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THE IMPLICATIONS OF AWARENESS DURING ANESTHESIA: A LITERATURE REVIEW

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ABSTRACT

A review of literature was conducted in order to explore the effects of unintended awareness during general anesthesia. The aims of the integrative review were to synthesize current evidence based practice, identify its implications on practice, and identify important research gaps in order to create recommendations for future research. The four main goals were to identify the most effective methods used to determine intra-operative awareness postoperatively, examine the incidence of awareness, evaluate the experiences of patients, and discuss the implications for the individual and society as a whole.

The PRISMA checklist (2009) was used to structure this systematic review of literature. An article search was conducted by searching the Nursing Reference Center, ProQuest Nursing and Allied Health Journals, and the Cumulative Index for Nursing and Allied Health (CINAHL) databases using key words “awareness” and “anesthesia.” The inclusion and exclusion criteria narrowed the results to 19 studies included in this literature review.

The results showed that there are numerous methods used post-operatively to make the determination of awareness. The most common method is a short patient interview conducted from one to three times. This wide fluctuation in research methods leads to a wide range of statistical incidence reported in these studies. Therefore, one of the major gaps in the literature is the development of a standardized tool to assess awareness.

Patient experiences during awareness most commonly featured auditory perceptions and the desire, but inability, to move. The review of literature also revealed multiple instances of unintended awareness events leading to the development of post-traumatic stress disorder (PTSD).

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Chapter 1

Introduction

General anesthesia during surgical procedures allows life-saving medical interventions to be performed while causing minimal distress to the patient. Inducing a reversible state of paralysis and unconsciousness allows surgeons to perform procedures that would be otherwise physically and mentally intolerable to the awake patient. Although definitions for the term 'general anesthesia' vary slightly, the essential components are reversible state of relaxed muscle tone, inhibition of autonomic hemodynamic reflexes, and unconsciousness (Lennmarken & Sandin, 2004).

The first documented case of anesthetic use was for a tooth extraction in 1846. The dentist William Morton successfully used ether as a painkiller for the procedure. The patient had memories of the surgery, but indeed felt no pain (Lennmarken & Sandin, 2004). Therefore, this was also the first documented report of awareness during anesthesia. Though at the time it was considered a success to perform an operation free of pain for the patient, the current goal of general anesthesia is for the patient to be unconscious during the full procedure.

This goal exists largely because of the introduction of drugs that cause complete muscle relaxation, also known as paralysis. In 1942 the use of the drug curare allowed surgeons to complete operations that were previously hindered by tense muscles (Robinson & Toledo, 2012). For example, a surgeon struggling to close a contracted abdominal wall bloused the patient with curare and was easily able to suture it after it had relaxed (Robinson & Toledo, 2012).

Presently, steroid-based drugs such as vecuronium and rocuronium are favored to provide a neuromuscular block due to their minimal side effects (Robinson & Toledo, 2014). However, because of these neuromuscular blocking agents, it is possible for a patient to be awake and in distress while receiving general anesthesia but powerless to communicate it to anyone. A breakthrough study conducted in 1970 that is still looked to as a major guide in the field today defined awareness during anesthesia as "the ability to recall, with or without prompting, any events which occurred during the period at which it was thought the patient was fully unconscious" (Brice, Hetherington, & Utting 1970, p. 535). Awareness during general anesthesia becomes an issue when a patient is able to recall experiencing any form of distress including fear, pain, or anxiety during the procedure.

Although it is widely recognized that accidental awareness is a serious potential complication of surgical procedures, the incidence of occurrence is difficult to know with certainty. There is evidence that this phenomenon is only reported to medical professionals in one out of 30 instances (Pandit, Cook, Jonker, & O'Sullivan, 2013). Furthermore, an awareness event can only be assessed via patient report, resulting in measurements that are purely subjective. The lack of an objective measuring tool for awareness during general anesthesia has potentially lead to under-appreciation for the frequency and severity of its impact.

Significance

Patients often report experiencing pain, anxiety, fear, and the inability to comprehend their situation during experiences of intra-operative awareness (Sandin, Enlund, Samuelsson, & Lennmarken, 2000). These stressors are significant issues in and of themselves; however, they

can go on to cause even more problems in the future. The implications of unintentional awareness during medical procedures often have a long-lasting impact on the lives of patients. Past studies have shown that intra-operative awareness has been associated with complications as serious as post-traumatic stress disorder (Lennmarken, Bildfors, Enlund, Samuelsson, & Sandin, 2002).

Current literature on intra-operative awareness identifies many issues that are not only relevant for the individual experiencing them, but for the people close to them and even society as a whole. In some cases, intraoperative awareness has resulted in increased anxiety in the workplace (Salomons, Osterman, Gagliese, & Katz, 2004). This could jeopardize workplace productivity. Long-term psychological complications may lead victims to seek out psychological help related to their problems (Ghoneim, Block, Haffarnan, & Mathews, 2008). As a result, the cost of healthcare for these individuals is further increased. With the current political changes surrounding cost of healthcare and insurance, it is increasingly important to analyze any additional expenses related to accidental awareness during surgery, especially if they are preventable.

Objectives

This paper will synthesize current evidence based practice on the subject of intraoperative awareness during general anesthesia in order to identify its implications on practice. Furthermore, important research gaps will be identified in order to create recommendations for future research. Four main objectives are addressed in this literature review:

1. Identify the most effective methods used to determine intra-operative awareness postoperatively.
2. Examine the incidence of awareness and barriers to obtaining accurate estimations of incidence, as well as strategies to overcome these barriers.
3. Evaluate the experiences of patients who report having been aware during an operation or procedure using general anesthesia.
4. Discuss the implications of the negative effect of intra-operative awareness on the individual and society as a whole.

Chapter 2

Methods

The PRISMA checklist (2009) was used to structure this systematic review of literature. Searches for scholarly literature were conducted using three databases. The Nursing Reference Center, ProQuest Nursing and Allied Health Journals, and the Cumulative Index for Nursing and Allied Health (CINAHL) databases were all searched using the key words "awareness" and "anesthesia." Only articles that met specific criteria were selected for inclusion in the literature review. Inclusion criteria consisted of:

- Scholarly, peer reviewed research studies
- English language publications
- Studies focused on adult population only, age 18 and older
- Published in 2000 or later

One important exception to the date limiter was allowed. The study *A Simple Study of Awareness and Dreaming During Anaesthesia* by Brice, Hetherington, and Utting (1970) was included due to the significance of the awareness assessment screening tool developed in this publication. The study remains relevant because nearly all modern-day studies feature a modified form of this assessment tool.

