

INTEGRATING AYURVEDIC PHARMACOTHERAPY WITH CRITICAL CARE: A PHARMACOLOGICAL EVALUATION OF POTENTIAL THERAPEUTIC AND SAFETY OUTCOMES

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ABSTRACT:

Critical illness is characterized by profound inflammatory, oxidative, immune, metabolic, and microcirculatory disturbances that contribute to progressive organ dysfunction and complicate pharmacological management. Ayurvedic pharmacotherapy has attracted interest as a potential adjunctive approach because medicinal plants and complex formulations contain bioactive constituents capable of modulating multiple pathophysiological pathways. This review critically evaluates the pharmacological basis, potential therapeutic applications, safety considerations, and translational prospects of integrating Ayurvedic interventions into critical-care practice. Emphasis is placed on anti-inflammatory, antioxidant, immunomodulatory, mitochondrial, and endothelial mechanisms relevant to sepsis, acute respiratory distress syndrome, acute kidney injury, hepatic dysfunction, cardiovascular instability, and neurocritical illness. The review further examines altered pharmacokinetics and pharmacodynamics during critical illness, including herb–drug interactions involving cytochrome P450 enzymes, drug transporters, and commonly administered intensive-care medications. Major safety concerns include organ-specific toxicity, herbo-mineral exposure, contamination, adulteration, formulation variability, and inadequate pharmacovigilance. Current evidence remains limited by heterogeneous interventions, insufficient pharmacokinetic characterization, inconsistent standardization, and scarcity of rigorous intensive-care trials. Future translation requires standardized formulations, mechanistic validation, dose optimization, biomarker-guided patient selection, multicenter randomized trials, and continuous safety surveillance. Ayurvedic pharmacotherapy may ultimately have adjunctive potential, but integration should remain evidence-driven, pharmacologically justified, and subordinate to established critical-care standards and therapies.

KEYWORDS: Ayurvedic pharmacotherapy; Critical care; Herb–drug interactions; Pharmacokinetics; Integrative medicine

1. INTRODUCTION

Critical illness is a complex state of general inflammation, instability, disturbance of metabolic and hemodynamic function, and progressive organ dysfunction, which requires intensive pharmacological care. It is very common for patients in intensive care units (ICUs) to be treated with multiple medications, such as antimicrobials, vasopressors, sedatives, analgesics, anticoagulants, and corticosteroids. Critical illness can significantly affect drug absorption, distribution, metabolism and elimination due to alterations in gastrointestinal function, presence of capillary leaky syndrome, fluid resuscitation, hypoalbuminemia, hepatic impairment, and acute kidney injury. These variations result in significant variability in therapeutic exposure and make traditional dosing approaches difficult (Morales Castro et al., 2023). Therefore, careful assessment of the pharmacokinetics, therapeutic efficacy, drug interactions and toxicity of complementary pharmacotherapies in critical care is needed.

Clinicians are now interested in the use of integrative and complementary medicine as adjunctive methods for symptom management, recovery and patient-centered care in ICUs. The evidence suggests several complementary practices have been adopted in intensive-care settings, but methodological diversity and lack of high-quality clinical evidence are notable factors that hinder its adoption, with the exception of several practices adopted in the intensive-care setting (Silva et al., 2024). Ayurveda is a very complex pharmacotherapeutic system that involves medicinal plants, polyherbal formulations, special formulations, and pharmacotherapeutic

principles that are unique for each case. The modern study of Ayurvedic medications has been more focused on their pharmacological actions, pharmaceutical characteristics, bioactive compounds, and formulations (Jhade et al., 2025). These are especially important in critically ill patients as organ dysfunction and concurrent drug treatment can significantly influence drug response.

The clinical research emerging in recent years has also investigated the effects of Ayurvedic therapy on complicated infectious diseases. Preliminary clinical evidence for integrative therapeutic strategies has been explored in the early stages of COVID-19 disease in the context of add-on Ayurvedic treatment (Thakar et al., 2021). Likewise, Ayurvedic therapy has been assessed as an adjunctive treatment to treat post-COVID-19 mucormycosis (Madikonda et al., 2022). The results, however, cannot be directly applied to critically ill patients due to variations between the severity of the disease, the study design, the organ function and the medication burden.

