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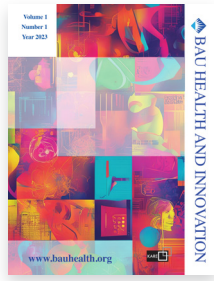

Review

Problems Related to Cables and Connections in the Operating Room: Systematic Review and Meta-Analysis

Dilay Hacıdursunoğlu Erbaş,[1] Hatice Azizoğlu,[2] Fatma Eti Aslan[1]

[1]Department of Nursing, Bahçeşehir University Faculty of Health Sciences, İstanbul, Türkiye
[2]Department of Nursing, Van Yüzüncü Yıl University Faculty of Health Sciences, Van, Türkiye

Abstract

In this systematic review and meta-analysis study, it was aimed to determine the problems caused by cables and connections used in the operating room. Cross-sectional studies published between January 2005 and September 2020 were included in the study. Five databases were scanned on September 12, 2020, to determine suitable studies. Different combinations were used with the keywords "surgical room OR operating room" AND "cables" AND "connections" and "safety." The scan initially reached 775 articles. Five of the studies included in the systematic review and meta-analysis were of the cross-sectional type. According to the combined results of these studies, 64% of operating room employees reported problems arising from cables and connections. About 45% of these problems have been detected during the surgery and 55% during the entire operating room process. It has been reported that an estimated 22% of the cables and connections in the operating room have malfunctions that the cable and connection problems arising from instrument failures are 14%, and the cable and connection problems developed in robotic surgery operations occur at an average of 42%. According to the combined results of these studies, it was determined that 22% of the cables and connections in the operating room had malfunctions and 64% of the operating room employees had problems due to cables and connections. Since there is no one solution that fits every surgery or team' for the operating rooms, all these shortcomings show the need for solutions for safe cable application in the operating room.

Keywords: Equipment and supplies, equipment safety, optical fiber, safety, surgical rooms.

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The operating room is one of the healthcare areas where high-tech devices are used and various surgical techniques are performed in the company with new information.[1] The impact of advanced technology has gained momentum with the revolutionary inventions of Kelling and Mouret in operating rooms with laparoscopic surgeries. This process continues today with minimally invasive and robotic surgery.[2–4] The situation has become complicated with the increase in the number of instruments used and transmitted in operations.[5] These types of instruments, which are increasing in number, are essential materials for performing surgical procedure and are caused by the cables and connections of the endoscopes and accessories (light source, high-resolution cameras, and monitors).[4,5] If we list these cables and connections; there are cautery device that performs the burning process, aspirator and hose that aspirates the operation area, gas hose used in laparoscopic surgery,

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Address for correspondence: Hatice Azizoğlu, MD. Van Yüzüncü Yıl Üniversitesi Sağlık Bilimleri Fakültesi, Hemşirelik Bölümü, Van, Türkiye
Phone: +90 530 873 48 93 **E-mail:** haticeazizoglu@yyu.edu.tr
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camera cable, light cable, and many other cables and connections depending on the surgery.[1]

Disorganized equipment caused by connections causes many undesirable situations such as congestion and cable-line entanglement. Cables and connections; There are opinions that any trocar occupies the place during the operation, it is difficult to control the connections, and that an extra team member is required to ensure that the operation field takes a stable condition. The high number of cables and the plugging and unplugging of the connections complicate the treatment process, as well as prevent nursing interventions and cable transfers. Due to these problems, the movements of operating room team members are prevented, there are problems in fixing the cable, and problems such as unwanted cable/connection failures and breaks may occur.[5–7] Furthermore, many patient deaths, permanent injuries, life-threatening situations, and the possibility of damage to the devices have been reported in hospitals related to the problems related to the cables of medical devices.[8] Despite these difficulties caused by cable entanglement, there is no suitable and comprehensive solution in the literature.[5,9,10] Various design solutions have been proposed to prevent the physical entanglement of connections and cables in the operating room. These recommendations; a panel attached to the equipment cart, a multi-compartment cover for accommodating instruments and a foot pedal;[11] a hanger over the ceiling that helps guidelines and cables into the sterile area;[12] ceiling-mounted columns that descend to the surgical environment when desired and return to a place after use;[13,14] ceiling-mounted equipment;[15] and marking of lines and cables with different colors and patterns.[16]

