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Review

Lessons from Ophthalmology in Preventing Wrong-Site Errors in Paired-Organ Surgery

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Abstract: Surgical errors involving paired organs can have severe consequences, particularly in procedures where laterality is a critical factor. Wrong-site surgeries indicate failures in risk management and patient safety protocols, requiring continuous improvements in preventive strategies. In ophthalmology, where precision is essential, the adoption of structured approaches has significantly reduced the incidence of such errors. The Universal Protocol, introduced in 2004 by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), has defined standardized procedures to prevent these events and has subsequently been adapted to ophthalmic surgery by specialized scientific societies such as the American Academy of Ophthalmology (AAO). Additionally, multidisciplinary interventions, including AI-assisted verification systems, human factors analysis, and enhanced surgical checklists, continue to strengthen error prevention. This review examines the implementation and development of these strategies in ophthalmic surgery, evaluating their effectiveness and identifying persistent challenges in surgical safety

Keywords: wrong-site surgery; surgical risk management; patient safety; Universal Protocol; paired organs; ophthalmology; checklists; human factors; AI-assisted verification

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1. Introduction

Wrong-site surgery encompasses a range of errors, including operating on the wrong patient, performing an unintended surgical procedure, or misidentifying laterality in procedures involving paired organs (Figure 1) [1]. These errors, despite being classified as never events, continue to pose a significant risk across multiple surgical specialties [2]. While mandatory surgical checklists and verification protocols have been widely implemented, patient safety remains a persistent concern, particularly in surgeries involving symmetrical structures where an incorrect laterality decision can have severe consequences [3–7]. Worldwide, surgical care is a double-edged sword: it saves lives but can also inflict harm when errors occur. Over 300 million surgical procedures are performed each year globally. Conservative estimates by the World Health Organization (WHO) indicate that at least 7 million patients a year suffer significant complications from surgery, of whom more than 1 million die as a result [8]. In a 2019 systematic review with meta-analysis, the authors highlighted that surgical and intensive care settings showed the highest prevalence of preventable patient injury—in surgical departments, about 10% of patients experienced

preventable harm [9]. Of note, some reports show that in surgical settings, miscommunication or inadequate situational awareness—rather than technical incompetence—often cause incidents [10].

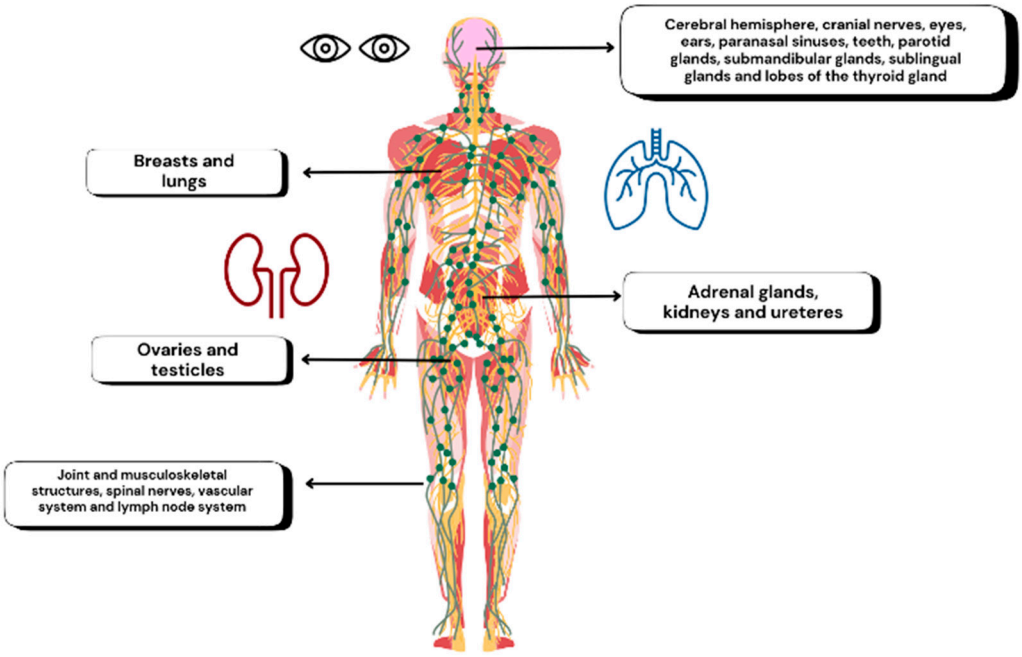


Figure 1. Schematic representation of paired organs. Evolutionarily, the presence of paired organs (e.g., eyes, kidneys, lungs) provides a protective redundancy. However, surgical removal of or error to the healthy counterpart can severely compromise overall function.