Search Strategy

Preliminary searches from the CINAHL database yielded a total of 134 results. In the Nursing Reference Center database, the same preliminary search resulted in 302 articles. The ProQuest Nursing and Allied Health Journals database resulted 37 articles from the search.

Between the three database searches, nine publications were identified as duplicates and subsequently removed. Articles were then eliminated by title and abstract if the subject did not pertain to awareness during general anesthesia. 59 studies focused only on methods of prevention of awareness during general anesthesia, which was not a theme of this literature review. Therefore, they were excluded.

This left a total of 13 articles eligible for full text review. A hand search of the reference list of these remaining articles yielded an additional six articles that met the above inclusion criteria. The Hawker quality appraisal tool (2002) was used to analyze all 19 of these articles to determine if they were satisfactory for inclusion in this literature review. This screening tool was used to rate nine key areas of each article:

- Title and abstract
- Introduction and aims
- Methods and data
- Sampling strategy
- Data analysis
- Ethics and bias
- Results
- Transferability
- Implications and usefulness

Each section could receive a ranking of ‘good,’ ‘fair,’ ‘poor,’ or ‘very poor.’ Each study received a rating of ‘good,’ making them eligible for inclusion in this paper. The full Hawker quality appraisal tool is shown in appendix A. The PRISMA flow diagram outlining the research process is shown below in Figure 1.

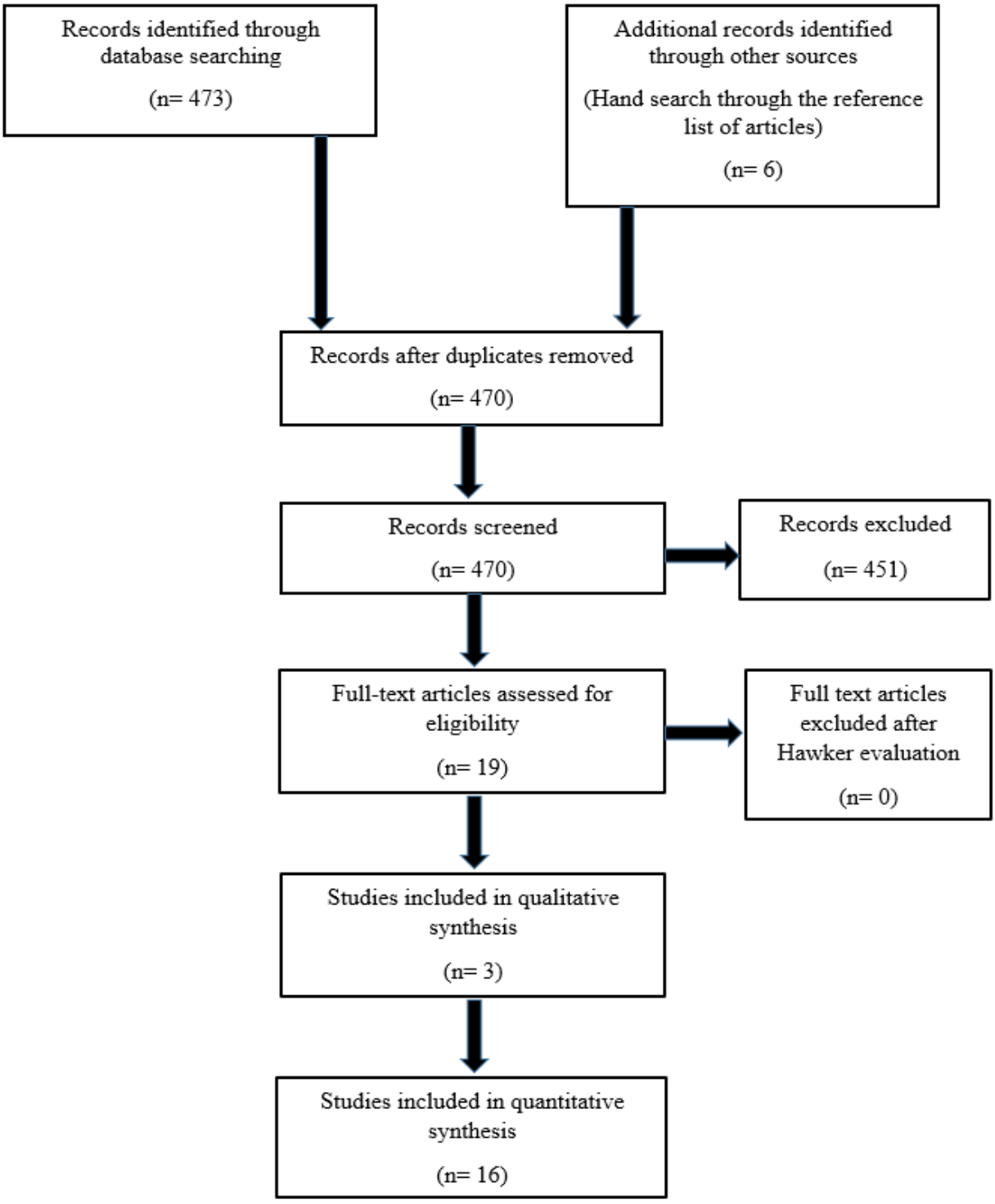

Figure 1. Literature Selection Process: PRISMA flow diagram

Chapter 3

Results

Modern research articles on the topic of awareness during general anesthesia use a variety of techniques to assess for the occurrence of awareness postoperatively. The most common is a modified form of an interview developed by Brice and colleagues in the 1970's. The variety of assessment methods creates a broad range of reported statistical incidence in the literature. However, it is important to look at patients who have experienced awareness during anesthesia as more than just a number. The American Association of Nurse Anesthetists recognizes that "a patient's experience of unintended awareness may manifest itself in several ways and may not be immediately apparent" in their position statement (2016, p. 3). Reported patient experiences during surgery include pain, anxiety, stress, and the inability to move or breathe (Sebel et al., 2004). These experiences have been shown to lead to severe psychological consequences in some patients. Research has proven that "it is no longer a matter of controversy as to whether or not intraoperative awareness with explicit recall can lead to PTSD or PTSD symptoms" (Mashour & Avidan, 2015, p. i21). The review of literature revealed four key themes: methods used to determine awareness postoperatively, the incidence rate of intra-operative awareness, patient experiences, and the short and long term implications of an awareness event. Each theme will be discussed in detail.