We see that the problems related to cables and connections that cause physical and electrical disruption in the operating room continue since these recommendations, which are not widely used in the clinic, are not implemented. There is no comprehensive literature review in the literature reflecting the problems experienced in the operating room due to cables and connections. It is thought that determining these problems will guide the surgical team members and researchers. In this systematic review and meta-analysis study, it was aimed to determine the problems caused by cables and connections used in the operating room.

Research Questions

- How do cables and connections used during surgery affect patients/healthcare professionals?
- What are the problems caused by cables and connections used during surgery?

For this purpose, answers were sought for the research questions prepared according to PEOS (Table 1).

Method

This study was conducted as a systematic review and meta-analysis. Preferred Reporting Items for Systematic Reviews and Meta-Analyzes statement (PRISMA) criteria were used in the preparation and reporting of the study.[17]

Eligibility Criteria

The selection of the studies suitable for this systematic review and meta-analysis was determined according to PEOS (Table 1). Studies, between January 2005 and September 2020; studies on cables and connections used in the operating room and published in national and international journals related to the problems experienced took place. The studies included descriptive, observational, and prospective studies published in English and Turkish. Intervention studies, reviews, case studies, and studies of their nature were excluded from the scope.

Scan Strategy

Scholar Google, Web of Science, Ovid, Cinahl, Medline, Sage Journal, and Wiley Online Library databases were scanned on September 12, 2020 to determine suitable studies. In these databases, different combinations were used with the keywords "surgical room OR operating room" AND "cables" AND "connections" and "safety." Besides, reference lists of the included studies were checked.

Selection of Studies

Based on the inclusion criteria, the titles and abstracts were reviewed by two researchers and full-text selections were made independently. Any inconsistencies in the selection of the included article were resolved through discussion. Reference lists of appropriate articles were reviewed.

Evaluation of the Methodological Quality of the Studies

Critical valuation checklists developed for analytical cross-sectional studies by the Joanna Briggs Institute (JBI) were used for the quality assessment of the articles. JBI's critical valuation checklist developed for analytical cross-sectional research consists of eight items. The questions in these checklists are answered with the options "yes, no, uncertain, not applicable."[18] The evaluation results for each study included in this study are given as "quality score" in Table 2. The quality assessment process was done independently by two researchers, and the questions that were answered differently were agreed on by discussion and combined into a single text.

Table 1. PEOS

Components of the problem	Definition/Explanation	Keywords*	Alternative search terms*
Patient/problem/participants (P: Patient/Problem/Population)	Staff working in the operating room and patients	Operating room, surgical room	
Intervention (E: Exposure)	Cables and connections used in the operating room	Cables, connections	
Findings (O: Outcomes)	Staff statements Fault messages Tool failure During the surgery problems Problems in the operating room Robotic surgery	Safety, Operating room, surgical room, cables, connections	
Pattern of the study (S: Study design)	Controlled clinical trials Descriptive research Retrospective studies		

Table 2. Quality assessment scores

Author's name, year of study	Type of study	Quality score
Koneczny 2009	Descriptive cross-sectional study	Yes: 5/6 No:3/2
Matern et al. 2007	Descriptive cross-sectional study	Yes: 5/7 No:3/1
Nayyar et al. 2009	Observational cross-sectional study	Yes: 7/7 No:1/1
Friedman et al. 2013	Descriptive cross-sectional study	Yes: 6/7 No:2/1
Tapper et al. 2009	Prospective cross-sectional study	Yes: 6/7 No:2/1

Data Retrieval (Withdrawal/Extraction)

Research data were obtained with the data extraction tool developed by the researchers. With this tool, data about the author and publication years of the studies, the study pattern, the type of problems developed for cables and connections, the sample size, and staff reports were obtained. This process was carried out by two researchers independently and compared to a single text. In cases where there are different data, the relevant article was checked again and the correct data were taken.

