Neurosurgical Subspecialties **2026** vol. 2(2) | 79–90
DOI: 10.14218/NSSS.2026.00007

Original Article

Evidence Summary for Blood Pressure Management in Patients with Ruptured Intracranial Aneurysms: Implications for Clinical Nursing Practice

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Received: April 03, 2026 | **Revised:** May 22, 2026 | **Accepted:** June 15, 2026 | **Published online:** June 29, 2026

Abstract

Background and objectives: Given that hemodynamic fluctuations acutely escalate the risk of devastating rebleeding and secondary neurological deficits in unsecured ruptured intracranial aneurysms, this study aimed to synthesize the best available evidence for blood pressure management in this population and to provide an evidence-based foundation for clinical nursing practice.

Methods: A systematic search was conducted in domestic and international databases and relevant websites for evidence pertaining to blood pressure management in patients with ruptured intracranial aneurysms, including clinical practices, guidelines, expert consensuses, evidence summaries, and systematic reviews/meta-analyses. The search period covered database inception up to June 2025. Two researchers independently performed literature quality assessments and evidence extraction, with particular attention to nursing-relevant evidence on hemodynamic monitoring, bedside assessment, complication prevention, fluid management, and follow-up coordination.

Results: A total of 17 studies were included, comprising 11 guidelines, 4 expert consensuses, and 2 clinical decision entries. The synthesized evidence yielded 32 recommendations, structured into 6 core clinical domains: personnel and environmental configuration, individualized blood pressure targeting, precision hemodynamic monitoring, complication prevention, fluid therapy strategy, and longitudinal follow-up protocols. These recommendations further clarified key nursing responsibilities in triage coordination, continuous blood pressure surveillance, neurological assessment, delayed cerebral ischemia surveillance, fluid balance monitoring, and long-term follow-up.

Conclusion: Blood pressure management in patients with ruptured intracranial aneurysms should be individualized and multidisciplinary. The synthesized evidence highlights key nursing priorities in hemodynamic monitoring, delayed cerebral ischemia surveillance, fluid management, and follow-up coordination, and may inform standardized clinical nursing protocols.

Keywords: Intracranial aneurysm; Aneurysmal subarachnoid hemorrhage; Blood pressure management; Evidence-based nursing; Evidence summary; Neurocritical care.

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How to cite this article: Wang H, Zhang J, Tan X, Sun L, Qu L, Zhan Y, *et al*. Evidence Summary for Blood Pressure Management in Patients with Ruptured Intracranial Aneurysms: Implications for Clinical Nursing Practice. *Neurosurg Subspec* 2026;2(2):79–90. doi: 10.14218/NSSS.2026.00007.

Introduction

Intracranial aneurysms (IAs) arise from localized pathological dilations of the cerebral arterial wall, attributed to congenital defects in the tunica media or acquired elastic lamina degeneration under the influence of hemodynamic factors.[1] Aneurysmal subarachnoid hemorrhage (aSAH), resulting from IA rupture, accounts for approximately 85% of all subarachnoid hemorrhage cases.[2]

Clinically, aSAH is characterized by high rates of mortality and morbidity; prior investigations have documented cumulative mortality rates reaching 37%, 60%, and 75% at 24 h, 48 h, and 7 days post-rupture, respectively.[3] Among long-term survivors, approxi-

mately 60% fail to return to their premorbid level of functioning,[4] and 40–70% experience cognitive impairment.[5]

Moreover, aSAH imposes a substantial healthcare and economic burden, with its initial hospitalization costs and resource utilization ranking highest among all neurovascular stroke subtypes.[6] Hypertension represents a critical risk factor for the occurrence and rebleeding of aSAH, with approximately 50% of patients with aSAH having comorbid hypertension. Conversely, hypotension may precipitate cerebral hypoperfusion and increase the risk of cerebral infarction.[7] Therefore, effective and evidence-based blood pressure management is of paramount importance in reducing the risk of rebleeding and improving patient outcomes. Nevertheless, clinical consensus remains fragmented regarding optimal blood pressure targets, monitoring frequencies, and pharmacological titration during the hyperacute and perioperative phases of ruptured IAs, leading to considerable variability in bedside practice. Consequently, this study aimed to systematically retrieve, critically appraise, and synthesize the latest evidence on blood pressure management in patients with ruptured IAs, providing a standardized, evidence-based matrix to inform clinical nursing practice.