Methods Used to Determine Awareness Postoperatively

Currently, a great deal of literature exists about methods to assess patients during their operations to detect possible awareness. This is done in the hopes that anesthetic agents can be

adjusted and awareness prevented. However, a gap in the literature remains present regarding how healthcare providers can best determine if these interventions were effective. Presently, the only way to know with certainty whether awareness took place is to ask the patients themselves after the procedure utilizing general anesthesia is complete.

The key factor to determine incidence and patient experience of intra-operative awareness is a reliable method of screening patients postoperatively. However, a method widely accepted as the "gold standard" is yet to be determined. The review of literature revealed that numerous methods exist for extracting patient reports regarding awareness. In fact, no two studies in this literature review have used identical methods for determining awareness postoperatively. This has led to large fluctuations in reported incidence rates, from 0.0068% to 0.16% (Pollard, Coyle, Gillbert, & Beck, 2007; Sandin et al., 2000).

A monumental study by Brice et al. (1970) set forth a screening tool designed to differentiate between patients who have absolutely no recall of their procedure, those who experienced awareness, and those who had dreams. Open-ended questions were asked to patients after their operation about their thoughts, experiences, and memories of the procedure. It is important to note that the questionnaire did not include any questions that directly asked patients whether they were aware during their procedure. However, the comprehensive list which asks patients to recall experiences before, during, and after surgery presents multiple opportunities for a patient to disclose awareness.

The following questions were asked of each patient:

1. What was the last thing you remember happening before you went to sleep?
2. What is the first thing you remember happening on waking?
3. Did you dream or have any other experiences whilst you were asleep?

4. What was the worst thing about your operation?
5. What was the next worst?

These questions were designed to elicit any possible recall. Additionally, the questions were asked twice, strengthening the evidence for using this tool. Patients were evaluated during the first 24-48 hours after the operation and again approximately one week later (Brice et al., 1970). By assessing patients twice, the subjects had another opportunity to report awareness and recall their experiences once the anesthesia was completely out of their system. This set of questions has since been modified and has been used in the majority of studies conducted in the past four decades.

A study was conducted by Mashour et al. (2013) to compare use of the Brice interview to a routine quality assurance follow-up used on the first postoperative day. At the time of the study, the quality assurance follow-up was standard practice at the participating hospitals. Mashour and colleagues wanted to know if the two methods produced a difference in reported incidence rates of intra-operative awareness.

The quality assurance interview was conducted by nurses, certified registered nurse anesthetists (CRNAs) and anesthesiology residents who asked the general question "Did you have any problems with the anesthesia for your surgery?" If a patient complained of awareness with recall when answering this question, the data was entered into an anesthesia information management system by selecting 'intraoperative awareness' from a list of possible complications (Mashour et al., 2013).

The Brice interview was modified to include the following five questions:

1. What was the last thing you remember before anesthesia?
2. What is the first thing you remember after waking up?

3. Do you remember anything between going under anesthesia and waking up?
4. Did you dream during your procedure?
5. What was the worst thing about your operation?

Overall, the study looked 21,601 patients. All of these patients underwent the routine quality assurance interview. Of these participants, 18,836 were also asked the modified Brice questionnaire once after surgery. This took place sometime between 28 and 30 days later (Mashour et al., 2013). Patients who had a positive response to question number three had their anesthesia records examined and were interviewed again by an anesthesiologist. A review committee blinded to the study then examined the two interviews and judged occurrence of awareness with recall to be definite, possible, or none. The reviewers determined definite awareness with recall in 19 of these 18,836 individuals, a 0.1% incidence rate. The quality assurance interview question resulted in three reports of awareness with recall in the 18,836 patients. This created an incidence rate of 0.02% when using the quality assurance interview method (Mashour et al., 2013). It is important that the Brice interview encompassed all reported events of awareness, no patients reported awareness with the quality assurance question and denied it on the Brice interview. Therefore, this study concluded that use of the modified Brice questionnaire method produces significantly higher rates of intra-operative awareness than a generalized, open-ended question about problems with anesthesia. Importantly, this means quality assurance initiatives which use spontaneous reports to determine awareness likely reveal a falsely low estimation of frequency.

Another form of the Brice interview questions was used in a Swedish study conducted by Sandin et al. (2000). A patient population of 11,785 was questioned a total of three times. First, immediately after general anesthesia in the post anesthesia care unit (PACU), again 1-3 days

later, and finally 7-14 days after anesthesia. The modified Brice questions, although similar to the previous study, included these minor changes to wording to help assess for conscious awareness:

1. What was the last thing you remember before you went to sleep?
2. What was the first thing you remembered after your operation?
3. Can you remember anything in between?
4. Can you remember if you had any dreams during your operation?
5. What was the worst thing about your operation?

Any patient with possible recall at any of the three interviews was interviewed a second time by four investigators (Sandin et al., 2000). Based on the results of this interview they determined the event to be definite, probable, and possible. In order for awareness to be deemed definite, the recalled event had to be confirmed by the operating room staff present during the surgery. Probable cases were ones in which no confirmation of the event could be obtained, but the team was convinced it was real. Cases were classified as possible if there were no definitive events indicating awareness (Sandin et al., 2000).

In all, 19 patients reported awareness when responding to the interview questions during at least one interview, 0.16% (Sandin et al., 2000). After reviewing the patient's descriptions seven were deemed definite, eight probable, and four were considered possible (Sandin et al., 2000). The published incidence statistic, 0.16%, included all of these patients, regardless of their likelihood of having been aware according to the research panel. Therefore, in order to better compare these statistics to other studies, which determined incidence based solely on instances of patients determined to be definitely aware, the definite incidence rate calculates to be 0.06%.

Another important finding from this study was that the timing of the interviews significantly correlated with the number of positive responses (Sandin et al., 2000). During the first interview in the PACU, six patients reported recall. When undergoing the second interview, which took place one to three days later, 12 individuals recalled awareness; this included five of the original six who had reported awareness in the PACU. A total of 17 patients recalled awareness during the final interview seven to 14 days after their procedure. Some of these patients' memories fluctuated and they recalled awareness at some interviews but not others. However, overall the number of patients reporting awareness grew significantly as time passed, nearly tripling. This suggests that ability to explicitly recall events during general anesthesia may increase as time progresses (Sandin et al., 2000).

A major study of anesthesia in the United States also used a modified Brice interview to assess for awareness (Sebel et al., 2004). 19,575 patients were interviewed initially in the recovery room immediately after surgery, and for a second time approximately one to two weeks post operatively. The questions in this version were as follows:

1. What is the last thing you remember before going to sleep?
2. What is the first thing you remember waking up?
3. Do you remember anything between going to sleep and waking up?
4. Did you dream during your procedure?
5. What was the worst thing about your operation?