Hence, integration of Ayurvedic pharmacotherapy in critical care cannot be based on the traditional use or mechanistic plausibility of the drug alone and should be based on a comprehensive benefit risk analysis. Herb–drug interactions, variable bioavailability, product standardization, and contamination, in addition to possible anti-inflammatory, antioxidant, immunomodulatory, and organ protection properties, need to be evaluated. This review critically investigates the pharmacological rationale, possible therapeutic use, pharmacokinetic and pharmacodynamic aspects, drug interactions, safety, clinical efficacy and implications for translation of Ayurvedic pharmacotherapy used as an adjunctive therapy in critical care medicine.

Research Objectives

- To evaluate the therapeutic potential and pharmacological mechanisms of Ayurvedic interventions in critical illness.
- To assess the safety, toxicity, and herb–drug interaction risks of Ayurvedic pharmacotherapy in critical care.
- To identify evidence gaps and future priorities for integrating Ayurvedic pharmacotherapy into critical-care practice.

2. Pharmacological Basis of Ayurvedic Therapeutics in Critical Care

The basic concepts of Ayurvedic pharmacotherapy are interconnected and describe the nature of the medicinal substances and their actions in terms of Dravya (substance), Rasa (taste), Guna (attributes), Virya (potency), Vipaka (post-digestive effect) and Prabhava (specific action). All these parameters help in guiding therapeutic selection, formulation, dosage and expected biological response while Rasa and Guna serve as important traditional parameters to guide pharmacodynamic activity (Ther, 2025). Patient and disease specific selection of drugs further differentiates Ayurvedic pharmacotherapy and makes it an idea of conceptual interface with modern precision oriented therapeutic approach. Therefore, to make the connection between the traditional Ayurvedic concepts and the experimentally established pharmacological actions on which it rests, the integrative research has been increased (Jha et al., 2025).

The Ayurvedic therapeutics are as follows: Herbal medicines, Polyherbal formulations, Rasayana drugs and Herbo mineral drugs. In polyherbal formulations, each of the pharmacologically active ingredients have multiple biological pathways and they may act in combination or synergistically (Rajini & Muralidhara, 2023). Additionally, there are more specific treatments in Ayurveda medicine, like medicinal leech therapy that suggests possible links between traditional therapy and biomedical mechanisms (Singh & Rajoria, 2020). In the molecular level, medicinal plants used in Ayurveda contain alkaloids, flavonoids, polyphenols, terpenoids, withanolides and curcuminoids which can affect the inflammatory, oxidative, metabolic and cellular signaling pathways. In order to overcome the complexity and functional diversity of such multi-component–multitarget interactions and understand their underlying molecular mechanisms, a strategy called network pharmacology is becoming increasingly relevant to the understanding of these interactions (Zeng et al., 2019).

However, in clinical translation, stringent pharmaceutical standardization is needed to enter the critical care. Therapeutic exposure can vary significantly due to botanical identity, phytochemical composition, processing conditions, batch consistency, stability and bioavailability. By providing a consistent chemical profile of herbal products that can be used to identify them, advanced chromatographic and spectroscopic fingerprinting can play a significant role in authentication and quality control measures (Noviana et al., 2022). In critically ill patients, who are physiologically unstable, have organ dysfunction and/or polypharmacy, there is a need for predictable composition, pharmacological activity and safety (Table 1).