Materials and methods

This evidence summary was systematically conducted following the Joanna Briggs Institute (JBI) methodology for evidence synthesis. The reporting process was guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 statement, where applicable, to ensure methodological transparency and reproducibility.

Formulation of the evidence-based question

The evidence-based question was structured using the PIPOST framework developed by the JBI Evidence-Based Healthcare Center.[8] The components were defined as follows: population (P): adult patients with ruptured IA; intervention (I): blood pressure management measures, including but not limited to blood pressure targets, monitoring frequency and modalities, selection and administration of antihypertensive agents, nonpharmacological interventions, and multidisciplinary management protocols; professional (P): neurosurgeons, physicians, and nurses in neurosurgery and neuro-intensive care units; outcome (O): rebleeding rate, incidence of cerebral vasospasm, incidence of delayed cerebral ischemia, among others; setting (S): neurosurgery wards, neurosurgical intensive care units, and stroke units in tertiary hospitals with the capacity to manage aneurysmal disease; type of evidence (T): clinical practices, guidelines, expert consensuses, evidence summaries, and systematic reviews/meta-analyses.

Literature search strategy

A systematic search was conducted following the "5S" pyramid model. The following databases and websites were searched: UpToDate, BMJ Best Practice, JBI, The Cochrane Library, PubMed, CINAHL, Embase, the Scottish Intercollegiate Guidelines Network (SIGN), the National Institute for Health and Care Excellence (NICE), the National Guideline Clearinghouse (NGC), the Canadian Medical Association Clinical Practice Guidelines Infobase (CMA Infobase), the Registered Nurses' Association of Ontario (RNAO), the Guidelines International Network (GIN), the American Heart Association (AHA), the European Stroke Organisation (ESO), the Stroke Alliance for Europe (SAFE), the European Academy of Neurology, China National Knowledge Infrastructure (CNKI), WanFang Data, VIP Database, SinoMed, and the Chinese Medical Journal Database. A combination of MeSH terms and free-text terms was employed. Chinese search terms included "intracranial aneurysm," "cerebral aneurysm," "subarachnoid hemorrhage," "blood pressure management," and "evidence summary." English search keywords were systematically aligned with the primary database formulations, including "Intracranial Aneurysm," "Subarachnoid Hemorrhage," "Blood Pressure Management," "best practice," "evidence summary," "systematic review," "meta-analysis," and "Practice Guideline." The search period spanned from database inception to June 2025. The precise Boolean formulas for individual databases, the explicit search execution timeline, and the rigorous procedural details of the quality appraisal process are detailed and compiled in Supplementary File 1.

Inclusion and exclusion criteria

Inclusion criteria

(1) study population: patients with ruptured IA (aged ≥18 years); (2) study content: blood pressure management strategies; when direct evidence focused on ruptured IAs was unavailable, high-quality publications on adjacent neurocritical care conditions, including spontaneous intracerebral hemorrhage and acute ischemic stroke, were accepted as indirect evidence; and (3) study type: clinical practices, guidelines, expert consensuses, evidence summaries, and systematic reviews/meta-analyses.

Exclusion criteria

(1) articles for which full text was unavailable or data were incomplete; (2) articles that failed quality appraisal; (3) guidelines or systematic reviews that had been superseded by comprehensive updated official editions; and (4) duplicate publications or directly translated guidelines. Guidelines without comprehensive updated replacement versions were not subject to criterion (3).

