JNI Jurnal Neuroanestesi Indonesia

Original Article

The High-Stakes Balance: Patient Safety and Neurosurgical Practice in a COVID-19 Pandemic

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Received: August 05, 2024; Accepted: August 26, 2024; Publish: June 21, 2025
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Abstract

Introduction: The COVID-19 pandemic profoundly affected neurosurgical practices globally, prompting the introduction of emergency health protocols to safeguard patients and healthcare personnel. While these measures were essential for controlling virus spread, they were resulted in challenges like surgical delays, resource shortages, and heightened stress for medical staff. This study aims to evaluate the impact of these protocols on neurosurgical care, identify the challenges posed, and suggest strategies to enhance patient safety and healthcare resilience in future outbreaks
Subject and Methods: This qualitative study involved a systematic literature review on PubMed, Google Scholar, and ScienceDirect, along with interviews with neurosurgeons, anesthesiologists, and intensive care specialists. Through thematic analysis, it explored the disruptions in neurosurgical care during the pandemic, the adaptive strategies employed, and their impact on patient outcomes and medical staff well-being.
Results: The study found that while emergency health protocols helped minimize COVID-19 transmission, they caused significant disruptions in neurosurgical care, with 30% of patients experiencing delays that adversely affected their outcomes. PPE shortages, inconsistent preoperative screening, and changing health protocols complicated surgical workflows. Hospitals with structured triage systems, expanded telemedicine, and enhanced preoperative screening managed the crisis better. Additionally, healthcare workers' psychological distress was reduced through improved mental health support and resource availability.
Conclusion: The COVID-19 pandemic has transformed neurosurgical practice, highlighting the need for adaptation and resilience in healthcare. Strengthening collaboration, optimizing resources, and integrating technology will better prepare neurosurgical teams for future public health emergencies while maintaining high-quality patient care.

Keywords: COVID-19, neurosurgery, health protocols, patient safety, surgical adaptation

J. neuroanestesi Indones 2025;14(2): 64–73

Introduction

The COVID-19 pandemic has significantly affected the medical field, particularly neurosurgery. As cases have surged, hospitals worldwide have had to adapt quickly to protect patients and healthcare workers from infections. In Indonesia, over 500,000 confirmed cases were reported by November 2020, highlighting the urgent need for strict health protocols in all medical procedures, including neurosurgery.[1] Emergency health protocols in neurosurgery is aimed to reduce virus transmission risks through adequate personal protective equipment (PPE), pre-procedure patient screening, and organized operating rooms. A 2020 study found that strict preventive measures can lower COVID-19 infection rates in neurosurgical patients.[2] Implementing this protocol faces significant challenges, particularly due to PPE shortages in many hospitals. This has raised safety concerns among medical personnel. A 2020 study highlighted that hospitals worldwide struggled to secure adequate PPE during the pandemic's peak.[3] This added pressure to health systems

doi: https://doi.org/10.24244/jni.v14i2.616
ISSN (Print): 2088-9674 ISSN (Online): 2460-2302

JNI is accredited as Sinta 2 Journal: https://sinta.kemdikbud.go.id/journals/profile/796

How to cite: Sumardi FS, et al, "The High-Stakes Balance: Patient Safety and Neurosurgical Practice in a COVID-19 Pandemic".

already stressed by the surge in COVID-19 cases. A 2021 study showed that many patients experience delays in emergency neurosurgical care, often due to postponed non-emergency procedures that can worsen their condition. A 2024 study indicated that around 30% of patients needing neurosurgery faced delays during the pandemic, which could be fatal.[5] Therefore, finding solutions that protect patients and medical personnel while ensuring timely care is essential. This study addresses how emergency health protocols have impacted neurosurgical practice during the COVID-19 pandemic and what strategies can enhance patient care while ensuring healthcare worker safety. It aims to explore the effects of these protocols on surgical delays, resource limitations, and the mental health of medical personnel, identifying practical solutions to improve neurosurgical resilience in future pandemics.