To address this issue, the Universal Protocol was introduced in 2004 by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) as a standardized method to prevent wrong-site, wrong-procedure, and wrong-patient surgeries [11,12]. This protocol is based on three fundamental steps [13]. The first is pre-operative verification, ensuring that the patient's identity, the planned procedure, and the correct surgical site are confirmed against medical records and consent forms. The second step involves surgical site marking, performed by the surgeon, to provide a clear and persistent visual reference throughout the procedure. Finally, an immediate time-out before incision requires the entire surgical team to pause and collectively reconfirm all critical details of the surgery, reducing the likelihood of errors due to miscommunication or cognitive bias [14].

Although these principles have remained constant, many professional societies, including national-level organizations, have adapted these guidelines to specific contexts such as outpatient ophthalmic surgery and intravitreal injections [1,15]. Ophthalmology is particularly relevant in the study of wrong-site errors due to its high procedural volume, precision demands, and susceptibility to laterality confusion [16].

Unlike internal paired organs, the eyes are externally exposed and frequently subject to interventions that require strict site verification [17]. Procedures such as cataract surgery and intravitreal injections involve repetitive workflows, increasing the risk of misidentification, particularly when safety checks are inconsistently applied. Additionally, the reliance on team coordination, surgical equipment, and site-marking protocols makes ophthalmology an ideal field for assessing the effectiveness of patient safety strategies [18]. While high-resource centers benefit from structured protocols and continuous staff training, challenges persist in environments with limited infrastructure, where miscommunication and cognitive biases remain significant risk factors [19–22].

Given these vulnerabilities, ophthalmology serves as a valuable model for understanding and preventing wrong-site errors in paired-organ surgery. This review examines existing safety measures, legal implications, and technological innovations aimed at reducing the incidence of these preventable surgical errors.

As illustrated in Figure 2, a systems-based approach encompassing structured communication pathways, verification protocols, and digital identification tools offers a comprehensive framework for error mitigation in paired organ surgery. The diagram synthesizes the multilayered nature of safety strategies and their interdependencies across clinical and organizational domains.

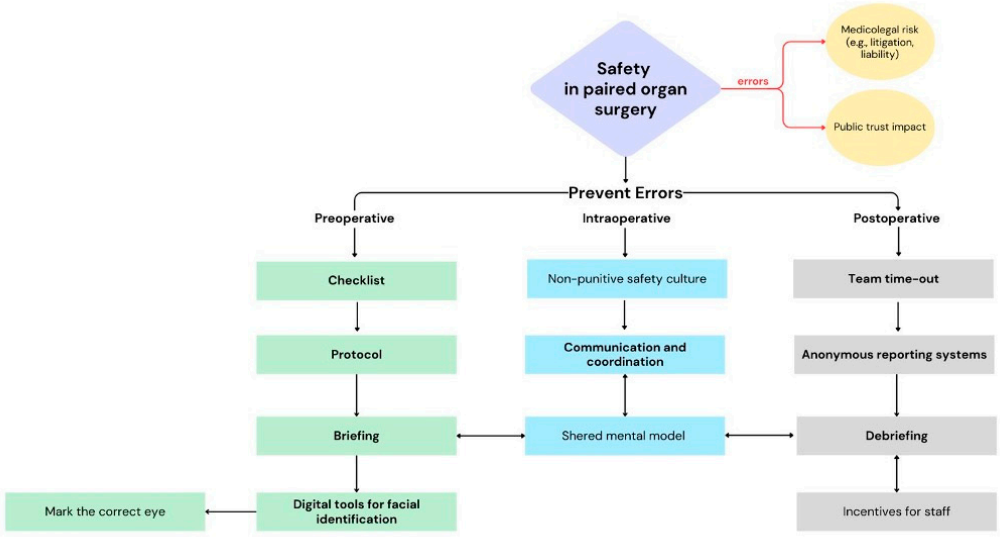


Figure 2. Systems-based safety model in paired organ surgery, illustrating key risk vectors and multilevel strategies for error prevention, including cognitive, procedural, and technological components.