Literature screening and data extraction

Two researchers trained in evidence-based methodology independently performed literature screening and data extraction. Initially, titles and abstracts were reviewed for preliminary screening, and studies that clearly did not meet the inclusion criteria were excluded. The full texts of the remaining articles were then reviewed for secondary screening to finalize the included literature. Any disagreements during the screening process were resolved through discussion between the two researchers or by consultation with a third researcher until consensus was reached. Due to the scarcity of nursing-specific protocols addressing pure ruptured IA hemorrhage cohorts, relevant guidelines from broader stroke and intracerebral hemorrhage categories were cross-referenced to fill clinical practice gaps. To preserve disease specificity, these indirect items were rigorously evaluated by our multidisciplinary expert panel and have been explicitly stratified as "Indirect" in Table 1.[9–25]

Quality appraisal of included literature

Two researchers independently appraised the quality of the included literature using appropriate standardized tools. In cases of disagreement, a third trained researcher was consulted to reach consensus. Guidelines were appraised using the Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument,[26] which evaluates six domains across 23 items; the intraclass correlation coefficient (ICC) was calculated to assess consistency between reviewers. Expert consensuses were appraised using the JBI Critical Appraisal Tool for Expert Opinion.[27] Independent quality appraisal using traditional instruments was not conducted for the UpTo-

DOI: 10.14218/NSSS.2026.00007 | Volume 2 Issue 2, June 2026

Table 1. Summary of evidence on blood pressure management in patients with ruptured intracranial aneurysms

Topic	Evidence content	Level of evidence	Recommended level	Evidence type	Clinical scenario	Inapplicable situations/ Special precautions
Personnel and environmental configuration						
Multidisciplinary collaboration	1. For patients with aSAH, care should be provided in a dedicated neurocritical care unit by a multidisciplinary team[13]	1	A	Direct	Suspected aSAH triage (<6 h from onset)	-
Stroke unit establishment	2. Acute stroke unit care reduces both death and dependency for patients with ICH in comparison with care on a general ward[23]	1	A	Indirect	Confirmed aSAH critical monitoring (days 3-14)	-
	3. Patients with intracerebral hemorrhage should be directly transferred to a hyperacute specialized stroke unit for consciousness tracking; any acute neurological deterioration dictates urgent re-imaging[21,23]	5	B	Indirect	Hunt-Hess II-IV patients requiring serial GCS tracking	Impending brainstem herniation requiring immediate surgery
BP control targets						
Principles of BP control	4. Maintain systolic blood pressure (SBP) strictly between 120–160 mmHg and ensure mean arterial pressure (MAP) stays above 90 mmHg in aSAH cohorts to mitigate re-rupture secondary to hypoperfusion[10,16,19–21,25]	5	A	Direct	Before aneurysm securing interval of ruptured unsecured aneurysm	Patients with severe intracranial hypertension (ICP >25 mmHg) or compromised CPP require individualized blood pressure targets to avoid CPP reduction resulting from excessive blood pressure lowering
	5. Following surgical securing of the aneurysm, sustain MAP within 80–100 mmHg provided the patient presents no signs of intracranial hypertension or cerebral vasospasm[17]	1	A	Direct	After aneurysm securing phase (clipped/coiled) without vasospasm	In patients with symptomatic cerebral vasospasm or DCI, induced hypertension may be required; therefore, these blood pressure targets should not be applied rigidly
History of hypertension	6. For patients presenting with a history of chronic hypertension or presenting clear radiological features of intracranial hypertension, titrate SBP and MAP toward their upper safety boundaries (160 mmHg and 100 mmHg, respectively)[16]	3	B	Direct	aSAH with chronic poorly controlled hypertension baseline	Micro-aneurysm morphology showing active acute rebleeding signs
No history of hypertension	7. For individuals lacking a hypertensive history or signs of elevated intracranial pressure, target the lower operational boundaries (SBP near 120 mmHg; MAP near 80 mmHg)[16]	5	B	Direct	Young, previously normotensive patients (Hunt-Hess I-II)	New focal deficits indicating active cerebral hypoperfusion.
BP monitoring						
Monitoring method	8. Utilize invasive continuous intra-arterial tracking or standardized non-invasive modalities for precise post-operative SBP surveillance[10,11]	2	A	Direct	Beat-to-beat tracking during rapid continuous IV titration	Severe peripheral arterial disease preventing arterial cannulation

(continued)