Statistical Analysis

In this systematic review, the data obtained from quantitative studies (five studies) were combined by doing a meta-analysis (pooled estimates). The meta-analysis of the study was performed using Comprehensive Meta-Analysis Version 3-Free Trial (https://www.meta-analysis.com/pages/demo.php). The heterogeneity between studies was assessed by the Cochran Q and Higgins I^2 tests and an I^2 >50% was considered to indicate statistically significant heterogeneity. The results were RandomEffect if the I^2 was 50% or more, and if less, FixEffect. About 95% confidence interval (CI) and estimated ratios were calculated for each outcome variable.[19]

Results

Scan Findings

As a result of the scanning, a total of 775 studies were reached. As a result of the examinations made according to the title, abstract, and full text, respectively, 20 articles were reached. Data extraction with five articles was performed as a result of removing repetitive records and examining them according to inclusion criteria. Explanations about the selection of the articles and the process of receiving them are shown in Figure 1.

Characteristics of Studies and Participants

Three of the studies included in the systematic review and meta-analysis were descriptive, one observational, and one prospective (Table 2). A total of 1124 operating room

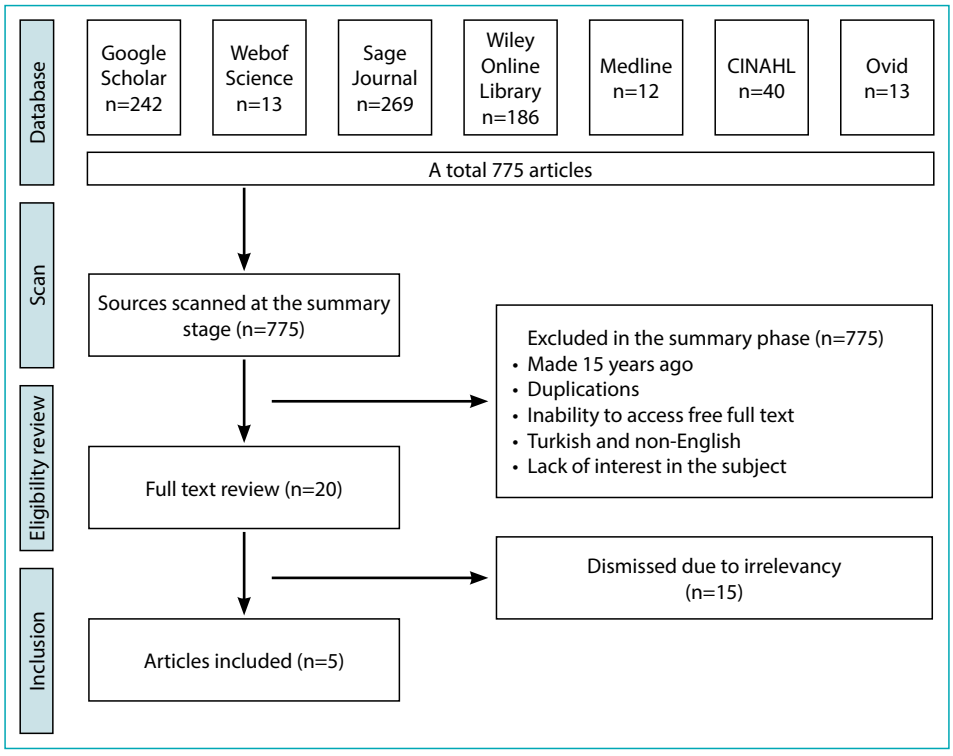

Figure 1. PRISMA flow chart.

employees and 5964 surgeries were involved in the studies. Two of the studies were conducted in the United States, two in Germany, and one in India. In the studies, it was seen that the average time between the year the data was collected and the year of publication was 2 years.