2. Methods

A literature search was performed in September 2024 using PubMed, Web of Science, and Google Scholar. The search employed the following keywords in combination with Boolean operators (AND/OR): claims clinical safety, patient safety, professional liability, surgical errors in ophthalmology, wrong, cataract, intravitreal injections, operating room, complications, medico-legal, collaborative work, human factors, medical decision-making, surgery, wrong site, wrong side, surgical mistakes, briefing, checklist, protocol. A total of 1655 records were retrieved.

The following PICO framework was used to select and include articles in this review: problem—medical/surgical errors involving the wrong eye or incorrect procedure; intervention—strategies for error prevention and patient safety management; comparison—classification of tools and technologies used to prevent errors; outcome—a structured set of effective measures to reduce surgical errors. For this review, we included studies published in the last 20 years, with exceptions for older studies deemed relevant for historical comparison. Only articles in English were considered. The final selection of studies was based on their relevance to wrong-site errors in ophthalmology and paired-organ surgery.

3. Main Surgical Errors in Ophthalmology

3.1. Historical Background and Overall Prevalence

Historical accounts of wrong-site surgeries—specifically wrong-eye enucleations—are documented as early as the 19th century. Many of these incidents stemmed from incomplete or flawed documentation [23]. While overall prevalence rates vary, large registries such as

the New York Patient Occurrence Reporting and Tracking System (NYPORTS) estimate the rate at approximately 6.9 events per 100,000 ophthalmic procedures [24].

However, self-reported surveys (e.g., pediatric strabismus surgeons reporting a wrong-site rate of 35%) suggest that the true burden might be underrecognized [25]. The inconsistency in definitions and the reluctance to report near misses create data gaps that hinder accurate estimation [26].

3.2. Types of Errors

Errors in ophthalmic surgery manifest in several ways, with incorrect intraocular lens (IOL) implantation being the most frequently cited cause of adverse events. These errors typically stem from biometric miscalculations or documentation inaccuracies, leading to patients receiving an unintended IOL power or model [19,24,27]. Another major category of errors involves wrong-eye procedures, such as enucleations or anesthesia blocks performed on the incorrect side, often due to inadequate site marking or incomplete time-out verification [28].

Medication mix-ups during intravitreal injections also represent a significant concern, occasionally resulting in the administration of the wrong drug or the injection being performed in the incorrect eye [29]. Given the high volume of intravitreal procedures performed annually, even a low percentage of errors translates into a considerable number of affected patients [9]. Strabismus surgery presents another setting prone to laterality errors, particularly in pediatric patients, where incorrect muscle identification can lead to surgical misalignment and unintended outcomes [25].

3.3. Key Contributing Factors

The root causes of ophthalmic surgical errors frequently involve deficiencies in preoperative verification. Time-outs, when performed improperly or omitted due to time constraints, significantly increase the risk of wrong-site interventions [19,30]. Workload pressures and resource constraints further exacerbate these issues. While high-volume centers benefit from refined workflows that reduce variability, the associated strain on staff can lead to lapses in safety measures [20–22].

Communication failures among surgical teams remain a leading cause of errors across multiple specialties. Misinterpretation of documentation, ambiguous surgical planning, or lack of verbal confirmation between team members are frequently cited as contributing factors [24,31,32]. Surgeon-related factors, such as the level of experience, simultaneous operation in multiple surgical suites, and fatigue, also play a role in error incidence. Less experienced surgeons and those managing multiple cases within the same timeframe may be at a higher risk of laterality errors [25].

4. Interventions to Reduce Wrong-Site Errors

4.1. Standardized Safety Protocols

The Universal Protocol, introduced in 2004, remains the cornerstone of efforts to prevent wrong-site surgeries [33]. Its core elements—preoperative verification, surgical site marking, and a final time-out before incision—are designed to create multiple checkpoints before a procedure is performed. These measures are not only applicable in major surgical settings but also extend to minor invasive procedures, such as intravitreal injections, where wrong-site interventions remain a concern [19].

In ophthalmic surgery, the time-out step is especially important as the final check before starting the procedure. It involves the whole surgical team and helps confirm the patient's identity, the correct eye, and the planned intervention. While AI systems can support this process by reducing documentation errors or providing reminders, the human-

led time-out remains a key defense against mistakes when there is last-minute confusion or unexpected doubt [34,35].

