical count, but the surgeon insisted that everything was OK. I stepped in and told him that I am the supervising nurse, and I will call his manager if he does not stop the surgery. He stopped and the sponge was found in the urethra”.

4) Recommendations to improve teamwork: most physicians and nurses suggested performing simulation training to improve teamwork in controlled settings. A surgeon suggested “a controlled simulation of interdisciplinary teamwork that would include training in leadership and communication skills”. A nurse suggested that the simulation should include “performance of safety standards and communication skills, such as speaking up and conflict management”. A risk manager suggested implementing interdisciplinary root-cause analysis after any adverse events. “Performing root-cause analysis by the OR staff will enable discussing teamwork issues freely and resolving them without concerns due to the presence of risk management or hospital administrators”. “It will lead to trust among the team members and better solutions that will prevent future errors”.

Surgeons, anesthesiologists, and nurses all thought that technological solutions would facilitate their work processes and promote a better work environment. Some surgeons suggested using a digital time-out adjusted to patient’s requirements. Anesthesiologists recommended computerized systems that would integrate patient data and signal an alert regarding anesthesia risks. Nurses thought that scanners would ease the surgical counting process.

**Discussion**

Teamwork is an essential component of risk reduction, patient safety, and staff psychological safety during a surgery, to prevent Never Events. For this study we analyzed interprofessional preoperative teamwork and its effect on intraoperative teamwork; we then identified factors affecting teamwork that are related to patient and psychological safety.

The results revealed that teamwork in the preoperative setting and consistent staff presence during a surgery, without turnover, were predictors of teamwork during surgery. A few studies have evaluated preoperative teamwork but not in relation to teamwork during surgery or to risks to patient safety, as analyzed here. Mykiebust et al. described the preoperative phase as busy, because each clinician must complete preparatory tasks as quickly as possible to prepare the patient, which can be chaotic when trying to simultaneously accomplish individual and collaborative tasks (25). This can lead to conflict and an unpleasant atmosphere. Although we did not find any studies that had directly evaluated the effect of preoperative teamwork on intraoperative teamwork in relation to safety standards, preoperative tension might continue during a surgery and inhibit the key determinants of psychological safety: speaking up, team collaboration, and experimentation (26).

Another predictor of teamwork during surgery is the number of team members. We found that that additional physicians and nurses increased the degree of teamwork. We did not find any studies that had defined an adequate team size or composition per surgery. However, other studies did find that adequate surgical team size had a positive effect on teamwork, possibly because there are more people available to help complete tasks and share the total cognitive load (27,28). Adequate staffing can compensate for unexpected emergencies or prolonged cases (29). Inadequate staffing has been identified as a barrier to teamwork, mostly by nurses and surgeons and to a lesser extent by anesthesiologists (30). In contrast, however, a few studies have found that larger teams might create barriers to optimal performance because of the greater communication demands and role ambiguity (31), which may prolong operative time (32).

Staff turnover during a surgery was considered to have a negative effect on teamwork, was perceived to show a lack of commitment, and risked a breakdown in communication due to the lack of familiarity among team members and with a patient’s condition. Nursing turnover during a surgery was found to increase opportunities for breakdowns in communication during handover (33), as it interrupts the flow of surgery (34) and may prolong it (35). A review found that anesthesiologists usually take breaks as part of their culture, but they are aware of the importance of handoffs in relation to patient safety. However, surgeons rarely take breaks, as they feel that leaving a surgery would affect its success (36).

One suggestion to improve teamwork arising from our study included working in a permanently designated team that is led by the surgeon. Surgical teams are often constructed on an *ad hoc* basis and are thus inconsistent, which can lead to a lack of familiarity (37).Familiarity enables a shared definition of teamwork and professional roles that can increase positive surgeon–anesthesiologist relationships (27,30). Doll et al. (38) found that a managerial decision to assign a particular anesthetist to a surgeon and a predefined surgical list resulted in decreased operative times. This may be because a team in which each clinician has confidence in her or his colleagues and works on the basis of common principles and values can better avoid risks to patient safety (39)

Evidence in the literature regarding who should lead a surgical team is sparse. Some have assumed that the surgeon is the leader (30), but others have assumed that it could be anesthesiologists due to their perioperative role in standardizing patient care and leadership (37).

Our interviewees described communication as an essential component of teamwork. In general, effective team communication improves patient outcomes and prevents errors (40). Safety risks can be identified and responded to by conducting a daily huddle (41).

Our findings revealed the existence of ineffective communication between surgeons and anesthesiologists, which may affect clinical decision-making and patient safety. Possible explanations for this ineffective communication include ineffective interprofessional communication (42) and differing mental models and role perceptions (11).

