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Review Article

Improving Safety and Reducing Clinical Errors in Anesthesia: Which Checklist Is Your Choice?

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ABSTRACT

The safety of the beating heart is a health service that means the absence of clinical errors during the implementation of health care. The period of anesthesia is identified as one of the most critical phases for patients requiring general anesthesia, carrying the potential for critical clinical errors that may have irreversible consequences. This study's main objective was to conduct a concise assessment of the anesthesia checklists utilized to enhance patient safety during general anesthesia procedures. To accomplish this, a comprehensive search was conducted using relevant keywords spanning from 1990 to 2023 across databases including PubMed, Springer, Google Scholar, Web of Science, Scopus, online libraries, and the Cochrane library. Initially, 188 studies were identified at the outset of the research, and among these, 13 studies that focused on the development of checklists for anesthesia safety were scrutinized. Included articles were reviewed separately and divided into 3 categories; Specific vs. Generalized Scope, Single-Stage vs. Multi-Stage, Single-Factor vs. Multi-Factor. According to the findings from these studies, the systematic and proper utilization of all available checklists can contribute to improved safety. However, due to the specialization of surgical procedures and the increasing emphasis on patient safety over the past decade, there has been a shift in the compilation of anesthesia checklists from being broad and general to becoming specific, transitioning from single-stage to multi-stage, and evolving from single-factor to multi-factor checklists.

Introduction

Safety is often likened to the lifeblood of healthcare services. In essence, it entails averting the occurrence of any harm while delivering medical care and these undesirable harms are referred to as clinical errors [1]. Clinical errors represent unwelcome occurrences during the execution of medical services, and they can result in complications such as irreversible physical injuries and even fatalities [2-4]. Among the medical services, the administration of general anesthesia stands out as one of the most delicate moments. Clinical errors in the context of anesthesia can arise from factors like the lack of preparedness of anesthesia staff for emergency situations, insufficiency of essential equipment in anesthesia facilities, and diminished focus among anesthesia personnel due to exhaustion and mental conflicts [5]. It's worth noting that managing general anesthesia, especially in specialized surgeries such as gynecology and obstetrics, carries high stakes due to the potential for numerous clinical errors like improper intubation, hypoxia, and aspiration. Consequently, anesthesia teams constantly endeavor to reduce the occurrence of clinical errors [6].

Checklists play an indispensable role in the delivery of healthcare services. They represent a sequence of tasks aimed at achieving specific objectives [7-8]. Essentially, they serve as instruments that enhance the awareness of healthcare practitioners and foster improved

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communication among specialized teams in the execution of assigned tasks using specialized knowledge. This, in turn, leads to the enhancement and advancement of safety quality and a reduction in clinical errors, particularly in critical situations [9-10]. Checklists are more than writing a set of things on paper. In fact, continuous training and basic use of the checklist can make it effective and improve the safety of patients [11].

This prompts the question: what kind of checklist is most suitable for enhancing patient safety during general anesthesia? What attributes constitute an effective checklist? What impediments hinder the successful implementation of checklists? Can clinical errors be entirely averted through checklist utilization? The purpose of this study is to provide a concise overview of the various checklists employed in the context of general anesthesia. It is our hope that this research will take a meaningful step in disseminating existing checklists and enhancing the safety of patients undergoing general anesthesia.

Methods

This present study, conducted in 2023, is a narrative review aimed at examining research related to checklists created and utilized in the context of general anesthesia. To gather relevant information, searches were carried out in several databases, including PubMed, Springer, Google Scholar, Web of Science, Scopus, online libraries, and the Cochrane library. This search involved using keywords such as "Clinical error Checklist," "General anesthesia," "anesthesia," "safe," "safety," and combinations of these keywords with logical operators "AND," "OR," and "NOT." The timeframe for this search spanned from 1990 to 2023.