Despite the widespread implementation of this protocol, challenges persist. Surgical site markings may become obscured by drapes or fade on darker skin tones, leading to potential misidentification [19,36]. Reliance on patient confirmation can also be problematic in cases involving elderly individuals, cognitively impaired patients, or those undergoing emergency procedures where effective communication is compromised [25,36]. Additionally, frequent staff rotations within the operating room can disrupt continuity in safety checks, undermining the effectiveness of the time-out process [19].

In response to these limitations, some institutions have adopted modifications to the standard protocol. Repeating time-outs at multiple stages of a procedure, including before critical intraoperative steps such as retrobulbar anesthesia or lens implantation, has been proposed as an effective strategy [35]. Furthermore, the integration of workflow redesigns and visual reference tools, such as those outlined in the Systems Engineering Initiative for Patient Safety (SEIPS) model, has demonstrated success in reducing IOL-related errors [27]. Main strategies for paired organs in general, with a focus on ophthalmology, are summarized in Table 1.

Table 1. Main strategies for paired organs, with a specific focus on ophthalmology. AIRS: Advanced Incident Reporting System; AR: augmented reality; NHS: National Health Service; NPSA: National Patient Safety Agency; NRLS: National Reporting and Learning System; WPSE: wrong-side/wrong-site, wrong-procedure, and wrong-patient adverse events.

Strategy	Content	Suggested by	Outcome	Reference
Standardized Security Protocols	Surgical checklist, Surgical Patient Safety System (SURPASS), WHO Surgical Safety Checklist	Joint Commission Universal Protocol	Improved compliance in identity verification (9.7% to 38.1%) and surgical site checks (32.2% to 52%) in Geneva hospitals. Reduction in postoperative complications from 27.3% to 16.7% in Dutch hospitals after implementing SURPASS.	[3,4,37,38]
Site Marking	Site marking protocols	Joint Commission on Accreditation of Healthcare Organizations and NPSA	Improved site-marking accuracy, reducing the incidence of wrong-site surgeries.	[39,40]
Continuous Training of Staff	Briefing and debriefing sessions, Medical team training programs	Canadian academic tertiary care hospitals, VHA system	One-third of briefings led to process improvements, and structured training at VHA hospitals reduced surgical errors.	[5,41]
Technology Support and Future Innovations	Tracking systems, Sentinel Event Database, COPIC database, Web-Based WPSE Incident Reporting Tool	NPSA and NHS England through NRLS	NHS reported 2,345,817 incidents in 2021–2022, with wrong-site surgeries increasing by 26% in 2023. COPIC database recorded 107 wrong-site procedures between 2002–2008.	[6,26,42]
Machine Learning	YOLOv3 algorithm and VGG-16 for laterality confirmation	Research studies on AI-based surgical safety	First-attempt authentication rate of 82.5%, increasing to 98.2% with repeated attempts.	[43]

Table 1. *Cont.*

Strategy	Content	Suggested by	Outcome	Reference
Virtual and Augmented Reality	AR head-mounted display, Eye trackers, Laser marking systems for enhanced visualization	Studies on AR/VR applications in surgical training	AR-based overlays assist in reducing surgical errors, while VR simulation improves surgical precision and training.	[44]
Knowledge of Safety and Shared Responsibility	Data collection through AIRS (Hong Kong Hospital Authority) and Veterans' Health Administration databases	Patient safety reporting systems	A web-based reporting system led to a decline of 0.17 events per 100,000 surgeries annually.	[5,45]

4.2. Continuous Training and Team Communication

Several studies identify inadequate communication as a primary cause of surgical errors [30,32,46]. Efforts to improve team coordination and information-sharing include structured educational programs focused on surgical safety, complication management, and adherence to standardized protocols [47–49].

Routine briefing and debriefing protocols have proven to be effective in reducing surgical miscommunication. Preoperative briefings allow teams to discuss potential challenges, confirm site marking, and review patient-specific considerations, while postoperative debriefings provide an opportunity to assess any deviations from protocol and implement improvements for future cases [5,50].

Leadership within the surgical team is another critical component in fostering a culture of safety. The attending surgeon plays a key role in ensuring that checklists are consistently applied, encouraging open dialog among staff, and maintaining accountability for verification processes [5,51,52].