Table 1. *(continued)*

Topic	Evidence content	Level of evidence	Recommended level	Evidence type	Clinical scenario	Inapplicable situations/ Special precautions
Monitoring frequency	9. Record blood pressure immediately upon emergency presentation, maintaining a 15-min tracking frequency until therapeutic targets achieve documented stability within the initial 24 h[18]	5	A	Indirect	First 24 h of admission or active infusion adjustments	Stable maintenance phases (>48 h post-op) on fixed doses
Management principles	10. For cases presenting acute intraparenchymal bleeding, initiate antihypertensive titration within 2 h of symptom onset; ensure the overall SBP reduction does not drop beyond 90 mmHg from baseline parameters[12,19]	1	A	Indirect	Stress-induced SBP spikes (>180 mmHg) post-rupture	Precipitous, abrupt iatrogenic SBP reductions inducing infarction
	11. Implement systematic and gradual reduction of elevated SBP thresholds in patients presenting with un-occluded or unsecured aneurysms[9,12]	1	A	Direct	Controlled, step-wise SBP down-titration pre-operatively	Induced profound iatrogenic systemic hypotension (SBP <100 mmHg)
	12. Enforce strict vigilance to prevent post-operative systemic hypotension following the repair of ruptured intracranial aneurysms[10,11]	1	A	Direct	Post-operative daily maintenance during vasospasm window	-
	13. Prioritize short-acting, highly titratable intravenous agents (e.g., nicardipine or labetalol) when active BP lowering is required; routinely avoid potent cerebral vasodilators such as nitroprusside or nitroglycerin to prevent hemodynamic volatility[9,12,18,20]	1	A	Direct	Acute neurocritical settings requiring second-by-second SBP control	Routine use of vasodilators that may increase intracranial pressure, such as sodium nitroprusside, is not recommended. In selected circumstances, potential benefits should be carefully weighed against risks with close monitoring
	14. In patients with acute aSAH and unsecured aneurysms, frequent blood pressure monitoring and tailored BP control leveraging short-acting medications are highly recommended to strictly avoid severe hypotension, extreme hypertension, and pathological BP variability prior to definitive vascular securing[13]	5	A	Direct	Hyperacute before aneurysm securing window (<24 h from symptom onset)	Intermittent manual IV boluses without continuous physiological tracking
	15. In patients with acute intracerebral hemorrhage displaying severe hypertensive spikes (SBP >200 mmHg or MAP >150 mmHg), contemplate rapid, intensive blood pressure reduction supported by 5-min tracking intervals[24]	2	B	Indirect	Malignant hypertensive crisis (SBP >200 mmHg) before aneurysm securing	Terminal structural failure (bilateral fixed mydriasis)
	16. For intraparenchymal bleeding cases with SBP >180 mmHg or MAP >130 mmHg accompanied by clear signs of intracranial hypertension, continuously track ICP and adjust intravenous titrations to safeguard a cerebral perfusion pressure (CPP) window of 61–80 mmHg[24]	1	A	Indirect	Comatose high-grade aSAH with functional invasive ICP monitors	Aggressive empirical BP lowerings without real-time CPP tracking

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DOI: 10.14218/NSSS.2026.00007 | Volume 2 Issue 2, June 2026