During the first postoperative interview 49 patients answered yes to question three (Sebel et al., 2004). That number increased to 80 positive responses during the one to two week follow-up interview. After listening to detailed patient descriptions from those individuals who reported memories, the principal investigators of the study classified reported experiences as dreaming, no

awareness, possible awareness, or awareness (Sebel et al., 2004). To qualify as awareness recalled events had to be confirmed by someone in attendance of the operation, or convince the investigators it was real even if it could not be confirmed. Possible awareness was determined if no events definitively indicative of awareness could be recalled. If the events were too vague and had a high probability of occurring such as talking or music, it was categorized as no awareness (Sebel et al., 2004).

Overall, it was determined that 25 cases of awareness definitely occurred, resulting in an incidence rate of 0.13% (Sebel et al., 2004). Additionally there were 46 cases of possible awareness, a 0.23% occurrence (Sebel et al., 2004). The findings of this study show a similar incidence rate to that found by Mashour and colleagues (2013).

Another adaption of the Brice interview used the following modified Brice interview for 87,361 patients (Pollard et al., 2007).

1. What was the last thing you remember before surgery?
2. What is the first thing you remember once you woke up?
3. Did you have any dreams while you were asleep for surgery?
4. Were you put to sleep gently?
5. Did you have any problems going to sleep?

The questions at the end which were added by this research team were designed to elicit information in a non-alarming way. The patients were interviewed in the immediate postoperative period and then again one to two days afterward. There were no follow-up interviews in the next few weeks after the procedure as there was in many of the other examined studies.

Like the Mashour et al (2013)., Sandin et al. (2000), and Sebel et al. (2004) studies, after the patient reports were taken, reported recall events were analyzed and classified as either definite or possible awareness. Researchers classified reported incidents as possible recall if the patient showed no evidence of pain or direct memory of any portion of the procedure (Pollard et al., 2007). The event was labeled definite awareness if specific events could be recalled, convincing the researchers of its authenticity. Using this technique, the study discovered a total of six cases of either definite or possible awareness. Statistically, this meant a 0.0068% incidence rate. This is significantly lower than many other studies using a modified Brice screening tool, especially when considering the fact that cases of possible awareness were included in the published incidence rate. Of these six cases, four were considered definite awareness and two were possible (Pollard et al., 2007). In order to better compare the study to others examined in this literature review, the incidence of definite awareness was calculated, resulting in a rate of 0.0046%.

One potential cause of comparatively low incidence was due to the timing of the interview and a lack of a late follow-up interview, more than a week after discharge. However, Pollard et al. (2007) note that in the time frame between the conclusion of the study and its publication none of the participants had spontaneously come forward with formal or informal complaints of awareness.

Another possibility for the low incidence rated in this study were that the modifications made to the screening questionnaire resulted in underestimation of incidence (Pollard et al., 2007). The biggest change was made to the third question, which was the key question used to assess for awareness in all of the previously examined studies. Rather than asking a derivative of the question “do you remember anything between going to sleep and waking up” as Mashour et

al. (2013), Sandin et al. (2000), and Sebel et al. (2004) did, Pollard et al. asked about dreams specifically. Additionally, the end of question was phrased "while you were asleep for surgery" (Pollard et al., 2007). This phrasing implies that the patient was in fact asleep, when that may not have been the case. There is a possibility that the phrasing of this question deterred some patients from stating that they had been aware. Another change was made to the fifth question which in the research conducted by Mashour et al (2013)., Sandin et al. (2000), and Sebel et al. (2004) asked about the worst part of the operation. Pollard et al. changed it to ask if there were problems going to sleep (2007). This alteration is another area which may have caused a difference in the number of reported incidents.

However, it is a possibility that the changes made to the questions did not greatly impact the incidence of awareness during anesthesia found by Pollard et al. (2007). Based on the results of Mashour et al. (2013), there evidence that explicit assessment for recall is more important than specific questions used.

Other than the comparative study conducted by Mashour et al. (2013), no studies critiquing the Brice interview method were found while conducting this literature review. This is a significant research gap. One issue which should be examined specifically is how the "modifications" made to the interview questions impact response rates. Another element which should be examined is how the number and timing of interviews affects interview results. As demonstrated by Sandin and colleagues (2000), the number of reported cases of awareness appears to grow with every interview. Supplementary research could reveal if this increase eventually reaches a limit. Furthermore, the interpretation of responses varies from study to study. Additional analysis needs to be completed to determine the best method of interpreting

and categorizing responses so that, ideally, a standardized tool can be developed. This would allow studies to be more precisely replicable.

Another method to assess the frequency of intra-operative awareness during general anesthesia is to survey anesthetists directly. This allows a far greater patient population to be assessed than studies which follow a specific cohort of patients for a set time period, from surgery on. Therefore, this different approach to determining incidence was used by the United Kingdom's 5th National Audit Project (NAP5) (Pandit, Cook, Jonker, & O'Sullivan 2013). Across the UK, 329 hospitals were sent a data summary form which asked anesthesia staff the question of how many new cases of awareness under general anesthesia, under their direct or supervised care, were reported to them in the previous calendar year (Pandit et al., 2013). Responses were received from all 329 hospitals, but only from 82% of their anesthetists. In total 153 new cases of awareness were reported for the past year across all of the centers (Pandit et al., 2013). Another section of the same study had calculated the number of general anesthetics administered per year in Britain to be 2,872,600. This number was adjusted for the 82% response rate, creating a calculated incidence 0.0065% (Pandit et al., 2013).

After this baseline estimation of incidence was determined, the researchers went on to create a database for filing new reports of awareness. For one year, a representative from each of the facilities had access to this database and any time they learned of an awareness event at their facility, it was entered into the database along with patient demographic data and a description of the event (Pandit et al., 2013). Routine screenings for awareness at each of the facilities remained in place, but the study required no further efforts to encourage patients to come forward. As a result the data collected relied heavily on spontaneous patient report. Complaints made on behalf of the patient by caregivers, relatives, or friends made up a small fraction of filed

incidents, nine cases. In six cases an anesthetist suspected awareness and initiated the discussion with the patient (Pandit et al., 2013).

A research panel reviewed each entry in the database. If the detail of the patient report was verified independently or was consistent with awareness and awareness was suspected in the case notes, the entry was deemed certain or probable (Pandit et al., 2013). If the report was reasonable, but lacked verifiability or a degree of detail, it was considered possible. After review, 141 of the 2,800,000 procedures using general anesthesia that year deemed 'certain,' 'probable,' or 'possible' awareness. The calculated incidence rate was therefore 0.005% (Pandit et al., 2013).