Table 1. Pharmacological Profile of Major Ayurvedic Therapeutic Classes Relevant to Critical Care

Ayurvedic therapeutic class	Representative constituents/examples	Principal pharmacological relevance	Potential critical-care relevance	Key reference
Single-herb medicines	Alkaloids, flavonoids, polyphenols, terpenoids, withanolides, curcuminoids	Anti-inflammatory, antioxidant, immunomodulatory and cytoprotective activities	Potential modulation of inflammation, oxidative stress and	Jha et al. (2025)

			cellular injury	
Polyherbal formulations	Multiple interacting phytoconstituents	Multicomponent and multitarget pharmacological effects	Potential simultaneous modulation of inflammatory, immune and metabolic pathways	Rajini and Muralidhara (2023)
Rasayana therapies	Plant-based restorative formulations	Adaptogenic, antioxidant and immunomodulatory potential	Potential relevance to physiological resilience and post-critical-illness recovery	Jha et al. (2025)
Herbo-mineral preparations	Herbal components with processed mineral/metal constituents	Formulation-dependent and incompletely characterized pharmacological effects	Potential therapeutic relevance requires rigorous benefit–risk assessment	Gaikwad (2025)
Standardized herbal preparations	Chemically characterized Phytochemical profiles	Improved reproducibility, identity and batch consistency	Essential for predictable exposure, safety and clinical translation in ICU populations	Noviana et al. (2022)

3. Mechanistic Therapeutic Potential in Critical Illness

Critical illness refers to multip system inflammatory, oxidative, immune, mitochondrial, microvascular, disturbances which lead to cellular injury and progressive organ dysfunction (Paul et al., 2020). These are pathways that can be harnessed as potential targets for bioactive compounds from standardized herbal preparations, but reproducible phytochemical characterization is crucial, particularly in assigning bioactivities to complex formulations (Noviana et al., 2022). Persistent inflammatory signaling, especially over NF- κ B, MAPK, JAK/STAT and the NLRP3 inflammasome pathways, is of particular importance, affecting cytokine production and inflammatory cell activation. Experimental evidence shows that bioactive natural compounds can act on both pathways simultaneously, which could explain the multi-target anti-inflammatory activity (Castejón et al., 2022). In addition, pro-inflammatory cytokines engage with hypoxia-inducible signaling, a process that could contribute to the connection between inflammation and cellular adaptation to tissue hypoxia in the context of severe illness (Malkov et al., 2021).

Another important therapeutic target is oxidative stress as excess ROS may lead to the damage of proteins, lipids, DNA and mitochondria. Endogenous antioxidant mechanisms are coordinated by the Nrf2 pathway, and there is a close relationship between mitochondrial ROS and Nrf2 pathway in redox homeostasis and cell survival (Kasai et al., 2020). In this context, phytochemicals that can modulate Nrf2-related signaling could have cytoprotective activity, but this needs to be directly demonstrated in the context of critically ill patients.

Dynamic interactions between innate and adaptive immunity are also a characteristic of immune dysregulation (Wang et al., 2024). Macrophages have a role in regulating granulopoiesis and neutrophil functions, highlighting their pivotal role in orchestrating inflammatory and antimicrobial responses (Schulz et al., 2021). Such modulation of these processes may be relevant to immune dysfunction in sepsis, but may be detrimental during different phases of the disease.

Mitochondrial damage also contributes to impaired cellular bioenergetics and metabolic adaptation during extreme physiological challenges. Metabolic interventions that have demonstrated protection against mitochondrial dysfunction support mitochondrial preservation as a potential therapeutic strategy (Tribble et al., 2021). Lastly, endothelial barrier failure and microcirculatory disturbances may occur, resulting in poor tissue perfusion and oxygen delivery. Microvascular dysfunction is a complex process of endothelial and vascular regulatory mechanisms (Padro et al., 2020). Together, these interlinked pathways create a framework for exploring the mechanism of action of Ayurvedic bioactives as multi-target adjuncts and highlight the importance of separating pharmacological plausibility from clinical effectiveness. (Figure 1).