Table 1. *(continued)*

Topic	Evidence content	Level of evidence	Recommended level	Evidence type	Clinical scenario	Inapplicable situations/ Special precautions
	17. For intraparenchymal bleeding cases with SBP >180 mmHg or MAP >130 mmHg but without elevated ICP clinical indicators, lower the blood pressure moderately and mandate formal clinical re-evaluations every 15 min[24]	3	B	Indirect	Alert patients with stable baseline intracranial compliance	Sudden explosive headache or projectile vomiting (suspected micro-rupture)
	18. If patients requiring continuous blood pressure maintenance possess intact, functional swallowing mechanisms, safely resume their established pre-admission oral antihypertensive regimens[19]	1	A	Indirect	Post-op plateau phase where patient tolerates oral intake	Persistent depressed consciousness levels or severe neuro-agitation
	19. In the presence of acute dysphagia or altered consciousness levels, temporarily withhold prior oral medications and substitute with intravenous titrations until swallowing function stabilizes or a nasogastric pathway is secured[19]	1	A	Indirect	Patients with lower cranial nerve palsies or bulbar paralysis	Oral administration without screening (absolute fatal aspiration risk)
Non-pharmacological interventions	20. Minimize external environmental triggers and defer non-urgent invasive bedside nursing tasks to safeguard patient calmness and prevent paroxysmal rebleeding episodes[10]	1	A	Direct	Standard non-pharmacological neuroprotection routine in single rooms	-
	21. Enforce strict bed rest regimes, execute systematic bowel regularity protocols to avoid straining, and maintain accurate hourly monitoring of systemic fluid inputs and outputs[9,10,12,20]	1	A	Direct	Pre-operative immobilization to minimize transmural pressure spikes	Bowel management interventions that may provoke a Valsalva maneuver or cause significant blood pressure fluctuations should be avoided
	22. Manage severe headache presentations or psychomotor agitation with minimal effective dosing of analgesics and sedatives; implement early weaning protocols as clinical tolerance permits[9,11]	1	A	Direct	Thunderclap headache/agitation driving sympathetic hypertensive loops	Excessive sedation that interferes with neurological assessment should be avoided; daily sedation interruption or awakening trials should be considered when clinically appropriate
Complication prevention						
DCI	23. Utilize specialized neurovascular imaging techniques (e.g., CTA or CTP) to detect subclinical vasospasm and predict the onset of delayed cerebral ischemia (DCI) when physical examinations are restricted[10,13,20]	1	A	Direct	High-grade, sedated aSAH where serial clinical exam is impossible	Fully alert, neurologically stable low-grade patients
	24. For high-grade aSAH cohorts, consider advanced invasive neuromonitoring parameters, including brain tissue oxygen tension and localized microdialysis (lactate/pyruvate and glutamate ratios), to predict DCI trends[13]	2	B	Direct	Severe, high-grade thick clot patients (modified Fisher 4) post-op	Community centers lacking multimodality sensor calibration tools

(continued)

Table 1. *(continued)*

Topic	Evidence content	Level of evidence	Recommended level	Evidence type	Clinical scenario	Inapplicable situations/ Special precautions
	25. Standardize the application of validated neurological tracking tools (such as GCS and NIHSS scores) to perform serial assessments for DCI and secondary neurovascular declines[10,21,25]	1	A	Direct	Shift-to-shift handovers and quantitative serial tracking for DCI	-
Cerebral vasospasm	26. Maintain normovolemia to prevent DCI; routine prophylactic hypervolemia is not recommended[14]	2	A	Direct	Asymptomatic postoperative phase within the DCI risk window	Patients with symptomatic cerebral vasospasm require individualized volume and blood pressure management based on cerebral perfusion status
	27. Schedule transcranial Doppler (TCD) scans daily or every other day to perform regular screening for vasospasm trajectories in aSAH patients[14]	1	A	Direct	Bedside non-invasive velocity screening during peak vasospasm window	-
	28. Administer standard oral nimodipine regimens for vasospasm prophylaxis; implement continuous intravenous nimodipine infusions as an authorized alternative only if oral/enteral ingestion pathways are compromised[10–12,14,15,20–23,25]	1	A	Direct	Routine pharmacological neuro-protection for all confirmed aSAH cases	In patients with refractory systemic hypotension (SBP <90 mmHg), nimodipine dose adjustment, temporary discontinuation, or alternative treatment strategies should be considered
	29. Dual antiplatelet therapeutic approaches may be considered to lower the overall incidence of clinical vasospasm and secondary DCI events[10,19]	1	B	Direct	Subpopulation undergoing endovascular coiling with stent placement	Early phases of open clipping, unsecured aneurysms, or coagulopathy
Volume management						
	30. Avoid the routine preoperative implementation of hypervolemia, hemodilution, and hypertensive therapy (traditional 3H protocols); restrict these interventions strictly to SAH individuals with documented hypovolemic states[19,21]	1	A	Direct	Fluid profiling of neurologically intact, normovolemic perioperative patients	Prophylactic traditional 3H therapy in asymptomatic cohort
	31. Determine fluid status by combining clinical volume assessments with hemodynamic monitoring parameters[14]	2	A	Direct	Dynamic fluid balance titration during intensive neurocritical monitoring	Empirical fluid bolus ordering without baseline hemodynamic checks
Follow-up						
	32. Arrange the initial post-operative neuroimaging follow-up window at 3–6 months, followed by serial surveillance at years 1, 2, 3, and 5, transitioning subsequently to a 3-to-5-year maintenance interval[19]	1	A	Direct	Outpatient surveillance tracking coil compaction or recurrence	-