Remarkably, this rate is most similar to the findings of Pollard et al., 0.0068% (2007). This is despite the two studies being conducted using extremely different methods of assessing for awareness.

Further considerations for the vast difference in results compared to previously published studies may include the types of anesthetic agents used or anesthesia providers involved. Additionally, the study was several times removed from the patients themselves, leading to a potential loss of reported incidences, and a probable loss of detail, especially considering the fact that researchers did not have access to the patients' medical records (Pandit et al., 2013).

Incidence

As is evidenced by the previous chapter, the incidence rate found by a study is impacted significantly by the methods used to detect intra-operative awareness. Table 1 shows the

reported incidence from each of the studies described in the previous section to provide a cohesive overview of the literature and allow for easy comparison.

Table 1. Incidence

Study	Method	Number of Patients	Definite Awareness	Probable or Possible Awareness
Mashour et al. (2013)	Modified Brice questionnaire used 1 time: 28-30 days post-op	18,836	19 (0.10%)	Not published
Sandin, Enlund, Samuelsson, and Lennmarken (2000)	Modified Brice questionnaire used 3 times: PACU, 1-3 days, and 7-14 days post-op	11,785	7 (0.06%)	12 (0.10%)
Sebel et al. (2004)	Modified Brice questionnaire used 2 times: PACU and 1-2 weeks post-op	19,575	25 (0.13%)	46 (0.23%)
Pollard, Coyle, Gillbert, & Beck, (2007)	Modified Brice questionnaire used 2 times: PACU, and 1-2 days post-op	87,361	4 (0.005%)	2 (0.002%)
Pandit, Cook, Jonker, & O'Sullivan (2013)	Survey of anesthetists	2,358,342 (Estimated)	110 (0.004%)	31 (0.001%)

The percentage of incidence found in these studies can be translated into other rates which better show its impact. Sebel et al. estimated 20 million general anesthetics to be administered in the United States annually (2004). Therefore, based on their findings, approximately 26,000 awareness during general anesthesia events occur in the United States each year, which equates to about 100 events each workday (Sebel et al., 2004).

Statistically, the baseline data from NAP5 show that in the U.K. for every 47 senior anesthetists, only one will learn of a new case of awareness each year (Pandit et al., 2013). Another interpretation of the data reveals that one case of awareness will occur in 36 years of practice for an anesthetist (Pandit et al., 2013).

Furthermore, the NAP5's estimation of 0.0065% incidence equates to one in 15,000 general anesthesia cases (Pandit et al., 2013). On the other hand, the studies by Mashour et al., Sandin et al., and Sebel et al. had approximately one to two cases of awareness per 1,000 patients. If both these rates are taken to be true, that means that per 15,000 anesthesia cases, about 30 patients may experience awareness yet only one will spontaneously report it to the provider (Pandit et al., 2013).

The results of each study included in Table 1 must be examined cautiously due to the multitude of barriers inhibiting accurate estimations of incidence. Mashour and Avidan noted that detection of intraoperative awareness relies on patient reports, not objective measurements, and is therefore unreliable (2015). As discussed previously, each method of assessment has advantages and disadvantages. Some methods have shown higher incidence rates than others.

Another barrier to accuracy, regardless of method of assessment, is interpreting patient reports. Ideally, the study should be able to determine if a report is genuine or imagined. Because each report is unique, it is difficult to find a reliable method of confirming its validity. Sometimes a report is can be confirmed with others present in the operating room. However, often reports are more vague and are therefore unable to be confirmed independently. Typically in these cases studies rely on a panel of researchers to categorize these reports based on likelihood of occurrence. However, the subjectivity of this method creates the potential for

inconsistency. Feasibly, the same study could be interpreted differently leading to different incidence rates.

Patient Experiences

Patients may experience a diverse range of sensations and emotions while aware during general anesthesia. That being said, some types of awareness are more common during others. This is largely due to the nature of the procedures themselves. Awareness is particularly common during the beginning of the procedure and the end of the procedure, during intubation or extubation. This is because these are the times which sedation is the lightest (Pandit et al., 2014).

Sebel et al. examined the different experiences of those reporting awareness (2004). The study found that the two most common sensations for patients reporting awareness were auditory perceptions and the inability to move or breathe. 48% of patients who experienced awareness experienced these sensations. Furthermore, 36% reported feeling anxiety or stress and 28% reported pain. Almost a quarter of the patients could feel their endotracheal tube, and 8% could feel the surgery without pain (Sebel et al., 2004).

Pollard et al. conveyed the experiences of the six patients who reported awareness in their study (2007). One patient reported vaguely feeling motion in the chest, which was thought to be from the operating room, they also recalled being awake in the intensive care unit. No pain or concern was experienced as a result of these sensations. A second patient recalled the inability to do anything while feeling extreme pain during stapling and pulling on the chest, saying they knew no one could hear them. The third patient reported a brief period of pain in the groin,

without worry or concern. Patient four explained hearing vague buzzing and feeling the initial chest incision, however they did not report pain and was not very concerned (Pollard et al., 2007, 273). After analysis by the researchers, all of these patients were deemed to definitely aware. There were two patients who had possible awareness according to the research committee. One of these patients reported apprehension about the anesthetic during the interview but had no direct memory of the procedure or evidence of pain. Another patient remembered extubation, their muscles "coming back," and hurting until they arrived at the recovery room but expressed no concern or anxiety about these circumstances in the interviews (Pollard et al., 2007).

As is evidenced in this study, some patients report sensory awareness and even pain during operations, yet do not express concern, on anxiety about the situation. However, several patients experienced anxiety during wakefulness in the findings of Sandin et al. (2000). In fact, of 19 patients who reported intra-operative awareness 9 also said they experienced immediate anxiety. Of these 19 patients, 13 experienced auditory perception, six experienced visual perception, seven reported pain, and 14 had tried but were unable to move. 12 reported immediate understanding of their situation. Of the nine patients who experienced immediate anxiety, four went on to develop delayed symptoms, which was defined as nightmares and anxiety. It is important to note that of the four who developed delayed symptoms, only one reported immediate understanding of the situation. In three weeks, all patients reported that they were satisfied that they understood the situation, that all delayed symptoms had disappeared, and that they did not need any further contact from the research team. However, one patient expressed that she would be concerned if she needed an operation in the future (Sandin et al., 2000).