Subject and Methods

This qualitative study analyzed secondary data from sources like PubMed, Google Scholar, and ScienceDirect, focusing on neurosurgical health protocols during the COVID-19 pandemic. It included articles from 2017 to 2024 that addressed neurosurgical practices, infection risks, and mitigation strategies. Data were categorized into key themes: challenges, mitigation efforts, and impacts on healthcare personnel and patients, supported by statistical data. Additionally, interviews with neurosurgeons, anesthesiologists, and other frontline staff provided firsthand insights compared with existing literature. The study also evaluated government policies and WHO guidelines regarding neurosurgical care during the pandemic, including protocols for treating COVID-19 patients needing surgery and measures to protect healthcare workers. This comprehensive approach offers valuable guidance for future emergency neurosurgical practices. This qualitative study analyzed secondary data from sources like PubMed, Google Scholar, and ScienceDirect, focusing on neurosurgical health protocols during the COVID-19 pandemic.

Result and Discussion

Study Selection

Through database searches (PubMed, Google Scholar, ScienceDirect), 725 records were identified. After removing 230 duplicate records, 495 records remained for screening. Titles and abstracts were screened based on the inclusion criteria, resulting in 115 full-text articles assessed for eligibility. After applying the exclusion criteria, 42 studies were included in the final qualitative synthesis.

Study Characteristics

The included studies were published between 2017 and 2024 and addressed various aspects of emergency health protocols in neurosurgery during the COVID-19 pandemic. These studies provided data on infection control measures, PPE usage, surgical delays, and the impact of COVID-19 on neurosurgical outcomes. Of these, 18 were cohort studies, 12 were cross-sectional, and 12 were systematic reviews or expert guidelines.

Risk of Bias and Quality Assessment

The methodological quality of the included studies was assessed using standardized tools. Studies with high methodological rigor provided strong evidence on the effectiveness of infection prevention strategies. Some studies had limitations, including small sample sizes and potential selection bias.

A qualitative analysis of literature and expert interviews identified four key themes in implementing emergency neurosurgical protocols during the COVID-19 pandemic: resource limitations, surgical delays, psychological strain on medical staff, and adaptive innovations. The findings highlight broader challenges beyond surgical techniques, particularly patient safety. Ensuring safety during the pandemic necessitates enhanced screening and improved treatment room organization to minimize infection risks, requiring hospitals to adopt stricter measures to protect patients and healthcare workers.

Impact of the COVID-19 Pandemic on Neurosurgery Practice

The COVID-19 pandemic, caused by the SARS-CoV-2 virus, has dramatically impacted healthcare, especially neurosurgery. New challenges have emerged that require serious attention. Data from Indonesia's Ministry of Health indicates that by November 2020, COVID-19 cases were still rising, prompting hospitals to implement strict health protocols to protect patients and medical staff.[1] Neurosurgery is among the most hazardous medical specialties due to procedures that generate aerosols, increasing the risk of virus transmission. Therefore, medical professionals in this field must maintain heightened vigilance and adhere to strict health protocols to protect patients and healthcare workers.

One of the main challenges in neurosurgery during the pandemic is the risk of COVID-19 infection for patients and medical personnel. A 2020 study highlighted that neurosurgical procedures could transmit the virus, stressing the need for caution, particularly when manipulating the respiratory tract.[6] A 2020 study highlighted the precarious nature of uncertainty regarding a patient's COVID-19 status, which complicated clinical decisions for surgeons. Neurosurgical procedures require high concentration and become more challenging due to potential virus transmission, posing risks to the patient and the medical staff.[6] Rigorous screening is essential before surgery, including a thorough health assessment and COVID-19 testing to prevent virus transmission. While effective screening can ensure safety, limited access to COVID-19 testing in some regions, particularly in less developed areas, can complicate and prolong the process. Obtaining test results on time is crucial in medical emergencies, as delays can lead to fatal consequences, especially for patients needing immediate surgery. Overcoming challenges like limited access to tests and lengthy result times is essential for the safe performance of surgical procedures. Improving healthcare infrastructure and test accessibility are vital to effectively address these issues, ensuring patient safety and protecting frontline medical personnel. This will ultimately enhance the quality of care during the ongoing pandemic. Data from another published study in 2020 showed that, out of 200 neurosurgical procedures analyzed, 15% of cases were confirmed to be positive for COVID-19