Minimizing nonessential disruptions in the operating room environment is also essential. Unnecessary phone calls, frequent movement of personnel, and unrelated conversations contribute to distractions that can lead to lapses in safety protocols [15]. Although some staff may perceive additional verification steps as burdensome, reinforcing their importance through education and institutional support can enhance adherence to safety measures [5,52].

4.3. Technology Support and Future Innovations

Technological advancements are increasingly being integrated into surgical workflows to reduce human error. Electronic tracking systems, such as those implemented by the NHS England National Reporting and Learning System, allow for the identification of patterns in wrong-site surgeries and near misses, enabling institutions to refine safety interventions accordingly [6,42]. In a recent pilot study, Yoo et al. developed a deep learning-based smart speaker to confirm surgical information during cataract surgery time-outs. The model achieved 96.3% accuracy on validation data and 93.5% accuracy in real-time testing using 200 simulated time-out speeches. The system showed 100% accuracy in confirming the surgical procedure and patient ID. These findings support the feasibility of using smart speakers to enhance patient safety and reduce wrong-site surgeries [53]. Another work by Tabuchi et al. showed that the implementation of an AI-based system in the patient identification and verification could improve the near-miss detection and provide significant economic benefits [54].

AI is revolutionizing ophthalmic surgery by improving precision, minimizing complications, and enhancing patient outcomes. Robot-assisted systems and AI-guided instru-

ments offer real-time feedback, aid in accurate incisions, and optimize procedures. While traditional cataract surgery relies on the surgeon's manual precision, AI-powered robotics provides greater control and accuracy, potentially reducing the risk of human error [55].

Artificial intelligence (AI) and machine learning offer new possibilities for error prevention. Deep learning models such as YOLOv3 and VGG-16 have been explored for patient identity verification, surgical site confirmation, and intraocular lens selection. Trials have demonstrated that with repeated verification attempts, these systems can achieve over 90% accuracy in key safety parameters [43].

Augmented reality (AR) and virtual reality (VR) technologies are also being investigated for their potential to enhance intraoperative visualization. AR overlays can provide real-time anatomical references, such as corneal maps or optical coherence tomography (OCT) scans, allowing for improved precision during procedures. Additionally, VR simulation modules offer an opportunity for surgeons to refine their technique in a risk-free environment, particularly for complex procedures that require high levels of dexterity and spatial awareness [44]. Interestingly, a recent work Lin et al. developed an AR device embedded in a pair of smart glasses. The device was employed for the verification of the correct surgical site and patient information. Results showed a good performance of the device in the surgical side identification, with a considerable reduction in the time invested for the verification when confronted with standard methodology [56].

Large language models have also been implemented, especially in the decision-making of the surgery, acting as a "second opinion" for the surgeon. For instance, ChatGPT-3.5 was able to recommend appropriate glaucoma surgeries with a high concordance to expert plans in typical cases [57]. Less concordance was found in the more complex cases. The same language model was found to be considerably effective in the development of post-surgical documentation. The AI-generated notes contained almost 79% of the required content per NHS surgical documentation guidelines, outperforming many human-written notes in completeness [58].

Although these technologies show promise, they should not be viewed as replacements for human verification [59]. A robust system that combines AI-based confirmation with traditional safety protocols is likely to yield the greatest reduction in wrong-site errors [43,60].

4.4. Shared Responsibility and the Culture of Safety

A strong patient safety culture relies on open incident reporting, effective team coordination, and a non-punitive approach to error identification [5,45]. Ophthalmic errors, like many surgical mistakes, often result from multiple contributing factors rather than a single point of failure. Ensuring that all members of the surgical team maintain heightened situational awareness is particularly critical in high-throughput environments [40].

To further conceptualize the multifactorial dynamics underpinning surgical errors in procedures involving paired organs, Table 2 offers a structured synthesis of contributory factors, categorized into organizational, procedural, and cognitive domains. Each factor is appraised for its cumulative impact on patient safety and medicolegal liability. This framework underscores how latent systemic vulnerabilities may intersect and intensify, giving rise to high-risk events even when established safety protocols are observed.