"Direct" indicates primary evidence derived explicitly from ruptured intracranial aneurysm literature, representing the baseline mandate for nursing interventions. "Indirect" signifies supplementary evidence adapted from authoritative spontaneous intracerebral hemorrhage or general stroke guidelines to fill clinical practice gaps where pure ruptured intracranial aneurysm hemorrhage nursing evidence is currently limited. In the synthesis weighting scheme, all indirect items were systematically assigned a conditional/supplementary weight rather than disease-specific authority and were rigorously validated for pathophysiological safety by our expert panel before clinical adoption. 3H, hypervolemia, hemodilution, and hypertensive therapy; aSAH, aneurysmal subarachnoid hemorrhage; BP, blood pressure; CPP, cerebral perfusion pressure; CTA, computed tomography angiography; CTP, computed tomography perfusion; DCI, delayed cerebral ischemia; GCS, Glasgow Coma Scale; ICH, intracerebral hemorrhage; ICP, intracranial pressure; IV, intravenous; MAP, mean arterial pressure; NIHSS, National Institutes of Health Stroke Scale; SAH, subarachnoid hemorrhage; SBP, systolic blood pressure; TCD, transcranial Doppler.

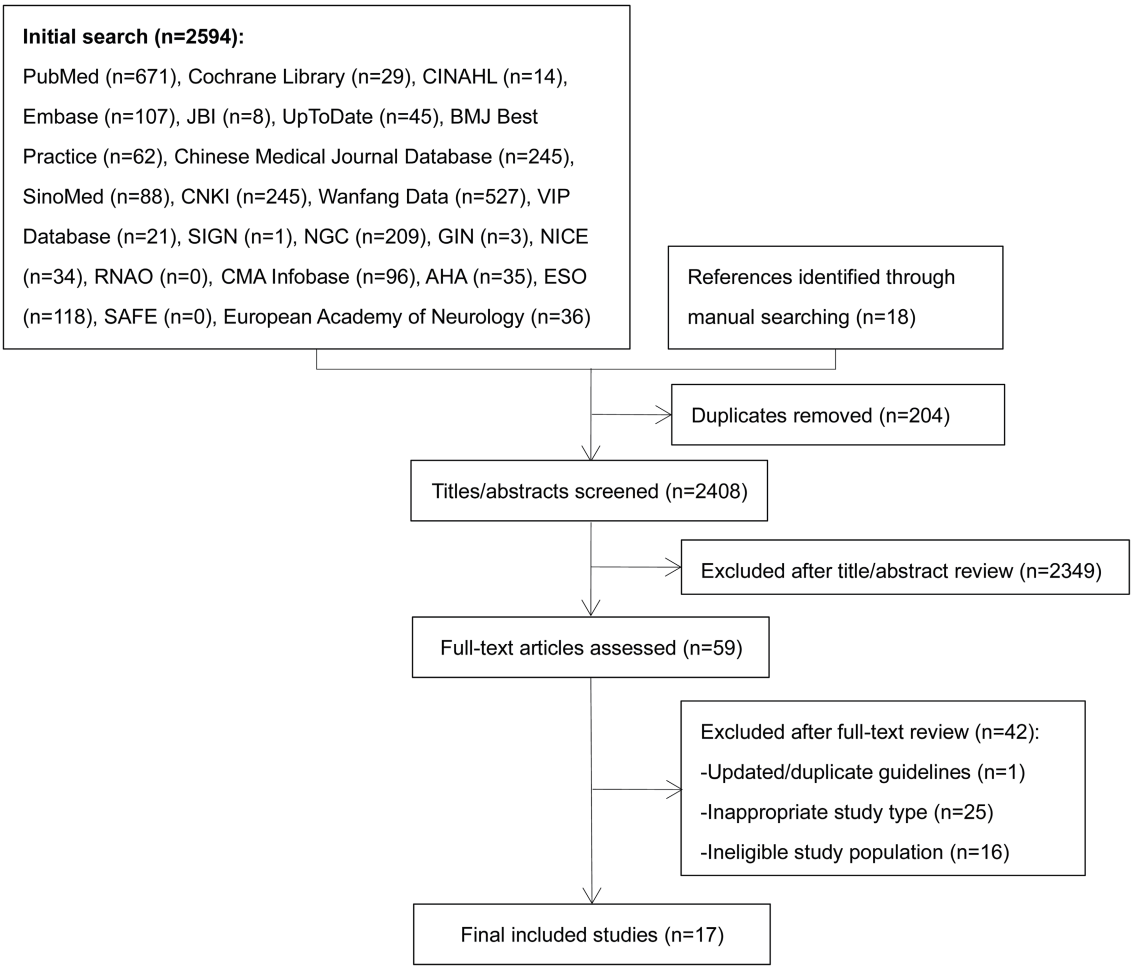

Fig. 1. Flowchart of literature screening. AHA, American Heart Association; CINAHL, Cumulative Index to Nursing and Allied Health Literature; CMA Infobase, Canadian Medical Association Clinical Practice Guidelines Infobase; CNKI, China National Knowledge Infrastructure; ESO, European Stroke Organisation; GIN, Guidelines International Network; JBI, Joanna Briggs Institute; NGC, National Guideline Clearinghouse; NICE, National Institute for Health and Care Excellence; RNAO, Registered Nurses' Association of Ontario; SAFE, Stroke Alliance for Europe; SIGN, Scottish Intercollegiate Guidelines Network; SinoMed, Chinese Biomedical Literature Service System; VIP, Chinese VIP Journal Database.