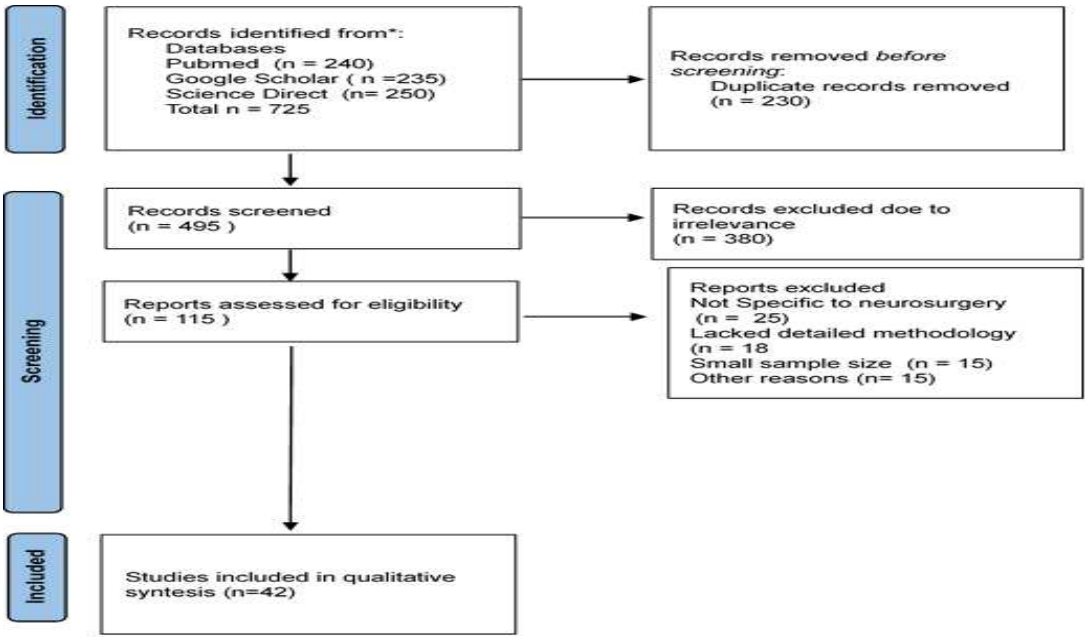

Figure 1: The screening methodology, based on PRISMA 2024
* All articles were selected manually by the author from their publisher's websites
** All articles fit the criteria for the review; therefore, there are no articles excluded

postoperatively.[2] This figure provides a clear picture of the situation faced by the medical world today. In the context of a pandemic, every neurosurgical procedure is a challenge, not only from a technical perspective but also from a public health perspective. The analysis notes that 15% is a significant figure, indicating that nearly one in seven patients may contract COVID-19 after neurosurgery. This poses challenges for healthcare facilities in mitigating risk through strict health protocols and careful monitoring.

The concern extends to healthcare personnel, as exposure risks could lead to staff shortages and impact the quality of care for other patients. Positive COVID-19 cases can disrupt hospital operations, necessitating patient isolation, temporary area closures, and enhanced disinfection—all of which require additional resources. Medical staff also experience stress and anxiety due to exposure to uncertainties, which can affect their mental health and performance. Therefore, hospitals must offer psychological support and resources. Collaboration among healthcare teams is vital for developing practical protocols for COVID-19-positive patients. By understanding these challenges and implementing strategies, healthcare facilities can enhance the safety of both patients and staff. Further research is needed to identify factors contributing to postoperative COVID-19 infections and establish best practices. A 2020 study indicated that SARS-CoV-2, the virus behind COVID-19, could significantly damage the nervous system. This highlighted the need to understand its effects beyond the respiratory system, posing serious concerns for healthcare professionals in managing affected patients.[7]

The impact of COVID-19 on the nervous system can range from mild symptoms to severe complications like confusion, loss of consciousness, or stroke. This indicates that COVID-19 not only affects physical health but also poses risks for neurological disorders, emphasizing the need for further understanding of this relationship. Patients with COVID-19 may experience neurological complications such as headaches, vertigo, and memory issues. It is essential for healthcare providers to evaluate these patients thoroughly, especially those exhibiting neurological symptoms, to determine effective treatment options. Medical personnel face challenges in managing patients with neurological complications. They need to assess the risks and benefits of procedures, including possible neurosurgical interventions. Collaboration with neurologists is crucial for planning comprehensive patient care and improving outcomes.

Increased understanding of the effects of SARS-CoV-2 on the nervous system is vital for guiding more effective clinical guidelines, enhancing patient care, and reducing complications risks. Additionally, healthcare workers must adapt to changing health protocols, which can create confusion and affect workflow and patient safety during the pandemic. A 2021 research publication revealed that many healthcare workers were dissatisfied with the frequency of protocol changes.[4] This dissatisfaction can arise for various reasons, such as a lack of clear information about the changes or an inability to keep up. This frustration can negatively impact healthcare workers' mental and emotional well-being, ultimately affecting the quality of care they provide. Adequate training and information for health workers are essential to help them adapt to changes in health protocols. Regularly providing clear and structured information minimizes confusion and boosts their confidence.