The responsibility for error prevention is not limited to the surgeon alone. Nurses, anesthesiologists, and technicians all play a crucial role in ensuring that site verification and procedural safety measures are correctly implemented [24,45]. However, the surgeon remains the final checkpoint, underscoring the importance of maintaining vigilance at every stage of patient care.

Table 2. Summarizes key contributing factors according to their origin and their potential to interact cumulatively, increasing the risk of wrong-site surgical errors.

Error Category	Description	Impact on Process	Consequences	Cumulative Effect	References
Distraction	Environmental interruptions (door open/close, noise, calls)	Reduced focus during preoperative checks	Missed time-out and de-briefing, site identification errors	Amplifies other mistakes (e.g., fatigue + poor communication)	[1,5,6,30]
Stress	Time pressure, legal responsibility, ophthalmology emergencies	Incorrect decisions	Wrong side surgery, wrong patient/IOL, wrong patient/wrong eye	Increases vulnerability to existing errors	[2,5,36]
Fatigue	Long shifts, heavy workload	Lower attention, document-reading errors	Incorrect site marking, dosing mistakes	Increases undetected errors by others	[5,32,36]
Poor Communication	No briefing, no instructions, unclear documents	Incomplete checks, confusion about site/procedure	Wrong eye procedure, incorrect medication	Amplifies other errors	[4,5,32]
Single Error	One mistake (e.g., missed marking)	Detectable if checks are in place	Less severe if isolated	Manageable with mutual supervision	[3,30,31,39]
Multiple Errors	Combination of issues(e.g., distraction + poor communication)	Breaks safety checks	Major issues (wrong eye, permanent harm, vision loss)	Exponentially increases risk and damage	[6,27,36]

5. Case Study on Intravitreal Injections

5.1. Growing Volume and Underreported Errors

Intravitreal injection therapy for retinal diseases such as neovascular age-related macular degeneration (AMD), diabetic macular edema, and vein occlusions accounts for millions of procedures annually in many regions [61–63]. These injections are often performed in outpatient settings rather than in formal operating rooms, raising concerns about the consistent application of safety checklists [19,64,65].

Studies indicate that the number of documented wrong-site or wrong-drug intravitreal injections is relatively low; however, underreporting is highly suspected, especially if the medication administered has similar therapeutic effects [15,19].

5.2. Common Pitfalls and Strategies

Errors in intravitreal injections can arise from various factors, including medication mislabeling, inadequate site verification, and breaches in infection control protocols. One of the most frequently reported issues involves confusion between different anti-VEGF agents, which may result in the administration of the wrong drug. This risk can be mitigated by implementing detailed labeling systems, standardized color-coding, and rigorous cross-checks by multiple staff members before the injection is performed [29].

Incorrect laterality remains another critical concern, particularly in high-volume settings where injections are administered sequentially in both eyes or across multiple patients. To minimize this risk, direct verification with the patient or caregiver—where possible—should be conducted before the procedure. Additionally, a secondary confirma-

tion by a staff member, integrated into the time-out process, provides an added layer of security [30].

Infection control lapses represent a significant threat to patient safety, with protocol deviations such as omitting the use of a lid speculum or inadequate antisepsis with povidone-iodine being major contributors to endophthalmitis [66–72]. Strict adherence to standardized sterilization techniques, along with a structured verification process before injection, has been shown to significantly reduce the incidence of complications [73]. In high-throughput clinics, incorporating a brief safety pause before each injection to reaffirm patient identity, laterality, and drug selection is a practical strategy to enhance procedural accuracy and maintain compliance with safety protocols.

6. Medicolegal Implications

Wrong-site errors in ophthalmology have substantial medico-legal repercussions, as they are considered entirely preventable and often classified as never events [74]. As a result, they represent one of the most legally indefensible surgical errors, frequently leading to malpractice claims, financial settlements, and disciplinary actions [75]. In many cases, such errors are not only attributed to individual negligence but also to institutional liability, particularly when hospitals or surgical centers fail to enforce standardized verification protocols [76].

The financial burden associated with these claims is considerable. In England, between 2013 and 2018, the NHS spent approximately £193 million on ophthalmology-related malpractice claims, with an annual increase in costs [77]. Similarly, in Italy, medical litigation has been rising steadily, with hospitals collectively spending billions of euros on patient compensation [78]. Given the high procedural volume in ophthalmology, especially in cataract surgery and intravitreal injections, the frequency of medico-legal disputes is not negligible.