The findings of this study open the door for further questions and other research opportunities. The finding that three out of four patients who developed late psychological symptoms were unable to understand what was going on during their experience of awareness is of particular interest. Investigation should be performed to determine if educating patients about the possibility of awareness before the procedure, and therefore help them to understand the situation should it arise, prevents nightmares and anxiety in the following weeks.

Short and Long Term Implications

Approximately two years after the study conducted by Sandin et al., a follow-up study was completed to determine if the patients were experiencing any symptoms related to their unintended awareness event, despite all patients having previously stated that they were symptom-free (Lennmarken et al., 2002). In order to avoid evoking pseudomemories, the study took a qualitative approach, allowing a personal relationship to develop and encouraging free expression with mild prompting if necessary (Lennmarken et al., 2002).

This study had a very high attrition rate, despite all patients from the previous study being reached out to repeatedly; six declined to participate, one had died, and two could not be reached, leaving nine of the original 19 patients to participate (Lennmarken et al., 2002). Four of the nine patients met all of the American Psychiatric Association's criteria for post-traumatic stress disorder (PTSD); see Appendix B. Three patients met some of the criteria for PTSD, while only two of the nine were completely free from mental issues. Of the four suffering from PTSD, two already had psychiatric help, although the other two were considered to need it, as with anyone suffering from PTSD. Three of these patients also reported another operation would

be inconceivable and the other patient was hesitant to undergo any future surgery (Lennmarken et al., 2002).

Interestingly, one of the criteria for PTSD is avoidance of anything associated with the trauma (American Psychological Association, 1994). Six patients declined to participate in the study, raising the question whether the reason behind their declination was a symptom of PTSD. In fact, two patients stated that the reason for their original false statements of not needing any follow-up was avoidance, thinking that their issues should go away if they avoided memories of the incidence (Lennmarken et al., 2002).

Furthermore this study brought to light that only one patient, of the four experiencing PTSD, reported pain during the operation (Lennmarken et al., 2002). However, all four patients reported experiencing intra-operative anxiety. In fact, of the nine patients followed up with only one patient who reported intra-operative anxiety was free of PTSD approximately two years later. Therefore, this study shows a closer correlation between intra-operative anxiety and severe late psychological sequelae than to pain and severe late psychological sequelae (Lennmarken et al., 2002).

In order to determine frequency of development of PTSD in surgically aware patients compared to those who had no memory during anesthesia, Leslie et al. conducted a study attempting to follow up with 13 patients who were previously identified as having experienced awareness (Leslie, Chan, Myles, Forbes, & McCulloch, 2010). Each of these patients were matched with three to four control patients who were similar both demographically and for surgical experience, with the only exception that the controls did not experience awareness. In total, seven confirmed awareness cases and 25 control patients were followed up with four to 6 years after their surgeries (Leslie et al., 2010).

Five of the seven awareness patients (71%) and three of the 25 control patients (12%) were experiencing symptoms meeting the criteria for PTSD at the time of interview (Leslie et al., 2010). Notably, the two patients who did not develop PTSD still reported psychological consequences within 30 days of surgery. For all of the patients, symptom onset had a broad range, between seven and 243 days post-operatively (Leslie, Chan, Myles, Forbes, & McCulloch, 2010). Of the five patients who developed PTSD, four reported pain during their operation, one said they were terrified, and four recalled the inability to move (Leslie et al., 2010).

These findings led the authors to conclude "severe late psychological sequelae were common and persistent in the confirmed awareness patients" (Leslie et al., 2010, p. 825). Another significant finding of this study was the fact that two of the five patients experiencing PTSD as a result of awareness reported their awareness only at the third interview, which took place 30 days post-operatively (Leslie et al., 2010). Because not all awareness identification studies include an interview up to 30 days after surgery, this shows the potential for patients to be suffering from PTSD related to intra-operative awareness, while no one in the medical profession even knows that they had an awareness event.

The life-altering effects of PTSD can perhaps best be explained by examining case studies. Salomons et al. completed two case studies of pain flashbacks in posttraumatic stress disorder (2004). The first patient analyzed by this research team was a 68 year old woman who had a laminectomy 13 years prior, during which no complications were recorded in her surgical record. However, she reported that she awoke several times during her procedure, yet did not tell any of the hospital staff postoperatively for fear of a negative reaction. During these periods of awareness, she reported feeling an excruciating burning pain in her back and down the left leg, the inability to move or speak, terror, and the overwhelming desire to flee. She also reported

hearing conversations of the operating room staff, the metallic clinking of instruments, and mention of the S2 nerve, to which she attributed the pain (Salomons et al., 2004).

After the procedure the patient reported a chronic daytime back pain, causing her to retire early (Salomons et al., 2004). At night, particularly when she was sleeping lightly, she suffered from what she reported to be a different type of back pain which she described as being identical to what she felt during surgery. It was noted by the researchers that this light sleep was similar to a light anesthetic state. Similar to her experience during surgery, she would feel a strong urge to move, which caused her to get out of bed and walk around the room, only to go back to bed and have the process repeat itself several times a night. In addition to this nighttime back pain, the patient reported vivid memories of the sound of the metal instruments and was unable to eat with metal utensils (Salomons et al., 2004).

Her combination of symptoms lead to a clinical diagnosis of PTSD (Salomons et al., 2004). Her pain was so debilitating that in hopes to relieve it she very reluctantly agreed to undergo a second laminectomy. Unfortunately, the surgery was not successful. After the interview the patient received trauma-focused cognitive-behavioral therapy, which eventually ended her nocturnal back pain and lead to improved sleep (Salomons et al. , 2004).

The second case examined by Salomons et al. was a 43 year old woman who had a laparoscopic tubal ligation 3 years before the interview (2004). She reported awareness during the procedure, although there were no records of complications in her surgical records. She reported significant pain and distress throughout the operation, attempting to gain the attention of the surgical staff but being unable. Her eyes were open enough to see the surgical environment, but not wide enough for anyone to notice. Her detailed account of the procedure was able to be verified against the surgeon's report, confirming its validity (Salomons et al., 2004).

In the following weeks she experienced nightmares and flashbacks of the operation (Salomons et al., 2004). This woman worked in a hospital and went back to work a few weeks later. While in the elevator, she saw a nurse in blue surgical scrubs with a mask. She reported onset of severe substernal chest pain after seeing the nurse, making her feel trapped, want to escape, and an unreal disconnect from her environment. This pain matched the area of pain during intubation. After leaving the elevator the pain ceased, however after that point she avoided blue scrub suits and elevators, even adjusting her work to do so. She stated that the chest pain would come on anytime she saw a blue scrub suit, even if only on television, and eventually just seeing the shade of blue would trigger it. Her cardiac workup was negative, but she had a clinical diagnosis of PTSD. After receiving trauma focused cognitive behavioral therapy, she reported milder pain when seeing scrubs and no longer met PTSD criteria (Salomons et al., 2004).