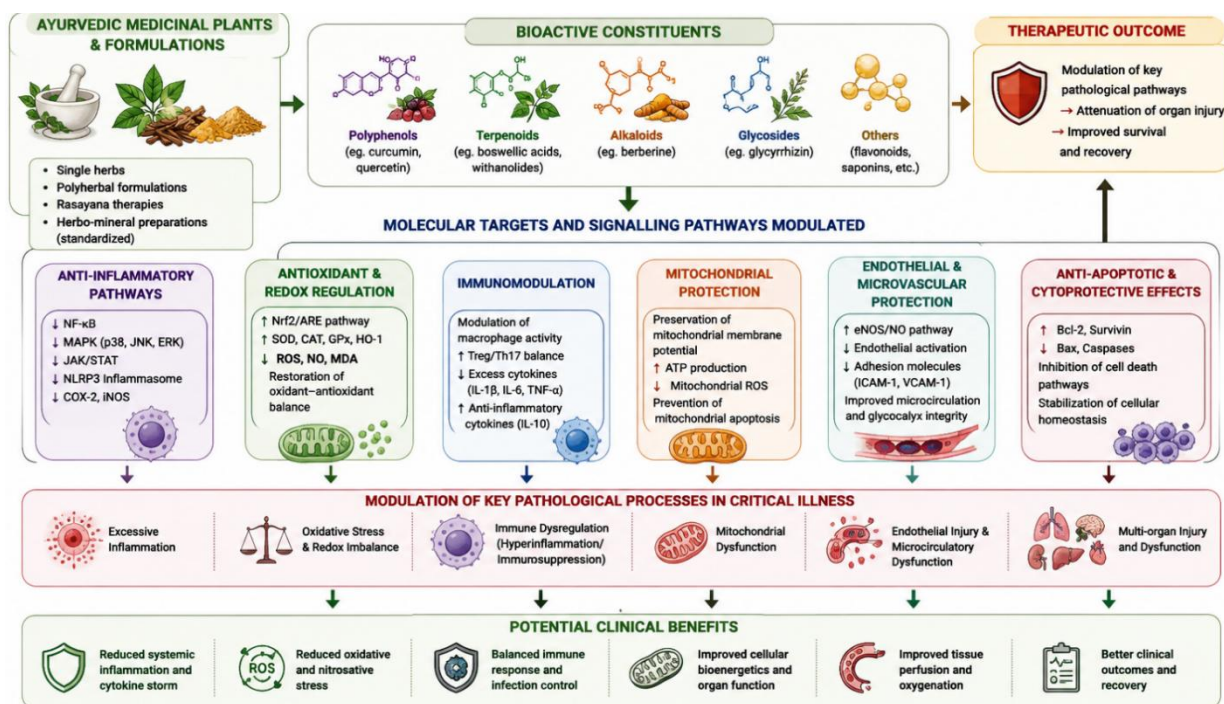


Figure 1. Mechanistic Therapeutic Framework of Ayurvedic Pharmacotherapy in Critical Illness

4. Potential Applications Across Major Critical-Care Conditions

The proposed critical-care syndromes are interlinked with several mechanisms of excessive inflammation, oxidative stress, immune dysfunction, mitochondrial damage, and impaired tissue perfusion, which can be targeted by the pharmacologically active Ayurvedic components. Sepsis and septic shock is a dysregulated host response to infection that may lead to circulatory, cellular and metabolic changes and multiple organ dysfunction (Cecconi et al., 2018). This response is mediated by complex interactions between innate and adaptive immunity (Wang et al., 2024), and by regulation between macrophages and neutrophils that impact antimicrobial defense and inflammatory injury (Schulz et al., 2021). Thus, compounds that have been shown to possess immune-modulatory and antioxidant properties in Ayurvedic medicine could be considered as additional candidates for investigation, with immune suppression and/or immunostimulation being excluded with caution.

Acute respiratory distress syndrome (ARDS) is characterized by severe inflammation of the lung tissue, loss of integrity of the alveolar-capillary barrier, increased permeability, and impairment of gas exchange (Matthay et al., 2019). Thus, pharmacological targeting of inflammatory and oxidative pathways could be a supportive measure. The regulation of ROS production in mitochondria and antioxidant defenses mediated by Nrf2 is a likely mechanism for decreasing oxidative cellular damage (Kasai et al., 2020).