Legally, failure to adhere to safety protocols is often interpreted as evidence of malpractice, particularly when errors involve laterality [79]. Courts and medical boards scrutinize whether site-marking guidelines, time-out procedures, and standardized checklists were properly followed. In jurisdictions with stringent medico-legal frameworks, a lack of documented verification can significantly weaken the defense of the surgeon and the healthcare facility [80].

Beyond financial settlements, wrong-site errors carry severe professional consequences. Cases involving ophthalmic surgical errors have led to temporary or permanent revocation of medical licenses, exclusion from insurance coverage, and reputational damage that extends beyond the individual practitioner to the institution where the error occurred [81]. The increasing use of patient safety audits and forensic reviews of surgical documentation means that surgeons must be meticulous in ensuring that every verification step is consistently recorded and applied [82].

Given the heightened medico-legal scrutiny, compliance with structured safety protocols is not merely a risk-reduction strategy but a legal necessity. Institutions must ensure that surgical verification is not perceived as a bureaucratic formality but as a legally binding safeguard that protects both patients and healthcare professionals from the profound consequences of preventable surgical errors [83]. However, excessive bureaucratization of these processes may, in some cases, lead to a loss of situational awareness, potentially introducing new risks rather than mitigating them [84,85].

7. Future Directions and Challenges

Advancing patient safety in ophthalmology requires a multifaceted approach that integrates technological innovation, improved protocols, and cultural shifts within healthcare systems. While AI-assisted verification systems have demonstrated potential in reducing laterality errors, their widespread adoption remains limited by costs, infrastructure constraints, and the need for continuous updates to match evolving surgical techniques and IOL technologies [86]. The challenge is particularly pronounced in resource-limited settings, where high workloads, inadequate training, and inconsistent adherence to safety protocols increase the risk of preventable errors [20–22]. Expanding international collaborations and standardizing safety measures in high-volume procedures such as cataract surgery could help bridge these disparities.

A key issue in surgical safety is the lack of harmonization between existing protocols. The World Health Organization (WHO) Surgical Safety Checklist, the Universal Protocol, and national guidelines often overlap but are not fully integrated, leading to variability in their implementation. Developing a unified workflow tailored to ophthalmology could improve compliance and reduce ambiguity in verification procedures. The challenge of managing low-frequency yet high-impact surgical errors parallels issues encountered in operational risk modeling, where the estimation of rare adverse events requires robust data integration strategies [87].

Beyond protocol optimization, fostering a safety-oriented culture is critical. Encouraging the systematic reporting of near misses, promoting structured feedback loops, and eliminating punitive responses to error disclosure are essential to strengthening error prevention strategies [88]. In many institutions, resistance to these changes stems from perceived administrative burdens, but shifting the focus from regulatory compliance to proactive risk management could enhance adherence and ultimately improve patient outcomes.

8. Conclusions

Wrong-site errors in ophthalmology persist despite established safety protocols, often due to inconsistent adherence and systemic inefficiencies. While checklists and timeouts reduce risk, their effectiveness depends on active engagement rather than routine execution. Emerging technologies such as AI and augmented reality offer potential improvements but must integrate seamlessly into clinical workflows without replacing critical human oversight.

A shift from reactive to preventive strategies is essential, prioritizing continuous risk assessment, reporting of near misses, and adaptation of protocols to real-world constraints. Preventing surgical errors requires more than compliance with guidelines—it demands a sustained commitment to safety culture, targeted training, and the evolution of verification systems to proactively mitigate risks before they impact patient care.

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Abbreviations

The following abbreviations are used in this manuscript:

AIRS	Advanced Incident Reporting System
AR	Augmented reality
JCAHO	Joint Commission on Accreditation of Healthcare Organizations
NHS	National Health Service
NPSA	National Patient Safety Agency
NRLS	National Reporting and Learning System
WPSEs	Wrong-side/wrong-site, wrong-procedure, and wrong-patient adverse events
IOL	Intraocular lens
YOLOv3	You Only Look Once version 3 (a deep learning model)
VGG-16	Visual Geometry Group-16 (a convolutional neural network model)
SEIPS	Systems Engineering Initiative for Patient Safety
COPIC	Colorado Physicians Insurance Company database
VEGF	Vascular endothelial growth factor
AMD	Age-related macular degeneration
WHO	World Health Organization

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