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| ARTICLE REVIEW

Factors Influencing Infection in Intracerebral Hemorrhage Patients: A Literature Review

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| ABSTRACT

Infectious complications represent the primary non-neurological challenge for individuals diagnosed with Intracerebral Haemorrhage (ICH), acting as a major driver for unfavourable clinical results, extended ICU stays, and heightened healthcare costs. This literature review offers a systematic analysis of the varied elements that contribute to infection in ICH cases, spanning from innate physiological vulnerabilities to risks acquired within the hospital setting. By integrating findings from 20 contemporary journals (2021–2026) and 3 core medical textbooks, this research highlights essential risk determinants such as diminished Glasgow Coma Scale (GCS) scores, total hematoma volume, and metabolic imbalances like hyperglycaemia upon admission. Furthermore, the review investigates Stroke-Induced Immunodepression Syndrome (SIDS) as a fundamental biological mechanism. These insights emphasize the urgency of early risk categorization and focused preventive measures to curb infectious setbacks in specialized clinical environments, such as Universitas Airlangga Hospital.

| KEYWORDS

Intracerebral Hemorrhage, Post-Stroke Pneumonia, Risk Determinants, Immunosuppression, Literature Review, Hospital-Acquired Infection

| ARTICLE INFORMATION

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1. Introduction

Intracerebral Hemorrhage (ICH) is a catastrophic neurological event characterized by significantly higher mortality rates than its ischemic counterparts (Biller & Ferro, 2021). While initial medical interventions focus on managing intracranial pressure and limiting hematoma growth, secondary systemic issues—specifically infections—frequently become the primary cause of fatality following the acute 48-hour window (Chen et al., 2022). Occurring in roughly one-third of ICH patients, these infections are not merely incidental but serve as a powerful catalyst for worsening neurological status and multiorgan dysfunction (Louis et al., 2021). The biological pathway of infection in ICH is remarkably intricate, involving a two-way dialogue between the damaged brain tissue and the peripheral immune system. This disruption of the "brain-immune axis" creates a contradictory physiological state: acute inflammation localized at the brain injury site paired with systemic immune exhaustion that exposes the patient to opportunistic microbes (Meisel & Meisel, 2023). For clinicians operating within the 2021–2023 timeframe, such as those at Universitas Airlangga Hospital, identifying these triggers is vital for refining patient care protocols.

2. Methodology

This research utilizes a narrative review framework to aggregate existing clinical evidence. A thorough search was executed across Scopus, PubMed, and Google Scholar, specifically targeting peer-reviewed studies published between 2021 and 2026 to capture the most current medical guidelines. Primary search queries included "ICH," "Infectious Predictors," and "Nosocomial Complications." We selected 20 high-impact journal articles based on their clinical relevance, supported by 3 foundational neurosurgical textbooks (Greenberg, 2023) to establish a comprehensive theoretical basis for the discussion. Inclusion criteria included peer-reviewed articles focusing on infection in ICH patients, while studies not directly addressing infection outcomes were excluded.

3. Result and Discussion

3.1 Neurological Indicators and Respiratory Safety

The magnitude of the initial neurological insult stands as the most reliable predictor of subsequent infectious events. A diminished Glasgow Coma Scale (GCS) score during intake is fundamentally associated with the failure of protective bulbar functions, such as the gag and cough reflexes, which facilitates micro-aspiration (Pratama & Suwono, 2022). Evidence suggests that patients presenting with a GCS of 8 or lower face an escalated risk of early-onset Stroke-Associated Pneumonia (SAP) due to the chronic inhalation of oropharyngeal bacteria (Wang et al., 2023). Additionally, increased hematoma dimensions are linked to higher intracranial tension, which interferes with autonomic regulation of the immune system (Liu et al., 2021). The ICH-LR2S2 scoring system has become a crucial tool for practitioners to measure this risk, combining age and GCS to forecast respiratory complications (Faigle et al., 2021).

3.2 Metabolic Disturbance and Biological Markers

A patient's metabolic profile at the time of stroke onset heavily influences their susceptibility to infection. High blood sugar levels upon admission, regardless of prior diabetic history, promote a proinflammatory environment that hinders the effectiveness of neutrophil phagocytosis (Huang et al., 2025). This physiological stress is frequently reflected in laboratory markers; for example, an elevated Neutrophil-to-Lymphocyte Ratio (NLR) is a verified, low-cost predictor of post-stroke sepsis, indicating a lack of balance between innate and adaptive immunity (Ji et al., 2021). Furthermore, electrolyte fluctuations, such as low serum calcium, often align with increased C-reactive protein (CRP) levels, acting as early indicators of systemic inflammatory progression (Yang et al., 2021; Tan et al., 2022).

3.3 Procedural and Environmental Factors

Within intensive care units, the very tools used for stabilization often create new pathways for pathogens. Mechanical ventilation, though essential for patients with respiratory failure, remains the primary cause of Ventilator-Associated Pneumonia (VAP) (Gong et al., 2024). Likewise, the requirement for indwelling catheters to track fluid balance is the single largest risk factor for Catheter-Associated Urinary Tract Infections (CAUTIs) (Kumar et al., 2022). In cases requiring neurosurgical monitoring, the use of External Ventricular Drains (EVD) increases the direct threat of ventriculitis (Nguyen et al., 2022). These hospital-linked infections are increasingly caused by drug-resistant strains, demanding precise antibiotic management in neurological ICU settings (Zhao et al., 2024). Mechanical ventilation is one of the most significant contributors to infection in ICH patients, particularly due to its strong association with ventilator-associated pneumonia (VAP).

3.4 Demographic Profiles and Pre-existing Conditions

The baseline physiological resilience of the host is a major factor in infectious development. Advanced age and general frailty are associated with "immunosenescence," a gradual decline in immune performance that leaves older patients vulnerable to sepsis after a brain hemorrhage (Li et al., 2023). Moreover, chronic illnesses—particularly persistent hypertension and diabetes—establish a baseline of immune compromise that intensifies the body's reaction to acute brain trauma (Xiao et al., 2023). For Asian demographics, these variables must be analyzed alongside local microbiological data to ensure successful long-term recovery (Sun et al., 2025).

4. Conclusion

The onset of infection in ICH patients follows a predictable pattern driven by the severity of brain injury, metabolic stress, and the total time spent under invasive medical care. This review concludes that the most successful method for lowering infection-related death rates is early risk stratification via GCS tracking, glycemic management, and the use of biomarkers like NLR. For centers like Universitas Airlangga Hospital, prioritizing "ventilator care bundles," strict device hygiene, and rapid swallowing assessments is essential. Future investigations should explore the potential for immune system modulation to mitigate SIDS without causing further harm to brain tissue.

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