Acute kidney injury (AKI) is also caused by a multifaceted interplay between inflammation, microvascular changes, tubular damage, and metabolic stress (Kellum et al., 2021). The use of Ayurvedic bioactives with experimentally proven antioxidants or nephroprotective activity could thus warrant investigation, but the same bioactives could also pose a risk of toxicity due to impaired renal clearance. Similar issues arise with acute hepatic dysfunction, as cytokine-mediated inflammation can significantly affect hepatocellular function and metabolic capacity (Shedlofsky & McClain, 2024), and careful consideration must be given to hepatoprotection and hepatotoxicity.

Three aspects of cardiovascular dysfunction and shock are impaired vascular regulation, myocardial stress, and compromised tissue perfusion. Microvascular dysfunction can have a profound effect on vascular homeostasis and oxygen delivery (Padro et al., 2020) and thus endothelial and microcirculatory protection are relevant therapeutic targets. Neurocritical illness also entails oxidative neuronal damage, neuroinflammation and metabolic disturbances. Experimental evidence that preservation of mitochondrial and metabolic function with neuroprotection follows this mechanistic pathway (Tribble et al., 2021). These disease specific pathways warrant further investigation of the pharmacotherapy approach in Ayurveda as an adjunct, mechanism-based approach, though clinical applications will depend on standardisation of formulation, pharmacokinetic studies, safety assessment and intensive clinical trials in critical care (Table 2).

Table 2. Potential Applications of Ayurvedic Pharmacotherapy in Critical-Care Conditions

Critical-care condition	Key pathological target	Potential pharmacological role	Reference
Sepsis/septic shock	Inflammation, immune dysregulation, oxidative stress	Anti-inflammatory, immunomodulatory,	Cecconi et al. (2018); Wang et

		antioxidant	al. (2024); Schulz et al. (2021)
ARDS	Pulmonary inflammation, alveolar–capillary injury	Anti-inflammatory, antioxidant, cytoprotective	Matthay et al. (2019); Kasai et al. (2020)
Acute kidney injury	Renal inflammation, oxidative and tubular injury	Antioxidant, anti-inflammatory, nephroprotective	Kellum et al. (2021)
Hepatic dysfunction	Cytokine-mediated hepatocellular injury	Anti-inflammatory, hepatoprotective	Shedlofsky & McClain (2024)
Cardiovascular dysfunction	Endothelial dysfunction, impaired microcirculation	Vasoprotective, antioxidant	Padro et al. (2020)
Neurocritical illness	Neuroinflammation, mitochondrial dysfunction	Antioxidant, mitochondrial and neuroprotective	Tribble et al. (2021)

5. Pharmacokinetics, Pharmacodynamics, and Herb–Drug Interactions

The large pharmacokinetic variability caused by critical illness may be a challenge to combine Ayurvedic medicines with conventional intensive care pharmacotherapy. Drug absorption, volume of distribution, metabolism and clearance may be altered by gastrointestinal hypoperfusion, motility impairment, enteral absorption, fluid resuscitation, capillary leakage and hypoalbuminemia, hepatic dysfunction and acute kidney injury (Morales Castro et al., 2023). Alterations in plasma protein levels are of special interest for highly bound compounds due to the interaction with plasma proteins, which can affect the free drug levels in plasma, distribution and the pharmacologic response (Smith & Waters, 2019). Thus, the release of these bioactives from Ayurvedic formulations could be challenging.

Another concern is pharmacodynamic interactions, as in critical illness the receptors' responsiveness and the physiological reserve may be altered. When used in conjunction with standard therapies, herbal treatments can have additive, synergistic, and antagonistic effects. Mechanisms of herb–drug interactions include pharmacokinetic changes (via modulation of drug-metabolizing enzymes, transporters, or pharmacodynamic effects due to overlapping actions) and pharmacodynamic changes (via modulation of drug-metabolizing enzymes, transporters, or pharmacodynamic effects due to overlapping actions) (Cziple et al., 2023). Cytochrome P450 (CYP450) enzymes and membrane transporters (P-glycoprotein) should be targeted in particular. Modulation of these systems may affect systemically available drug, leading to therapeutic failure or concentration-dependent toxicity. Experimental interaction studies highlight the need for systematic characterisation of CYP-mediated metabolism and transporters in assessing potential for interaction (Zhang et al., 2021).