Quality Assessment Findings

Among the studies included in this systematic review and meta-analysis, 5–7 items of the eight-item quality assessment tool of five cross-sectional studies were met as "yes" (Table 2).

Publication Bias

To determine publication bias in meta-analysis studies, Kendall's tau b coefficient should be calculated. In the absence of publication bias, this coefficient is expected to be close to 1 and the two-tailed p value is expected to be greater than 0.05. According to the values calculated in this statistic (Kendall's tau b = 0.32; p = 0.08), there was no publication bias in the included studies.

Meta-Analysis Findings

In this systematic review and meta-analysis, the developing problems of cables and connections and failure reports were categorized as instrument failures, personnel reports, and cable and connection problems occurring in robotic surgery operations. In three of the studies (Konenczny,[20] Matern et al.,[21] Nayyar et al.[22]), malfunctions for cables and connections were reported. According to the combined results of these studies, it was reported that an estimated 22% of the cables and connections in the operating room had malfunction (95% CI: 0.009–0.052; z=–8.270; p=0.000; I^2=92%). In three of the studies, it was reported that there were cable and connection problems due to instrument failures (Konenczny,[20] Matern et al.,[21] Nayyar et al.[22]). According to the combined results of the studies, cable and connection problems due to device failures were seen at a rate of 14% (95% CI: 0.001–0.275; z=–2.543; p=0.000; I^2=96%). In two of the studies (Friedman et al.,[23] Tapper et al.[24]), it was reported that operating room staff had problems with cable and connections. According to the combined results of the studies, an estimated 64% of operating room employees were reported to have problems with the cables and connections in the operating room (95% CI: 0.481–0.760; z=1.715; p = 0.086; I^2=96%). In three of the studies, it was reported that problems arising from cables and connections in the operating room occurred in robotic surgery operations (Konenczny,[20] Matern et al.,[21] Nayyar et al.[22]). According to the combined results of the studies, cable and connection problems developed in robotic surgery operations were observed with an average rate of 42% (95% CI: 0.024–0.075; z=–10.131; p=0.000; I^2=95%) (Fig. 2).

In this systematic review and meta-analysis, the problems related to cables and connections in the operating room