Effective communication between hospital management and healthcare workers is crucial. Good communication channels allow health workers to ask questions and clarify protocols, fostering a collaborative work environment. Emotional support is also vital. Psychological support programs can help health workers cope with the stress of frequent changes, ensuring their well-being and motivation. Adapting to changing health protocols is challenging, but with proper training, communication, and support, health workers can better navigate these challenges, ultimately improving the quality of healthcare and patient confidence in services.

Solutions for Overcoming Challenges

Implementing health protocols in neurosurgical practice requires a planned, evidence-based strategy to ensure the safety of patients and healthcare workers. Strengthening patient screening systems before surgeries the key. A PCR test for COVID-19 is essential to detect any infection prior to the procedure, helping to minimize virus transmission in the operating room.

Additionally, conducting a thorough risk assessment of the patient's medical history and other relevant factors is vital to ensure only safe patients undergo surgery, protecting both them and the medical team. Furthermore, increasing the availability of appropriate personal protective equipment (PPE) is crucial, as many hospitals faced shortages during the pandemic. Collaboration among the government, health institutions, and the medical industry is necessary to address this challenge. This collaboration aims to ensure that healthcare workers have an adequate supply of PPE. A 2020 research publication emphasized the importance of thorough operating room preparation, including computerization, to monitor and manage PPE supply and operating schedules.8 With this approach, hospitals can ensure that all health protocols are followed without compromising operational efficiency.

A 2020 research publication recommended implementing strict infection control protocols. These protocols included the use of N95 masks, face shields, and appropriate medical attire during surgical procedures.[9] Adhering to these protocols can minimize the risk of virus transmission and ensure the safety of health workers. Data published in 2020 from several hospitals in Europe showed that 30% of medical personnel experienced difficulties accessing appropriate PPE during the pandemic's peak.[10] Personal protective equipment protects medical personnel from the risk of exposure to infection, which can occur in a hospital setting, especially when dealing with infected patients. In this context, the use of appropriate PPE protects not only medical personnel but also patients and the wider community. Some hospitals have implemented this protocol, but PPE availability and quality concerns persist. Many struggle to obtain sufficient quantities, particularly during the pandemic's peak, raising the risk of transmission to medical staff and patients. According to a report from the World Health Organization (WHO), inadequate personal protective equipment (PPE) was one of the significant problems affecting the global health system at that time.[11] At the height of the pandemic, many medical personnel were forced to work without adequate PPE, increasing their risk of virus exposure. This situation created an unsafe working environment and caused concern among medical personnel. Many medical personnel have expressed concerns about their safety and that of their patients due to inadequate protective equipment (PPE). This shortage not only poses health risks but also affects their mental well-being, leading to stress and a diminished ability to provide quality care. According to a WHO report, high stress and fatigue levels can significantly reduce effectiveness in delivering health services. Hospitals must ensure adequate PPE availability while also providing psychological support, such as counseling and stress management programs, to help healthcare workers maintain their mental health and performance.

Effective communication among medical teams is also essential, particularly with the challenges posed by PPE that can obstruct hearing and vision. Implementing training on communication strategies while wearing PPE and utilizing wireless communication tools can improve coordination and safety within medical teams. A 2017 research publication revealed that poor communication could lead to medical errors, which could be fatal in neurosurgical procedures.[12] Therefore, it is essential to develop effective communication strategies even under restrictive conditions. This study highlights the challenges medical personnel faced during the pandemic. Essential measures like providing adequate personal protective equipment (PPE) and psychological support are vital for their safety and the quality of patient care. Improving PPE availability and communication within the team can foster a safer work environment for medical

staff. In this context, it is essential to understand how health protocols can be integrated into neurosurgical practice without compromising the quality of care. A 2020 research publication showed that local anesthesia could be a safer alternative to general anesthesia in some surgical procedures, including carotid endarterectomy, which may reduce the risk of COVID-19-related complications.[13] This signals the need to carefully evaluate the anesthesia methods used in neurosurgery during the pandemic. Implementing technology can effectively address challenges in healthcare, such as using telemedicine for pre-operative consultations. This allows patients to discuss remotely with surgeons, reducing in-person visits and transmission risk. It also offers convenience for patients and alleviates pressure on the healthcare system during the pandemic, making technology a valuable tool for enhancing healthcare efficiency and effectiveness.