Findings

In the initial phase, using the specified keywords and searching across the mentioned databases, adhering to entry criteria which encompassed articles in the English language published from 1990 to 2023 and were related to checklists for general anesthesia, and implementing exit criteria that excluded books and checklists pertaining to local anesthesia, as well as those articles that did not meet the requirements based on their titles and abstracts, a total of 188 studies were initially examined. Subsequently, following a thorough review of the titles and content of these articles, 13 articles were identified that focused on compiled checklists, as outlined in (Table 1), and will be further elaborated upon below.

Table 1- Summarized Characteristics of Included General Anesthesia Checklists

Title	Author	Year	Aim	Conclusion	General	Specific	Single stage	multi-stage	Single factor	Multi-factor
Safe anesthesia assessment checklist	Babajani [12]	2023	Compilation of a complete checklist for all stages of anesthesia	The aforementioned checklist is valid and reliable, and it is hoped that the use of this checklist can reduce clinical complications and improve safety. .	*			*		*
Designing and evaluating the effectiveness of a pre-induction checklist on improving the clinical performance	Ali Khalafi [13]	2021	Designing and evaluating the checklist before induction of anesthesia on the performance of anesthesia staff	Using this checklist can improve the performance of anesthesia staff and improve patient safety.	*		*			*

A novel checklist for anesthesia in neurosurgical cases	Ghaly Ramsis [14]	2021	Designing a checklist for neurosurgery	The aforementioned checklist improves safety in neurosurgery patients and is recommended to others to use it.	*	*	*
Development and pilot testing of a context-relevant safe anesthesia checklist for cesarean delivery in East Africa	Alexander, Louise [15]	2019	Preparing a checklist for cesarean surgery	Effective training and implementation of this checklist has improved safety and reduced clinical errors.	*	*	*
The ryder cognitive aid checklist for trauma anesthesia	Behrens [7]	2016	Preparing a checklist for anesthesia in trauma patients	The use of this checklist increases the ability of health workers in critical situations and improves the safety of patients.	*	*	*
Development and implementation of checklists for routine anesthesia care	Krombach [5]	2015	Dividing anesthesia routines to prevent them from being forgotten	Training and continuous use of the checklist has prevented forgetfulness in the implementation of anesthesia and can improve patient safety.	*	*	*
An anesthesia pre induction checklist to improve information exchange	Tscholl [16]	2015	Development of a checklist to improve information exchange, knowledge of critical information, understanding of safety and possibly understanding of teamwork in anesthesia teams.	The use of this checklist has resulted in a tremendous improvement in information exchange, knowledge of critical information, understanding of safety by anesthesia teams, and improved teamwork.	*	*	*

Neuro-anesthesia handover checklist	Shafiq [17]	2015	Use of the checklist at the time of delivery of neurosurgery patients	Using this checklist, it is possible to improve the transfer process of neurosurgery patients and increase safety.		*		*	*
Checklist for anesthesiological process: analysis of risks	Ghirardini [19]	2014	Development of an anesthesia checklist to express risks during surgery compared to the traditional method of error reporting	Using this checklist can better investigate the cause of accidents and failures in order to prevent them in the future.	*			*		*
A checklist for trauma and emergency anesthesia	Tobin, J.[18]	2013	Increasing the ability of anesthesia group in emergency situations	The use of this checklist with the theory that aspects of medical care and vital steps are not neglected leads to a reduction in the rate of complications and mortality of patients and also improves the communication of the anesthesia team in the care of patients with a critical condition.		*		*		*
Errors and Omissions in Anesthesia: A Pilot Study Using a Pilot's Checklist	Hart, Elaine [20]	2005	Examining the level of skill and preparation of anesthesiologists to check equipment and devices before anesthesia	By conducting continuous training, the preparation of anesthesiologists can be increased and the safety of patients can be improved.	*		*			*
Revised checklist for anaesthetic machines	Kendell [21]	1998	Preparing a checklist for anesthesia machine control	Accurate implementation of the checklist can detect many errors and defects of anesthesia devices and prevent many complications.	*		*		*	