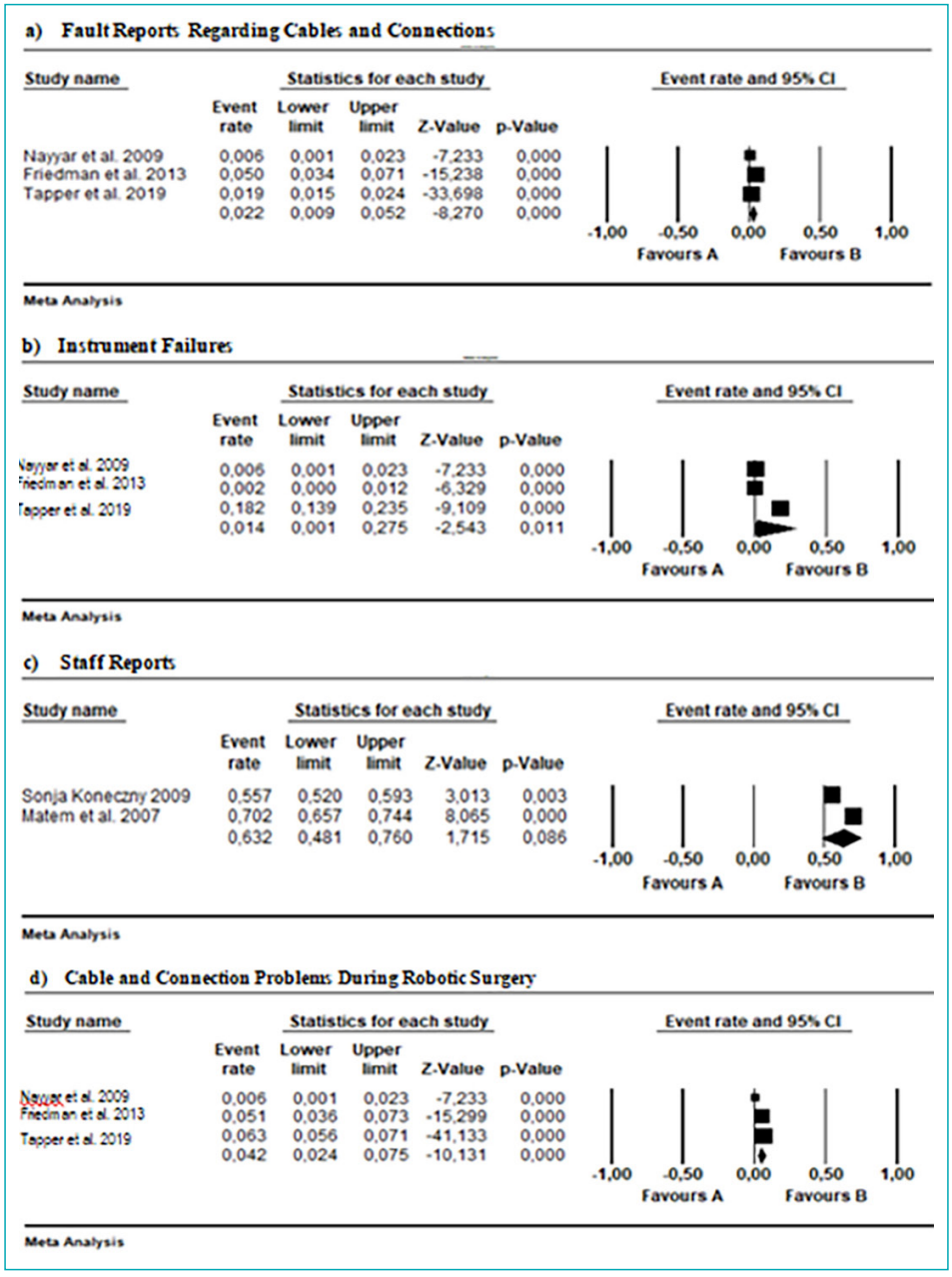

Figure 2. (a) Fault reports regarding cables and connections, (b) Instrument failures, (c) Staff reports, (d) Cable and connection problems during robotic surgery.

CI: Confidence interval.

were considered as the surgery and operating room process. In three of the studies, it was determined that the questions regarding the cables and connections used in the operating room may also occur during the surgery (Friedman et al.,[23] Tapper et al.,[24] Koneczny[20]). According to the combined results of these three studies, 45% of the problems arising from the cables and connections used during surgery were detected (95% CI: 0.194–0.734; z =–0.329; p=0.742; I^2=98%). In two of the studies, problems related to cables and connections were reported in the period covering the entire operating room process (Friedman et al.,[23] Tapper et al.,[24]). According to the average results of the two studies, 55% of the problems related to cables and connections were reported during the operating room (95% CI: 0.518–0.576; z=3.183; p=0.001; I^2=0%) (Fig. 3).

This study was conducted as a systematic review and meta-analysis to examine the problems related to cables and connections used in the operating room. The combined