Another case analysis was conducted by Prendergast and Cullen-Drill, who explained the situation of a 50 year-old woman who experienced awareness during her anesthesia ten years prior (2012). This woman reported chronic fatigue and insomnia, along with anxiety and panic symptoms. The patient reported that during her procedure she was not fully unconscious and that she experienced the sensation of being covered with dirt, buried alive. After the procedure she re-experienced this sensation multiple times, which eventually led her to be fearful of lying in her bed to go to sleep. To cope with this fear, the woman said she slept on her sofa, with the lights on, and only for brief periods. A full psychiatric evaluation revealed that the patient was suffering from anxiety, depressed mood, sleep disruption, chronic fatigue, and flashbacks. As a result, she was diagnosed with major depressive disorder and PTSD (Prendergast & Cullen-Drill, 2012).

Her treatment included clonazepam, as needed, for sleep, psychoeducation, gradual desensitization techniques, attending a support group, and positive self-talk techniques (Prendergast & Cullen-Drill, 2012). She also gradually moved her sleeping location closer to her bed. Within nine months of beginning this treatment regimen, the patient reported minimal anxiety, no fear of sleeping, and no more panic symptoms (Prendergast & Cullen-Drill, 2012). This case study shows that the late psychological symptoms of awareness during anesthesia can be effectively treated. There is hope for these patients and they do not have to continue to suffer.

It is important to note that the findings of these studies show that the impact of awareness during anesthesia can extend beyond the person themselves and have consequences for the rest of society.

The patient with nocturnal back pain in the study conducted by Salomons et al. used medical services heavily after her procedure. She received a disability pension, used benzodiazepines, barbiturates, and various analgesic agents in an attempt to control her back pain (2004). Her early retirement, which was due in part to her back pain may have been avoided if the procedure had gone as planned or if she had received effective help after the procedure. Her extensive use of the medical system, along with the disability was certainly costly.

As can be seen in the other patient examined by Salomons and colleagues, in unique situations the psychological issues experienced after awareness during anesthesia can even affect a person in the workplace.

In addition to these issues, awareness during general anesthesia may result in medical malpractice claims. According to the Closed Claims Project, a database that has been collecting information on all anesthesia claims from 37 United States liability insurance companies since 1985, claims for awareness make up approximately 2% of all claims in the database (Kent,

2010). Analysis of the database has also shown that the median awarded amount for these claims is on the rise, with a range of $924 to $1,050,000 (median $71,500) in 2007. Kent also notes that other anesthesia complications have not been subject to increased payment amounts as is the case with awareness (2010).

Chapter 4

Discussion

This systematic literature review synthesized current evidence based practice on the subject of intraoperative awareness during general anesthesia and identified its implications on practice. Furthermore, it identified important research gaps and created recommendations for future research that will be further discussed within this chapter.

Implications on nursing practice

Nurses and all members of the healthcare team should be educated on the issues associated with awareness during general anesthesia. Nurses have a central role in the interdisciplinary healthcare team, and may often serve as an educator. Thus, there is a multitude of interventions nurses may use to combat the issues associated with general anesthesia. Knowing that auditory perceptions are among the most common for awareness patients, nurses can encourage professional and courteous communication in the operating room (Sebel et al., 2004). Postoperatively, nurses have abundant opportunity to assess for awareness. If awareness is reported, therapeutic communication techniques should be used to learn more about the patient experience. Nurses can support their patient by giving appropriate psychiatric referrals and ensuring a close follow-up. Other members of the nursing profession may help to provide any necessary psychiatric support. Furthermore, because the nurse often spends the most amount of time with the patient, they have great opportunity to discuss the surgery with the patient and communicate any patient reports to the whole surgical team. This would help to ensure rates of

awareness are properly documented and not underreported, so that the surgical team can attempt to address, or hopefully prevent, any negative outcomes related to this issue.

Limitations

Some limitations to this literature review were acknowledged. As with any literature review, the use of different databases and search terms may have returned different search results. Therefore, it is possible that relevant articles to the topic of awareness during general anesthesia were missed in the research process. However, this is unlikely due to the structured and thorough nature of the literature search process. onally, all of the quantitative data on the short and long term implications of awareness came from studies also examined for methods. The lack of high quality randomized controlled trials, was another limitation of this literature review. Rather, most of the studies resulted from the search were only descriptive. Additionally the review was limited by inclusion of only studies that were only in the English language. Significant studies on the topic may have been missed because the author was unable to translate the article.

Conclusion

This systematic review of literature underlines many of the key issues regarding unintended awareness during general anesthesia. Analysis of current literature reveals that one of the most controversial aspects concerning this topic is the post-operative methods used to assess for the occurrence of awareness. Ultimately, the majority of modern studies use a modified form of a patient interview tool developed by Brice et al. in 1970. However, these

studies differ in their modifications to the interview questions and in the timing and number of interviews. From the reviewed literature, a trend emerged that the number of patients reporting awareness grew with as time elapsed between each interview. However, none of these studies conducted enough interviews for a trend to be evident as to how long these numbers would continue to grow. More research is needed to determine how both the number and the timing of the interviews impacts response rates.

The only study found in this literature search which directly compared the Brice interview with another method of assessment was conducted by Mashour et al. (2013). This study showed that the Brice interview methods produced significantly higher incidence rates that a quality assurance method which broadly asked if the patient experienced any problems with their anesthesia (Mashour et al., 2013).

Of all the articles eligible for inclusion in this literature review only the study conducted by Pandit et al. did not rely on a modified Brice interview to assess for awareness (2014). The incidence results of the alternate methods used by Pandit and colleagues were considerably lower than those of most of the other studies reviewed, which used the Brice method. However, the discovered incidence was remarkably similar to one particular study that used the Brice interview method which was conducted by Pollard et al. (2007). The study created by Pollard and colleagues only interviewed patients two times, up to two days after their procedure at the latest (2007). This was in stark comparison to the other reviewed studies which interviewed patients much later, up to 30 days postoperatively.