An evaluation of anesthesiologists' present checkout methods and the validity of the FDA checklist	March [22]	1991	Evaluation of the USA Food and Drug Administration anesthesia machine checklist	The aforementioned checklist is completely valid and reliable, and by using it, many problems in managing the airway and ventilation of patients can be avoided.	*	*	*

Comprehensive Three-Stage Anesthesia Safety Assessment Checklist (Pre, During, and Post-Anesthesia)

Babajani et al conducted this study in 2023 to prepare a comprehensive checklist that covers all stages of general anesthesia. Their research resulted in a multi-stage, multi-factor checklist applicable to various surgical procedures. Initially, existing anesthesia checklists were gathered, and their components were extracted through online research. Subsequently, a 31-item checklist was compiled. This checklist underwent assessment for face and content validity, and after completing this phase, its reliability was established through the ICC method, involving 155 surgeries. The researchers assert that implementing this checklist can significantly enhance patient safety during general anesthesia [12].

Development and Evaluation of a Pre-Anesthesia Induction Checklist

Khalafi et al. carried out this study in 2022 to design and evaluate the effectiveness of a pre-anesthesia checklist in enhancing the clinical performance of healthcare workers. Their approach involved creating a single-stage, multi-factor checklist for use across surgical procedures. Initially, the checklist's validity and reliability were assessed, and following its implementation, the employees' attitudes toward its safety and acceptability were measured. The study's results indicated that the checklist's utilization can enhance the performance of anesthesia staff and improve patient safety [13].

Innovative Neurosurgery Checklist

In 2021, Mr. Ramis and colleagues conducted a qualitative study in which they designed a checklist to assess safe anesthesia during neurological procedures. This checklist covers anesthesia procedures across three phases: before, during, and after anesthesia. The research findings underscore the checklist's significant impact on ensuring safe anesthesia. The lead researcher encourages hospitals and operating rooms performing neurosurgery to adopt this checklist [14].

Development and Implementation of Anesthesia Safety Checklist for Caesarean Sections in East Africa

Luiz et al. conducted this study in 2019 with the objective of creating and evaluating an anesthesia safety checklist tailored to the context of cesarean surgeries in East Africa. Given the World Health Organization's alarming statistics regarding maternal mortality rates in developing nations, the research aimed to address this issue by devising a new checklist. Initially, an evidence-based checklist was established using the Delphi technique, involving 60 obstetricians and gynecologists at a 2014 annual anesthesia conference. The checklist was designed to be comprehensive, yet concise, contextually relevant, well-organized, and highly readable, ensuring ease of use, even in critical and emergency situations. Following checklist development, its efficacy was assessed through clinical observations of simulated critical clinical scenarios, confirming its effectiveness in reducing adverse events [15].

Ryder Cognitive Aid Checklist for Trauma Anesthesia

Behrans et al. carried out this study in 2016 with the goal of creating the Ryder cognitive aid checklist for trauma anesthesia. The study's objective was to enhance the competence of medical staff during emergency situations, ultimately improving patient safety. This two-page checklist comprised five primary sections, covering actions to be taken before the arrival of out-of-hospital patients, upon the patient's arrival at the hospital, initial assessment and management, patient resuscitation, and post-operative care. The results following the implementation of the checklist indicated an enhancement in the clinical skills of healthcare personnel in critical situations and a reduction in errors during emergencies [7].

Pre-Anesthesia Induction Checklist for Improved Information Exchange

In 2015, Tscholl et al. conducted a study aimed at developing a pre-anesthesia induction checklist to enhance information exchange, the grasp of essential information, safety awareness, and teamwork among anesthesia teams at the University of Zurich, Germany. By comparing anesthesia teams using the pre-anesthesia checklist with a control group that did not, the research intervention was carried out. The study employed the Delphi process, involving seven anesthesia consultants

with over a decade of clinical experience. This process led to the creation of the APIC pre-anesthesia checklist, which filled gaps in the WHO surgical safety checklist by addressing aspects it did not cover. The researchers concluded that the checklist's use could result in significant improvements in information exchange, vital information comprehension, safety awareness among anesthesia teams, and teamwork enhancement [16].