ICU polypharmacy exacerbates these concerns. Antimicrobials, vasopressors, inotrope, antiplatelet agents, anticoagulants, sedatives, analgesics, antiarrhythmics, antiepileptics, and corticosteroids are commonly used for critically ill patients, which poses a great risk for clinically relevant interactions. Multicomponent Ayurvedic formulations can complicate the complexity of drug–drug interactions, which are already a significant problem for patients in the ICU (Ali et al., 2020), as the pharmacology of the individual ingredients are not fully understood.

Critical-care technologies add to the uncertainties. Renal replacement therapy and hemodialysis can affect the elimination of circulating constituents, and extracorporeal membrane oxygenation can affect apparent distribution and drug exposure by sequestration in the circuit and physiological changes (Morales Castro et al., 2023). Gastrointestinal absorption may also be affected by enteral feeding. Therefore, the following studies are necessary for integration of Ayurvedic pharmacotherapy: Formulation specific pharmacokinetics, systematic screening of drug interactions, organ function assessment and prospective monitoring of therapy and toxicity (Table 3).

Table 3. Pharmacokinetic, Herb–Drug Interaction, and Safety Considerations in Critical Care

Clinical concern	Mechanism	Potential consequence	Monitoring priority	Reference
Altered absorption/distribution	Gut dysfunction, fluid shifts, altered protein binding	Unpredictable exposure	Clinical response, drug levels where available	Morales Castro et al. (2023); Smith & Waters (2019)
CYP450 interactions	Enzyme inhibition or induction	Toxicity or therapeutic failure	Interaction screening, dose adjustment	Zhang et al. (2021); Cziple et al. (2023)
Transporter interactions	P-glycoprotein and related transporter modulation	Altered drug disposition	Exposure and adverse-effect monitoring	Zhang et al. (2021)

ICU polypharmacy	Additive, synergistic, or antagonistic effects	Increased interaction burden	Medication reconciliation	Ali et al. (2020)
Renal/hepatic dysfunction	Reduced metabolism or clearance	Bioaccumulation and organ toxicity	Renal and hepatic function tests	Morales Castro et al. (2023)
Herbo-mineral exposure	Metal accumulation or contamination	Hepatic, renal, neurological toxicity	Product quality and toxicology assessment	Gaikwad (2025)
Pharmacovigilance gaps	Under-recognition of adverse events	Delayed safety signal detection	Structured adverse-event reporting	Khalili et al. (2020)

6. Safety, Toxicity, and Clinical Evidence

Safety evaluation is an integral part of the process of incorporating Ayurvedic pharmacotherapy into critical care as critically ill patients are physiologically less resilient, multiple-organ dysfunction and extensive use of concomitant medicines. Therefore, potential for toxicity should be assessed organ, cell and systemically. Hepatic and renal injury is of special concern because it affects many pharmacologically active constituents, and cardiovascular, neurological and hematological effects can exacerbate the condition of patients who are already sick. Modern toxicology focuses on organ-specific responses of the cells, and the mechanisms of oxidative stress, to determine organ-specific patterns of tissue injury (Chen et al., 2025). Furthermore, flow cytometry will likely be able to provide more rapid characterization of toxicity-related changes, and enhance mechanistic safety evaluation, by advanced cellular techniques (Joshi et al., 2025).

The composition of herbo-mineral preparations may contain either metals or constituents derived from them and therefore the assessment is particularly stringent. Issues of concern include the concern for the presence of lead, mercury, and arsenic, which require proper chemical characterization, validated manufacturing methods, dose–exposure assessment, and evaluation of potential bioaccumulation. Therefore, resolving the safety, standardization, quality assurance, and regulatory confidence issues in herbo-mineral formulations is essential for their international acceptance (Gaikwad, 2025). The risks to safety can include microbial or chemical contamination, botanical misidentification, inappropriate processing, batch-to-batch compositional variations, and adulteration. All of these can affect the pharmacological activity and/or toxicity, and for this reason it is essential to perform product-specific quality control prior to clinical evaluation.