A 2017 research publication highlighted the importance of using local anesthesia in specific procedures, such as subdural hematoma evacuation, which could reduce patient time in the operating room and the risk of transmission.[14] Innovations in operational management, such as the triage system implemented in some hospitals, show that rapid adaptation can help overcome challenges. By identifying patients who require immediate action, hospitals can reduce the risk of transmission and ensure that resources are used efficiently. This aligns with recommendations from a 2020 publication that suggested better operational management during the pandemic.[10]

Some hospitals have successfully implemented operational management innovations to overcome this challenge. For example, a hospital in Jakarta implemented a strict triage system to determine which patients required immediate surgery and which could be delayed.[4] This reduces the operating room's burden and allows for more efficient use of resources. Despite the non-ideal conditions, many teaching hospitals have begun implementing remote training programs for neurosurgery residents. This aims to ensure that even if they cannot practice directly in the operating room, they still gain the necessary knowledge and skills.[4] This approach has proven to be effective in improving resident confidence and readiness when returning to hands-on practice.

Ongoing training for medical personnel is crucial. During the pandemic, many institutions offered seminars and online training to enhance staff skills and knowledge about health protocols, preparing them for emergencies and boosting their confidence in handling COVID-19 patients. This practical training improves safety for patients and healthcare workers, highlighting the need to support the well-being of medical personnel. A 2021 research publication noted that psychological support and well-being programs for healthcare workers were crucial. Frontline health workers often face stressful situations and need adequate support to maintain their motivation and performance.[4] Hospitals must provide mental health services and support programs for health workers to help them cope with stress and burnout. Creating a supportive work environment is essential for improving their performance in challenging situations.

Collaboration among various disciplines, such as epidemiologists and public health experts, is crucial for effective health protocol planning and implementation. This holistic approach can enhance resilience against future health challenges, including pandemics. Additionally, cooperation between hospitals and health institutions is vital. Sharing best practices and experiences, particularly in managing COVID-19 cases, can lead to better preparedness for future surges. For instance, some European hospitals have formed networks to exchange resources and information

Impact of Health Protocols on Neurosurgical Outcomes

Implementing strict health protocols during the COVID-19 pandemic has significantly changed healthcare delivery. Measures like mask-wearing, hand sanitizers, and visitor limits aim to protect patients and medical personnel from virus transmission. These protocols impact not

only general healthcare but also neurosurgical outcomes. Research indicates that patients undergoing neurosurgery during the pandemic face a higher risk of postoperative complications, which can prolong recovery and increase care burdens. Therefore, surgical teams must consider the patient's COVID-19-related health status when planning procedures.[15-20] One relevant study was conducted by a 2020 research publication, which noted that COVID-19 infection can affect the central nervous system. This suggests that the virus impacts the respiratory system and can affect the patient's neurological function.[15] As such, patients undergoing neurosurgical interventions while infected with COVID-19 could potentially experience worse conditions. This emphasizes the importance of understanding the impact of COVID-19 on patients' neurological health.[15-20]

Statistics show that mortality and morbidity rates in COVID-19-infected patients undergoing surgery have increased significantly. In a study conducted at several hospitals in France, it was found that neurosurgery patients who were confirmed positive for COVID-19 had a substantially higher mortality rate compared to non-COVID-19 patients. The publication of the 2024 findings illustrated how important it was to conduct rigorous screening and risk evaluation before performing surgical procedures on patients with a history of COVID-19 infection.[16] Various factors can cause higher mortality in neurosurgical patients infected with COVID-19. One of them is the presence of higher comorbidities in these patients, such as heart disease, diabetes, or hypertension. In addition, the COVID-19 infection may worsen the patient's general health condition, reducing the body's ability to recover after surgery. Therefore, a thorough risk evaluation is crucial in determining whether a surgical procedure can be performed safely.

Rigid screening also includes checking for symptoms associated with the COVID-19 infection. Patients showing symptoms, such as fever or cough, should receive special attention and may need to undergo a COVID-19 test before being scheduled for surgery. This not only protects other patients in the hospital but also the medical personnel involved in the surgical procedure. As such, the implementation of strict health protocols in the context of neurosurgery is an indispensable step. The importance of post-operative monitoring has also increased during the pandemic. Given the higher risk of infection, patients undergoing neurosurgical procedures should receive extra attention. The post-operative recovery process is a critical phase that requires careful monitoring to ensure patients do not experience complications. Therefore, hospitals must develop more comprehensive monitoring protocols to ensure patients receive proper care after surgery.