Compilation and Implementation of Routine Anesthesia Task Checklist

Krumbach et al. conducted a study with the aim of developing and implementing a checklist for routine anesthesia care, proposing an approach to enhance patient safety in 2015. The research was based on the belief that neglecting routine anesthesia tasks could lead to accidents and irreparable risks. The study emphasized that not only the pre-induction stage but also the conditions during and after anesthesia were critical. Consequently, the researchers compiled a checklist that covered several steps, including the initiation of anesthesia procedures, pre-induction, post-induction, checks at 5 minutes and 30 minutes post-induction, and responses to emergency situations. Their findings indicated that routine checklists should be expanded to encompass conditions beyond induction, and the correct utilization of checklists, rather than blind adherence, is essential for risk prevention [5].

Checklist for Safe Transfer of Neurosurgery Patients

Shafiq et al. conducted a study in 2015 to develop a checklist for the secure transfer of patients after neurosurgery. This checklist, created as a single-stage process after the completion of anesthesia (recovery), was tailored specifically for neurosurgical cases. Implementation of this checklist resulted in improved post-surgery transfer of neurosurgery patients, a reduction in error rates, and enhanced safety [17].

Checklist for Emergency Anesthesia and Trauma

Tobin et al. conducted a study in 2013 to create a checklist for emergency anesthesia and trauma. Recognizing trauma as a significant cause of mortality in various age groups, the study aimed to enhance the training of anesthesia teams, particularly anesthesiologists, for trauma and emergency scenarios. A multi-step checklist was developed, covering actions before the patient's arrival, upon the patient's arrival in the operating room, induction of anesthesia, intubation, anesthesia maintenance, cardiopulmonary resuscitation, and post-operative steps. Implementation of this checklist led to a reduction in complication and mortality rates, as well as improved communication in the care of critically ill patients [18].

Anesthesia Error Expression and Analysis Checklist

Girardini et al. conducted this study in 2013 with the objective of creating a checklist for the analysis of anesthesia-related risks. This retrospective study emphasized that various methods exist for analyzing adverse medical events within hospital settings, each with its inherent limitations. The study aimed to compare an intraoperative anesthesia checklist with the traditional method of reporting and problem description. They developed a checklist that provided a more structured framework for risk analysis in anesthesia, encompassing measures to be taken before, during, and after surgery. The findings indicated that this checklist proved to be more sensitive in identifying risks compared to traditional reporting methods. Its use enabled a more comprehensive investigation of the causes of accidents and failures, contributing to better prevention in the future [19].

Anesthesia Error and Omission Test Checklist; Experimental Study

In 2005, Mr. Hart and colleagues conducted a study to assess the skill and readiness of anesthesiologists in equipment and device checks prior to anesthesia. The study addressed concerns about anesthetists' capabilities in conducting cesarean surgeries. They engaged 20 experienced and interested experts to create a checklist using the Delphi technique, resulting in a final checklist comprising 40 items. Most experts found the final checklist highly useful, with 16 of them expressing willingness to use it. Eighteen of them considered the number of items appropriate, while 16 of them found the written checklist suitable, although others preferred a verbal version. It was believed that developing checklist use and providing training to anesthesia teams could significantly enhance patient safety, which is of utmost importance [20].

Revised Checklist for Anesthesia Machine Control

Kendel et al. conducted a study in 1998 to develop an improved checklist for the examination and control of anesthesia machines, which was based on a modified version of the British and Irish Association of Anesthesiology guidelines. Over a 45-day period, approximately 132 checklists were completed in a general hospital setting. This checklist was single-factor. The study's results demonstrated that the meticulous application of the checklist could effectively detect errors and defects in anesthesia machines, thus preventing numerous complications [21].