Biological plausibility and safety should be established in the pre-clinical setting using a well-designed cellular and animal model of inflammation, sepsis, oxidative damage and dysfunction of organs as appropriate. But efficacy in the pre-clinical setting is not enough to justify use in the ICU. Clinical evidence should be developed in a well-designed progression of human studies, including observational studies and the conduct of randomized controlled trials of well-defined doses, clinically relevant outcomes, and systematic adverse-event reporting with a standardized formulation.

Therefore, strong pharmacovigilance is a key element of the clinical translation process. To be effective, systems must be structured for adverse-event detection; consistent in documentation; consistent in causality assessment; consistent in signal identification; and continuous in evaluating medicine-related risks (Khalili et al., 2020). In critical care, this should also include medication reconciliation and prospective herb–drug interaction monitoring. Together with careful toxicology, pharmaceutical quality assurance and stepwise clinical evidence and active pharmacovigilance, these conditions are necessary prerequisites to determine if the potential benefits of Ayurvedic interventions outweigh the risks for critically ill populations.

7. Translational Challenges, Research Gaps, and Future Perspectives

Many methodological, pharmacological and regulatory uncertainties lie in the way that Ayurvedic pharmacotherapy is being practiced in critical care. The current evidence base is currently very small and is heterogeneous, with different patients, formulations, dose regimens and measures of outcomes. Important, however, is that there are very few clinical trials that focus specifically on patients in the ICU, which makes it difficult to draw conclusions about efficacy and safety in these patients with severe physiological instability. Pharmacokinetic uncertainty is another big challenge due to lack of characterization of dose–exposure–response relationships of many Ayurvedic bioactives. Critical illness adds to the complexity of dosing by various factors, including hepatic and renal dysfunction, changes in protein binding, fluid shifts and extracorporeal therapies. Population pharmacokinetics, organ-function based dose adjustment, and, if possible, TDM should thus be included in future investigations.

Similarly, pharmaceutical standardization is of equal importance for reproducible translation. Botanical authentication, quantitative phytochemical characterization, contaminant screening, batch consistency testing, stability testing, and good manufacturing processes should be prerequisites to clinical testing. There is also a need for harmonized regulatory requirements to establish the criteria for acceptable composition, manufacturing, labelling, pharmacovigilance and clinical evidence. This shift could be quickened by new technologies. Multicomponent–multitarget relationships can be characterized by network pharmacology and systems biology, treatment-responsive phenotypes and interindividual variability by metabolomics and pharmacogenomics.

Computational predictions would require experimental and clinical validation, but could also further help predict herb–drug interactions, toxicity signals and prioritize candidates. Future trials should go beyond the use of general measures of traditional formulations to a more standardized, mechanism-based approach to intervention. Biomarker guided patient stratification, formal pharmacokinetic–pharmacodynamic studies, predetermined safety measures, and patient-centred outcomes (including mortality, organ support-free days, length of stay in the intensive care unit and functional recovery) are all priorities. Future adequately powered multicenter randomized controlled trials will be required to prove clinical utility. The evidence-based integration should thus have a clear trajectory, starting from the selection of candidates, through the standardization of the pharmaceuticals, screening for interactions, individual benefit–risk assessment, multidisciplinary supervision and ongoing monitoring of safety. A system like that can move the field from empirical adjunctive use to scientifically supported use, that can be reproduced, and that can be done in a safe way, to be integrated with critical care pharmacotherapy (Figure 2).