Date clinical decision entries, as static frameworks are structurally incompatible with continuously updated databases. To control bias and ensure evidence validity, our research team performed secondary validation by independently retrieving and verifying the original primary studies and foundational guidelines referenced within the UpToDate transcripts prior to evidence synthesis.

Evidence extraction and summary

Two trained researchers independently extracted and cross-checked the evidence, with discrepancies resolved by a third researcher. Evidence integration followed three criteria: (1) consistent recommendations were consolidated into the clearest statement; (2) complementary data were logically merged; and (3) conflicting evidence was resolved by hierarchically prioritizing evidence-based sources, high-quality methodologies, and contemporary authoritative publications, while prioritizing direct ruptured aneurysm data over extrapolated indirect contexts. The extracted evidence was graded using the JBI Evidence Pre-Grading System (2014 version),[28] where Levels 1 through 5 represent decreasing methodological rigor and evidence strength.

Results

Literature search

A total of 2,594 articles were retrieved. Following deduplication, title and abstract screening, and full-text review, 17 articles were ultimately included.[9–25] These comprised 11 guidelines,[10,11,13,15,18–23,25] 4 expert consensuses,[12,14,16,17] and 2 clinical decision entries.[9,24] The literature screening process is illustrated in Figure 1, and the basic characteristics of the included studies are presented in Table 2.[9–25]

Results of quality appraisal

Among the 11 included guidelines, 10 were rated as Grade A and 1 as Grade B (Table 3).[10,11,13,15,18–23,25] The quality evaluation process demonstrated excellent methodological consistency between the two independent reviewers, yielding a single-measure ICC of 0.859 (95% CI: 0.817–0.892; $P < 0.001$) and an average-measure ICC of 0.924 (95% CI: 0.900–0.943), confirming highly robust inter-rater agreement throughout the AGREE II evaluation process. The Grade B guideline scored poorly in "Applicability" (12.5%)