Anesthesia Machine Maintenance and Control Checklist

Mark et al. conducted a study in 1991 to assess the maintenance and control checklist of the anesthesia machine established by the United States Food and Drug Administration. The study focused on evaluating the checklist's validity and reliability. This particular checklist was designed as a single-factor checklist applicable to all types of surgeries. Following the research, it was determined that the checklist was both valid and reliable. Utilizing this checklist proved

effective in avoiding many problems related to airway management and patient ventilation [22].

According to the obtained information, 13 checklists were reviewed separately and divided into 3 categories; Specific vs. Generalized Scope, Single-Stage vs. Multi-Stage, Single-Factor vs. Multi-Factor.

I. Specific vs. Generalized Scope: Among the aforementioned checklists, certain ones were designed for application across all surgical procedures, making them versatile and suitable for a wide range of operations. An example of this is the checklist developed before anesthesia induction by Tscholl et al. [16]. However, other checklists were tailored for specific surgical contexts, as exemplified by the neurosurgery checklist crafted by Ramis et al. [14]. In total, from the checklists included in the study, 8 checklists were prepared for all surgical procedures and 5 checklists were prepared specifically for specific procedures. The extent of this distinction is detailed in (Figure 1).

II. Single-Stage vs. Multi-Stage: In some of the aforementioned checklists, the focus is solely on a single stage of the anesthesia process, such as the checklist created before anesthesia induction by Tscholl et al. [16]. On the contrary, several other checklists encompass not only the pre-induction phase but also address all anesthesia stages, including during and post-anesthesia, like the checklist designed for emergency anesthesia and trauma by Tobin et al. [18]. In total, from the checklists included in the study, 6 checklists were compiled in a single-stage format and 7 checklists were compiled in a multi-stage format. The extent of this distinction is detailed in (Figure 2).

III. Single-Factor vs. Multi-Factor: Some of the checklists among those mentioned concentrate on a single specific factor, such as the assessment and verification of anesthesia machine functionality, as seen in the revised checklist for anesthesia machines by Kendel et al. [21]. Meanwhile, other checklists do not confine their focus to a single factor but rather encompass various factors, including equipment checks, patient assessment, drug administration, and more, as illustrated by the checklist before anesthesia induction established by Krumbach et al. [5]. In total, from the checklists included in the study, 3 checklists were compiled as single factors and 10 checklists were compiled as multi-factors the extent of this distinction is detailed in (Figure 3).

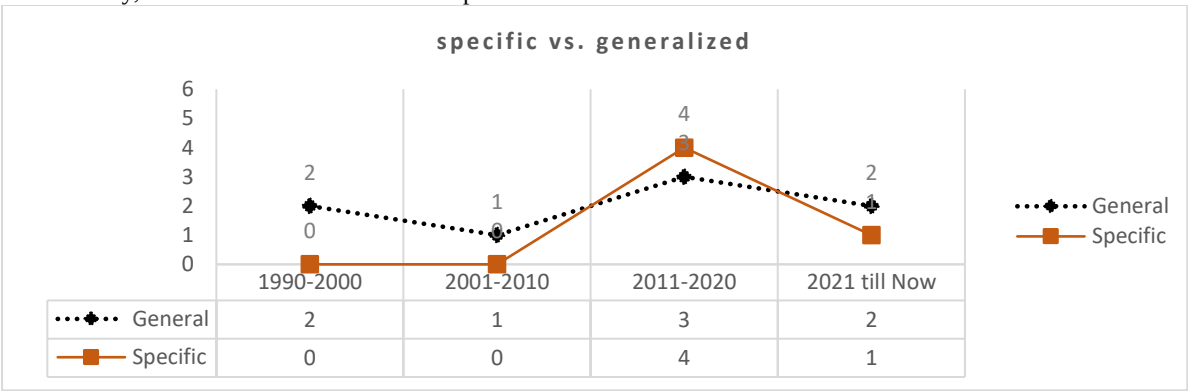

Figure 1- Checklist development trends entered into the study in terms of general and specific use of surgical procedures from 1990 to 2023.