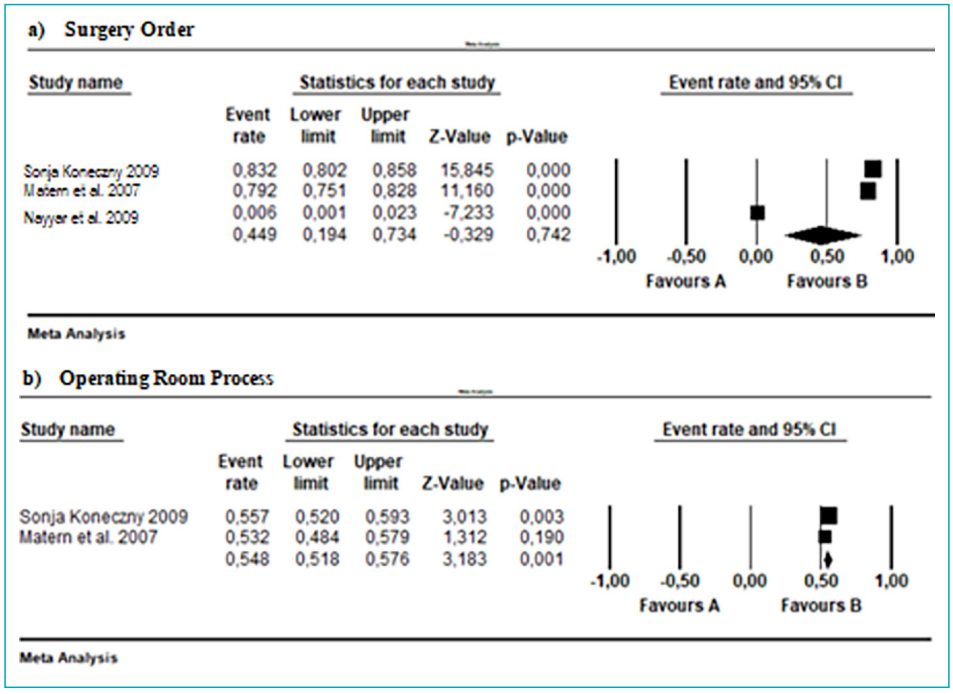

Figure 3. (a) Surgery order, (b) Operating room process.

results of five studies are presented in the study. The results obtained may contribute to the elimination of problems related to cables and connections used in the operating room. In this systematic review and meta-analysis; an estimated 64% of operating room employees were reported to have problems with the cables and connections in the operating room. In the study by Koneczny and Matern,[25] 43% of the employees reported that cable routing prevented their work. The failure rate in cables and connections in the operating room was 22%, and cable and connection problems caused by device failures were 14%. In the study conducted by Courdier et al.,[26] it was reported that the failure rate due to cables was 42.3%, and device failure (video light cable) was reported at a rate of 3.4%. In our study, problems related to cables and connections used in the operating room were 45% during the operation and 55% during the operating room process. Koneczny and Matern[25] reported a problem of 21.4% during surgery and 28.5% during the operating room process. About 78.5% of them stated that they had problems during device transport in the operating room. Cable and connection problems developed in robotic surgery operations were seen with an average of 42%. In the study conducted by Alemzadeh et al.[27] cable and connection problems recorded in the database for 14 years regarding cables and connections were reported to be 47.9% on average.

According to the combined results of these studies, it has been determined that 22% of the cables and connections in the operating room have malfunctions and 64% of the operating room employees have problems due to cables and connections. Problems related to cables and connections were detected at a rate of 14% due to instrument failures, 42% during robotic surgery, 45% during surgery, and 55% during the entire operating room process. Since there is no one solution that fits every surgery or team' for the operating rooms, all these shortcomings show the need for solutions for safe cable application in the operating room. Many of these shortcomings can be overcome by simple means such as reducing the number of different devices and compulsory training in the use of devices, as device operation is one of the main causes of potential hazards in the operating room. It is thought that it will be beneficial to use new and effective techniques (cable organizers, wireless operation, etc.) in routing the connections during the surgery to ensure cable safety in the operating room. Solutions should be produced for the problems related to cables and connections used in the operating room and it is deemed appropriate to support the effectiveness of these solutions with studies.

Study Limitations

The small number of studies is the most important limitation of this meta-analysis. The current findings resulting from these limitations should be carefully evaluated. Considering the last fifteen years in the evaluated studies and not questioning the criteria to prevent all problems caused by cables and connections in the operating room are other limitations.

Disclosures

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Authorship Contributions: Concept – F.E.A., H.A., D.H.E.; Design – F.E.A., H.A., D.H.E.; Supervision – F.E.A.; Data collection and/or processing – H.A., D.H.E.; Data analysis and/or interpretation – H.A., D.H.E.; Literature search – H.A., D.H.E.; Writing – H.A., D.H.E.; Critical review – F.E.A.

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