Effective post-operative monitoring includes regular checks of vital signs and surveillance for symptoms that may indicate complications. In the context of a pandemic, telemedicine is becoming increasingly relevant. Telemedicine allows medical personnel to monitor a patient's condition remotely, reducing the need for physical visits to the hospital. This helps reduce the risk of COVID-19 transmission and comforts patients who may feel anxious about going to the hospital. The use of technology in post-operative monitoring can also improve information delivery efficiency. Patients can report symptoms or changes in their health condition through health apps or telemedicine platforms. This way, the medical team can take immediate action, making patients feel more involved in their recovery. This is a crucial step to ensure patient safety and well-being during recovery. In addition, developing a comprehensive monitoring protocol should involve patient education. Patients must be given clear information about the signs to look out for after surgery and the steps to take if they experience any suspicious symptoms. Adequate education will better prepare patients for the recovery process and can contribute to their safety.

Analysis and Recommendations on Emergency Health Protocols in Neurosurgery Amid Future Outbreak in Indonesia

Implementing emergency health protocols in neurosurgery during the COVID-19 pandemic

has presented significant challenges globally. In Indonesia, medical facilities have adopted various strategies, but gaps remain compared to international best practices.

1) Indonesia's Current State: Successes and Challenges

Indonesia has made significant progress in integrating strict health protocols in neurosurgical procedures. Hospitals implemented enhanced screening, personal protective equipment (PPE) usage, and modified surgical workflows to minimize transmission risks. Collaboration between hospitals and institutions was the key in managing neurosurgical cases during the pandemic.

However, persistent challenges remain:

- Surgical Delays: Approximately 30% of neurosurgical patients experienced delays due to procedural backlogs, which led to worsened outcomes.
- Resource Limitations: PPE shortages and lack of rapid COVID-19 testing hindered timely interventions, especially in rural areas.
- Mental and Physical Fatigue: Healthcare workers experienced burnout due to prolonged exposure to high-risk environments and evolving protocols.

Despite these challenges, continued adaptation and investment in healthcare infrastructure have improved emergency preparedness for future outbreaks.

2) High-Priority Areas for Improving Patient Outcomes and Safety

To enhance neurosurgical care and reduce perioperative complications, the following areas should be prioritized:

- Strengthening Preoperative Screening: Expanding access to rapid PCR tests and incorporating AI-driven risk assessment models can ensure early detection of COVID-19 infections in surgical candidates.
- Optimizing Operating Room Management: Implementing a triage system to prioritize critical neurosurgical cases can prevent fatal delays.
- Enhancing Infection Control Measures: Continued education on the proper use of PPE and post-operative monitoring strategies can reduce nosocomial infections.
- Leveraging Telemedicine: Preoperative and postoperative virtual consultations can limit hospital exposure while maintaining high-quality care.
- Expanding Multidisciplinary Collaboration: Neurosurgeons, anesthesiologists, and epidemiologists should coordinate to develop evidence-based perioperative safety protocols tailored to pandemic conditions.

3) Boosting Healthcare Worker Morale and Confidence

During the pandemic, frontline workers in Indonesia's neurosurgical field faced immense psychological and professional challenges. Addressing their concerns is essential for sustaining workforce resilience and ensuring quality patient care:

- Improving PPE Availability: Consistent access to high-quality PPE reduces anxiety among healthcare workers.
- Providing Mental Health Support: Regular psychological counseling and structured debriefing sessions can help alleviate stress and prevent burnout.
- Offering Continuous Training and Clear Communication: Frequent protocol changes created confusion; transparent, evidence-based updates can restore confidence and efficiency.
- Acknowledging and Incentivizing Medical Personnel: Financial incentives, career growth opportunities, and public recognition of healthcare workers' efforts can improve motivation and job satisfaction.

Conclusion

The strict health protocols implemented during the COVID-19 pandemic have significantly affected healthcare, particularly neurosurgery. Patients with COVID-19 face higher risks of postoperative complications and mortality, highlighting the need for rigorous screening and evaluation. Enhanced post-operative monitoring, including telemedicine, is crucial for patient safety. It's hoped that with the right strategies,

neurosurgical outcomes can still improve during the pandemic. Additionally, multidisciplinary collaboration among hospitals to share best practices can enhance protocol implementation

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