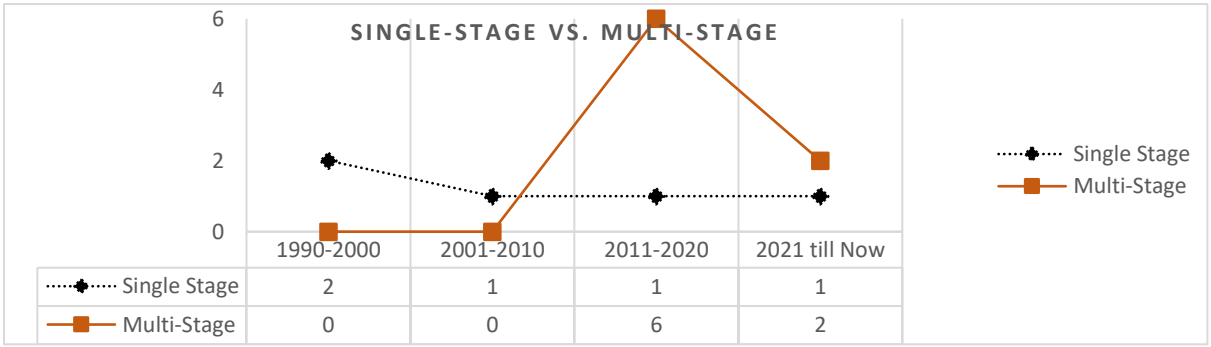

Figure 2- Checklist development trends entered into the study in terms of single-stage and multi-stage from 1990 to 2023.

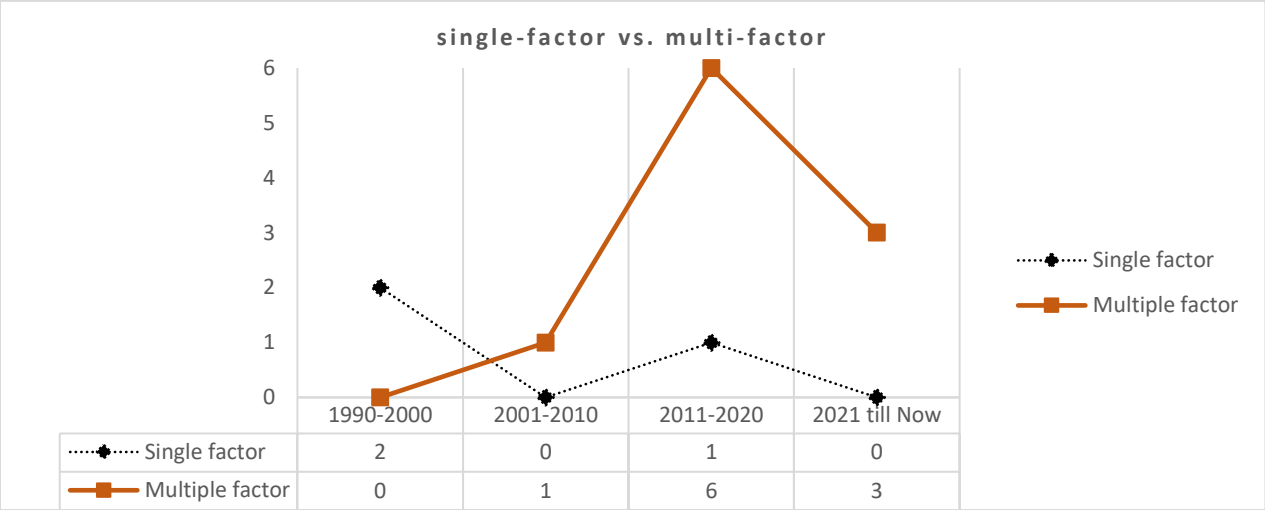

Figure 3- Checklist development trends entered into the study in terms of Single-Factor and Multi-Factor from 1990 to 2023.