Our findings revealed there was some disrespectful communication between surgeons and nurses. In an earlier survey of 7,465 clinicians, 70.1% had experienced incivility and 36.9% had been bullied (43), which may inhibit individuals from speaking up and prevent the maintenance of a psychologically safe team (17). The reasons suggested include intrapersonal (personality traits, psychological conditions, transient psychological states), organizational (production pressures, mismanagement, administrative inefficiency, working conditions), and interpersonal (perception of status, hierarchy, situational triggers) (43,44).

**Strengths and limitations**

The strengths of this study include that it revealed new insights into teamwork in the OR, specifically in relation to safety. The mixed methods design allowed us to obtain a comprehensive picture of the effect on teamwork of performing an SSC. We also explored factors contributing to or preventing teamwork during surgery that could risk patient safety and a team’s psychological safety.

There were some limitations to this study, including the inability to control the observational data collected. Therefore, details regarding physicians’ and nurses’ areas of expertise and years of experience in their profession are lacking, as are data on other team members that may affect teamwork.

**Conclusion**

This study revealed that the level of preoperative teamwork can predict the level of intraoperative teamwork, specifically with regard to patient safety. We also found that the number of clinicians participating in a surgery and their level of turnover affects teamwork. Factors that would support effective teamwork are designated teams with defined roles and having leaders who promote teamwork and effective communication.

We recommend promoting the psychological safety of medical staff by mediating between individual professional roles and collaborative team roles. This could be accomplished by creating designated surgical teams with a defined leader who manages all aspects of a surgery and its teamwork, which will promote patient and psychological safety. This type of team should have sufficient familiarity with each other to solve problems, engage in mutual learning from errors, and improve safety. These teams would benefit from soft-skills training and an advanced technological environment that facilitates work processes. Further study is needed to define the appropriate size and composition of a surgical team needed to ensure patient safety in every procedure.

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**Author contributions:** All authors participated in developing the initial idea and design of the study; data collection, analysis and interpretation; and writing the initial draft and critically revising the manuscript. All authors take responsibility for the accuracy of the material contained in the study.

**Ethics:** Ethical approval for the study was obtained from the Medical Research and Ethical Committee of the Israeli Ministry of Health (MOH 032-2019), on 27 December 2019. The need for informed consent was waived because only deidentified data were used. The individuals interviewed provided verbal consent to participate and received no compensation.

**Data availability:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

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**Appendix 1. Structured observation of items representing teamwork throughout a surgery**

**Preoperative: Surgical Safety Checklist**

***Sign-in phase***

|  |  |  |  |
| --- | --- | --- | --- |
| **N/A** | **No** | **Yes** | **Statement** |
|  |  |  | Sign-in performed by surgeon, anesthesiologist and nurse |
|  |  |  | Signature (surgeon, anesthesiologist, nurse) |

***Time-out phase***

|  |  |  |  |
| --- | --- | --- | --- |
| **N/A** | **No** | **Yes** | **Statement** |
|  |  |  | Sign-in performed by all staff members present in the operating room |
|  |  |  | Time-out is performed by staff members before surgical cut |
|  |  |  | All staff members stop their activity and listen to the time-out |
|  |  |  | Verbal agreement of all staff members to details of the time-out |
|  |  |  | Signature of all staff members |

**Intraoperative: Surgical count**

***Second count - closure of fascia/cavity is initiated***

|  |  |  |  |
| --- | --- | --- | --- |
| **N/A** | **No** | **Yes** | **Statement** |
|  |  |  | Count is performed by scrub nurse and circulating nurse |
|  |  |  | Surgeon announces to nurses his intention to close the fascia/cavity before its actual closure in order for the nurses to start counting |
|  |  |  | Count is performed by two nurses when surgeon announces intention to close the fascia/cavity |
|  |  |  | Surgical count is made out loud by two nurses with the participation of all other staff members (surgeon and anesthesiologist) |

**Appendix 2. Semi-structured interview**

**Key informant interview guide**

**INTERVIEW LOGISTICS**

|  |  |
| --- | --- |
| Interview Date (month/day/year) |  |
| Interviewer |  |
| Duration of Interview (minutes) |  |
| Additional Notes |  |