These findings suggest that various versions of the Brice interview produce higher incidence rates than the few other methods it has been compared to thus far. However, the literature comparing the Brice interview method to other forms of postoperative awareness

assessment is extremely limited. This is a significant gap in the research that ought to be addressed in future studies. Ideally, with a great deal of further research, a standardized tool or system for assessing awareness postoperatively should be developed.

There was a wide range in the reported incidence rate of definite awareness during anesthesia seen in the literature, from 0.004% to 0.13%. The variations between the studies methods for awareness assessment likely influenced the results, which could be one of the factors in this discrepancy. This further highlights the need for a standardized assessment method, which would allow researchers to more accurately compare incidence rates between facilities, specific patient populations, geographic regions, or other groups.

Current literature shows a broad spectrum of patient awareness experiences. Auditory perceptions and the inability to move or speak were the most common patient experiences according to Sebel et al. (2004). The frequent ability of awareness patients to hear and recall conversations raises the question of whether verbal reassurances from operating room staff could be beneficial for psychiatric outcomes of these patients. No studies on this subject matter were found in this literature search process. Therefore there is a great potential for further research on this topic.

An important finding, across several of the reviewed articles, is that some patients report experiencing pain and distress, but not all. This shows the importance assessing the quality of the experience of a patient who reports awareness, not just making the determination of occurrence. As was seen in the study by Lennmarken et al., intra-operative anxiety was the biggest predictor of patient development of late psychological symptoms, such as PTSD (2002). Therefore assessments and follow-ups should be targeted to patients whose awareness experience had qualities that put them at higher risk for developing psychological symptoms.

The evidence is clear that late psychological symptoms including PTSD does occur in this patient population at a higher rate than in patients who are unable to recall intra-operative events (Leslie et al., 2010). Leslie et al. also noted that two of the five patients experiencing PTSD as a result of awareness reported their awareness only at the third, 30 day postoperative interview (2010). Notably, not all awareness identification found in the literature search process included an interview up to 30 days after surgery. Thus, there is potential for patients to be suffering from PTSD related to intra-operative awareness, while no one in the medical profession is aware that the patient experienced an awareness event.

Due to the potential for serious psychological symptoms, it is imperative to develop an accurate method of assessing for awareness that is conducted as a standard of care on every post-operative general anesthesia patient. The findings of Pandit et al. show that for every 15,000 anesthesia cases potentially 30 patients may experience awareness, yet only one will spontaneously report it to the provider (2013). There is great potential for a well-developed standardized assessment tool to pick up on awareness cases that might otherwise have been missed if insufficient assessment methods were used, or spontaneous reports were relied upon. This identification is important because psychological referrals and interventions could be implemented sooner in this high-risk population. Overall, the need for the development of a standardized method of post-operative assessment for awareness during general anesthesia is abundantly evident.

Appendix A

Hawker et al. Quality Appraisal (2004)

1. Abstract and title: Did they provide a clear description of the study?

Good	Structured abstract with full information and clear title.
Fair	Abstract with most of the information.
Poor	Inadequate abstract.
Very Poor	No abstract.

2. Introduction and aims: Was there a good background and clear statement of the aims of the research?

Good	Full but concise background to discussion/study containing up-to-date literature review and highlighting gaps in knowledge. Clear statement of aim AND objectives including research questions.
Fair	Some background and literature review. Research questions outlined.
Poor	Some background but no aim/objectives/questions, OR Aims/objectives but inadequate background.
Very Poor	No mention of aims/objectives. No background or literature review.

3. Method and data: Is the method appropriate and clearly explained?

Good	Method is appropriate and described clearly (e.g., questionnaires included). Clear details of the data collection and recording.
Fair	Method appropriate, description could be better. Data described.
Poor	Questionable whether method is appropriate. Method described inadequately. Little description of data.
Very Poor	No mention of method, AND/OR Method inappropriate, AND/OR No details of data.

4. Sampling: Was the sampling strategy appropriate to address the aims?

Good	Details (age/gender/race/context) of who was studied and how they were recruited. Why this group was targeted. The sample size was justified for the study. Response rates shown and explained.
Fair	Sample size justified. Most information given, but some missing.
Poor	Sampling mentioned but few descriptive details.
Very Poor	No details of sample.

5. Data analysis: Was the description of the data analysis sufficiently rigorous?

Good	Clear description of how analysis was done. Qualitative studies: Description of how themes derived/ respondent validation or triangulation. Quantitative studies: Reasons for tests selected hypothesis driven/ numbers add up/statistical significance discussed.

Fair	Qualitative: Descriptive discussion of analysis. Quantitative.
Poor	Minimal details about analysis.
Very Poor	No discussion of analysis.

6. Ethics and bias: Have ethical issues been addressed, and what has necessary ethical approval gained? Has the relationship between researchers and participants been adequately considered?

Good	Ethics: Where necessary issues of confidentiality, sensitivity, and consent were addressed. Bias: Researcher was reflexive and/or aware of own bias.
Fair	Lip service was paid to above (i.e., these issues were acknowledged).
Poor	Brief mention of issues.
Very Poor	No mention of issues.

7. Results: Is there a clear statement of the findings?

Good	Findings explicit, easy to understand, and in logical progression. Tables, if present, are explained in text. Results relate directly to aims. Sufficient data are presented to support findings.
Fair	Findings mentioned but more explanation could be given. Data presented relate directly to results.
Poor	Findings presented haphazardly, not explained, and do not progress logically from results.
Very Poor	Findings not mentioned or do not relate to aims.

8. Transferability or generalizability: Are the findings of this study transferable (generalizable) to a wider population?

Good	Context and setting of the study is described sufficiently to allow comparison with other contexts and settings, plus high score in Question 4 (sampling).
Fair	Some context and setting described, but more needed to replicate or compare the study with others, PLUS fair score or higher in Question 4.
Poor	Minimal description of context/setting.
Very Poor	No description of context/setting.

9. Implications and usefulness: How important are these findings to policy and practice?

Good	Contributes something new and/or different in terms of understanding/insight or perspective. Suggests ideas for further research. Suggests implications for policy and/or practice.
Fair	Two of the above (state what is missing in comments).
Poor	Only one of the above.
Very Poor	None of the above.

Appendix B

American Psychiatric Association Criteria for PTSD (1994)

A1. Extreme mental stress, detailed recall of the event

A2. The person's response involves fear, helplessness

B. Persistent re-experiencing of the mental trauma

C. Persistent avoidance of stimuli associated with the mental trauma

D. Increased arousal; flashbacks, attacks of panic, anxiety, sleep disturbances, nightmares, etc.

E. Long duration of symptoms (>1 month)

F. Impairment of social life

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