Discussion

Conducting surgical procedures under general anesthesia represents one of the most critical phases of patient care within medical facilities. In recognition of this, the World Health Organization has endeavored to develop checklists, such as the safe surgery checklist, with the goal of enhancing safety and mitigating clinical errors [23]. Given the paramount importance of the anesthesia process, anesthesia teams have persistently sought to employ a comprehensive and all-encompassing checklist that spans all anesthesia stages and encompasses various factors, including patient assessment, monitoring device checks, and anesthesia machine evaluation [24].

The objective of this study is to review the checklists devised for general anesthesia, aiming to contribute to the enhancement of safety practices. The use of checklists in the medical domain, particularly in emergency scenarios, poses a significant topic of discussion. It prompts the question of whether checklists are beneficial or detrimental, and whether their application is effective or futile. When a checklist is purposefully designed and devoid of ambiguity, it can indeed enhance safety and reduce clinical errors. Nevertheless, it is prudent to regard the checklist as a supplementary tool, one that, when coupled with proper training for healthcare professionals, elevates their performance and aids in preventing clinical errors [11].

An effective checklist should possess characteristics such as clarity and purpose (articulating what needs to be done and how), prescriptiveness (outlining a set of essential tasks), intelligibility (being easily comprehensible), conciseness (not being overly time-consuming), and evidence-based design (possessing validity and reliability) [25]. In the effective implementation of checklists, several obstacles may arise, including inadequate training of healthcare personnel, insufficient communication between teams, time-consuming checklist completion and application, and ambiguities within checklist items [26]. Additionally, factors like limited awareness of the checklist, lack of training on checklist utilization, absence of leadership, and negative attitudes of staff toward the checklist's nature can lead to incomplete checklist implementation [27].

Research reveals a myriad of checklists formulated for general anesthesia worldwide. These checklists can be categorized as single-stage or multi-stage, general or tailored for specialized surgeries like gynecology, neurosurgery, and emergency cases. For example, Krumbach et al. (2015) aimed to enhance patient safety by developing a multi-stage, multi-factor, and general checklist for routine anesthesia procedures, driven by the belief that neglecting routine anesthesia tasks can result in clinical errors jeopardizing patient safety [5]. Ramis et al., in light of the complexities of neurosurgery, introduced a multi-step checklist tailored to neurosurgical procedures, advocating its use [14]. Tscholl et al. (2015) devised a single-step checklist named the "checklist before induction of anesthesia" to enhance information exchange, promote teamwork, and bolster safety awareness within anesthesia teams. This checklist was inspired by the WHO safe surgery checklist and was crafted through the Delphi method in consultation with seven anesthesiologists [16].

In essence, the ongoing debate centers on the shared objective of all these checklists: to enhance patient safety and reduce clinical errors. Each of them is superior to the other in some way and is useful. Finally, it can be noted that due to the importance of patient safety, the compilation of checklists has evolved and currently we see the compilation of various types of checklists used in anesthesia, as illustrated in Table 1.

Conclusions

Based on the research conducted in this study, researchers have come to the conclusion that over the past decade, the evolution of anesthesia checklists has progressed from a generic approach to a practice-specific approach and from single-factor checklists to multi-factor checklists, leading to comprehensive checklists. Has been additionally, there is a shift from single-step checklists to those that address all stages of anesthesia, including pre-induction, intra-operative and post-anesthesia stages. In fact, it can be emphasized that due to the complexity and specialization of surgical interventions and the increasing importance of safety issues, the process of developing anesthetic checklists has become comprehensive and specific.

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