**INTERVIEW QUESTIONS**

|  |
| --- |
| Part I: General information about your work position 1. How would you describe your main role at Ministry of Health (MOH)/hospital?  2. Type of clinician: Physician Nurse Other  3. Administrative status: Do you have an administrative role in the MOH/hospital?  Yes  No  <1 1-4 5-7 8-10 11-15 16-20 >21  4. Years of MOH/hospital experience: |
| **Part II: Attitude towards ‘Never Events’ in operating rooms in Israel** |
| Now I would like to focus on your attitude towards ‘Never Events’ in the operating rooms in Israel  5. How would you define 'Never Events’ in the operating rooms?  PROBE: Are there different types of 'Never Events’ in the operating rooms?  PROBE: Preventable vs. Not Preventable  6. In general, to what extent do you feel that 'Never Events’ are a real safety issue in the operating rooms?  7. Based on your experience, how frequent are 'Never Events’ in the operating rooms?    8. Based on your experience, what are the main causes of 'Never Events’ in the operating  rooms?  PROBES: On different levels; system-level factors, individual factors  9. Does MOH/your hospital (i.e., operating department) utilize a structured interventional program to eliminate 'Never Events’ in the operating rooms? If yes, please elaborate  10. Do you personally remember any targeted actions that were conducted in MOH/your hospital (i.e., operating department) to eliminate 'Never Events’ in the operating Rooms? If yes, please elaborate?  11. How comfortable are you reporting issues related to 'Never Events’ in the operating room to your manager/administration?  PROBES: How comfortable are your colleagues? |
| **Part III: Personal experience with ‘Never Events’ in the operating room** |
| 12. Were you exposed to ‘Never Event’ in the operating room? If yes, can you please tell me what happened?  PROBES: In your opinion, what were the main causes of the ‘Never Event’ in this case?  PROBES: Do you think the ‘Never Event’ in this case was preventable?  PROBES: Do you have any suggestions for how to avoid a case like that in the future?  13. Any other comments you have about this case? |
| **Part IV: Suggestions for innovative tools or processes to reduce ‘Never Events’** |
| 14. To what extent do you think that innovative solutions can help to eliminate ‘Never Event’ in the operating room?  PROBES: Care processes, educational sessions, IT solutions  15. Any suggestions for innovative tools or processes to eliminate ‘Never Event’ in the operating room?  16. Do you think that predictive analytics solutions could predict potential ‘Never Events’ in the operating room?  17. In general, what other suggestions or comments might you have for us? |

Thank you for participating. Your opinion and input are very appreciated.

THANK YOU VERY MUCH.

Table 1: Characteristics of surgeries observed.

|  |  |  |
| --- | --- | --- |
| **Characteristic** | | **Observations, number, and percentage of total surgeries (N=2184)** |
| **Surgical specialty** | General surgery | 820 (37.5%) |
| Orthopedics | 431 (19.7%) |
| Gynecology | 239 (10.9%) |
| Otolaryngology | 216 (9.9%) |
| Urology | 177 (8.1%) |
| Plastic surgery | 89 (4.1%) |
| Vascular surgery | 58 (2.7%) |
| Cardiology | 55 (2.5%) |
| Ophthalmology | 51 (2.3%) |
| Neurosurgery | 39 (1.8%) |
| **Duration of surgery\*** | >1 hour | 361 (16.5%) |
| 1–2 hours | 1164 (53.3%) |
| 2–3 hours | 196 (9%) |
| 3–4 hours | 360 (16.5%) |
| >4 hours | 103 (4.7%) |
| **Number of physicians present** at the surgical phase **(mean ± SD)** | Time out | 3.28 ±0.97 |
| First surgical count | 3.02 ±1.02 |
| Second surgical count | 3.18 ±0.90 |
| **Number of nurses present** at the surgical phase **(mean ± SD)** | Time out | 2.30 ±0.57 |
| First surgical count | 2.29 ±0.58 |
| Second surgical count | 2.22 ±0.52 |

\*Duration of surgery is represented in categories of hours, one minute differentiates between categories; SD, standard deviation

Table 2: Results of the binary logistic regression predicting a lack of teamwork throughout the surgery.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Odds ratio** | **95% CI for OR** | | **P-value** |
| **Lower** | **Upper** |
| Lack of teamwork at preoperative sign-in | 1.972 | 1.741 | 2.233 | <0.001 |
| Lack of teamwork at preoperative time-out | 2.142 | 1.879 | 2.441 | <0.001 |
| Mean number of physicians participating in the surgery | 0.830 | 0.726 | 0.950 | 0.007 |
| Mean number of nurses participating in the surgery | 0.798 | 0.642 | 0.992 | 0.042 |
| SD of the number of physicians participating in the surgery (turnover) | 1.258 | 1.001 | 1.580 | 0.049 |
| SD of the number of nurses participating in the surgery (turnover) | 1.227 | 0.985 | 1.528 | 0.068 |

SD, standard deviation

Table 3: Characteristics of interviewees.

|  |  |  |
| --- | --- | --- |
| **Characteristic** | | **Respondents, N (%) (N = 25)** |
| **Sex** | Male | 10 (40%) |
| Female | 15 (60%) |
| **Profession** | Anesthesiologist | 6 (24%) |
| Surgeon | 3 (12%) |
| Nurse | 9 (36%) |
| Risk manager (physicians and nurses) | 7 (28%) |
| **Experience in profession, years** | 1–9 | 0 (0%) |
| 10–19 | 5 (20%) |
| 20–29 | 7 (28%) |
| 30–39 | 10 (40%) |
| >40 | 3 (12%) |
| **Experience in current position, years** | 0–4 | 9 (36%) |
| 5–9 | 9 (36%) |
| 10–14 | 2 (8%) |
| 15–19 | 1 (4%) |
| 20–25 | 4 (16%) |