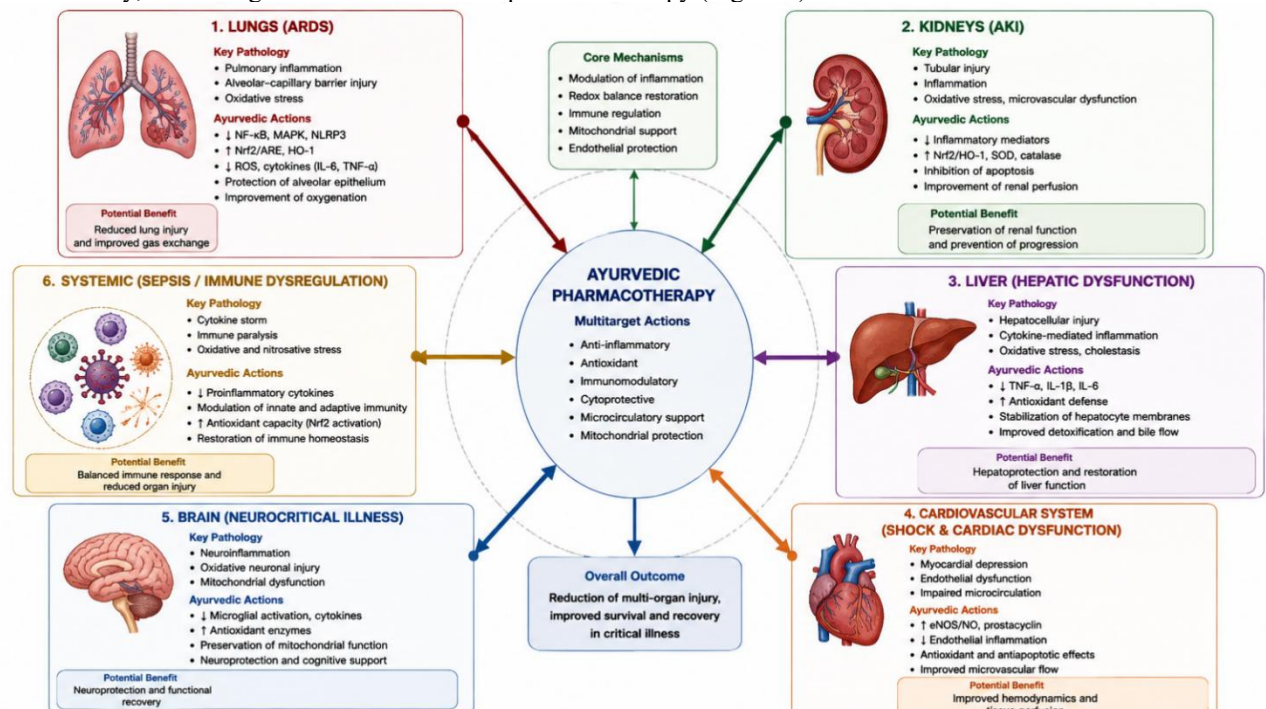


Figure 2. Multi-Organ Therapeutic Targets of Ayurvedic Pharmacotherapy in Critical Illness

8. CONCLUSION

The integration of Ayurvedic pharmacotherapy with critical care is a field of integrative medicine that has great scope but poses significant scientific and practical challenges and needs to be carefully harmonized with the principles of traditional Ayurvedic medicine and modern pharmacology and evidence-based medicine. These medicinal compounds have a wide array of bioactive components that could work to modulate inflammation, oxidative stress, immune response, impaired mitochondrial function, and microvascular damage, offering encouraging therapeutic targets in the fields of sepsis, acute respiratory distress syndrome, acute kidney injury, hepatic dysfunction, cardiovascular instability, and neurocritical illness. But mechanistic plausibility and preclinical efficacy do not equal clinical benefit. Polypharmacy and critical illness significantly affect the pharmacokinetics and pharmacodynamics, and polypharmacy greatly raises the chances of clinically relevant herb–drug interactions and hazardous interactions. Further, there are formulation variability issues, contamination, adulteration problems, herbo mineral constituents and other issues related to the manufacturing standards, which highlights the importance of strict pharmaceutical quality control. Standardized formulations, detailed toxicological characterization, pharmacokinetic–pharmacodynamic studies, patient stratification based on biomarkers, and suitably sized multicenter randomized controlled trials with clinically relevant endpoints should be emphasized in future research. A strong pharmacovigilance and/or multi-disciplinary oversight should be maintained throughout the clinical translation process. Finally, integration of Ayurvedic interventions with current critical care therapies should be based on the reproducible evidence of efficacy, the acceptable benefit–risk ratios, the product quality of the approved products, and ongoing safety surveillance in critically ill patients.

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