Table 2. Basic characteristics of included literature (n = 17)

Author	Source	Type of literature	Title	Year of publication
Singer *et al*.[9]	UpToDate	Clinical Decision	Aneurysmal subarachnoid hemorrhage: Treatment and prognosis	2025
Society of Neurosurgery of Chinese Medical Association[10]	CNKI	Guideline	Chinese Guideline for the Clinical Management of Patients with Ruptured Intracranial Aneurysm (2024 Edition)	2024
Chinese Society of Neurology[11]	CNKI	Guideline	Chinese Guidelines for the Management of Severe Stroke 2024	2024
Wang Zengwu *et al*.[12]	CNKI	Expert Consensus	Chinese Expert Consensus on Hypertension Management in Stroke Patients	2024
Hoh *et al*.[13]	AHA	Guideline	2023 Guideline for the Management of Patients with Aneurysmal Subarachnoid Hemorrhage: A Guideline from the American Heart Association/American Stroke Association	2023
Xu Yueqiao *et al*.[14]	CNKI	Expert Consensus	Expert Consensus on the Management of Severe Aneurysmal Subarachnoid Hemorrhage (2023)	2023
Treggiari *et al*.[15]	PubMed	Guideline	Guidelines for the Neurocritical Care Management of Aneurysmal Subarachnoid Hemorrhage	2023
Picetti *et al*.[16]	SIAARTI	Expert Consensus	Early management of patients with aneurysmal subarachnoid hemorrhage in a hospital with neurosurgical/neuroendovascular facilities - part 1	2022
Picetti *et al*.[17]	SIAARTI	Expert Consensus	Early management of patients with aneurysmal subarachnoid hemorrhage in a hospital with neurosurgical/neuroendovascular facilities - part 2	2022
Shoamanesh *et al*.[18]	WSO	Guideline	Canadian stroke best practice recommendations: Management of Spontaneous Intracerebral Hemorrhage, 7th Edition Update 2020	2021
Sandset *et al*.[19]	ESO	Guideline	European Stroke Organisation (ESO) guidelines on blood pressure management in acute ischemic stroke and intracerebral hemorrhage	2021
Zhang Tongyu *et al*.[20]	CNKI	Guideline	Chinese Guidelines for the Diagnosis and Treatment of Ruptured Intracranial Aneurysm 2021	2021
Chinese Society of Neurology[21]	CNKI	Guideline	Chinese Guidelines for the Diagnosis and Treatment of Subarachnoid Hemorrhage 2019	2019
Cho *et al*.[22]	PubMed	Guideline	Korean clinical practice guidelines for aneurysmal subarachnoid hemorrhage	2018
Steiner *et al*.[23]	ESO	Guideline	European Stroke Organisation (ESO) guidelines for the management of spontaneous intracerebral hemorrhage	2014
Rordorf *et al*.[24]	UpToDate	Clinical Decision	Spontaneous intracerebral hemorrhage: Treatment and prognosis	2014
Steiner *et al*.[25]	Embase	Guideline	European stroke organization guidelines for the management of intracranial aneurysms and subarachnoid hemorrhage	2013

AHA, American Heart Association; CNKI, China National Knowledge Infrastructure; Embase, Excerpta Medica Database; ESO, European Stroke Organisation; SIAARTI, Italian Society of Anaesthesia, Resuscitation and Intensive Care; WSO, World Stroke Organization.

and "Editorial Independence" (37.5%), which led to its downgrading. Given its methodological limitations and earlier publication date, a prudent approach was adopted when utilizing the evidence from this guideline: (1) it was never used as a primary or sole evidence source; (2) it served exclusively as supplementary validation when aligned with Grade A or more recent protocols; and (3) in cases of conflict, contemporary higher-level evidence was prioritized. Consequently, its inclusion did not compromise the reliability of the synthesized framework. Additionally, the four expert consensuses demonstrated reliable quality across their respective

Table 3. Quality evaluation results of guidelines (n = 11)

Guideline	Scope and purpose	Stakeholder involvement	Rigor of development	Clarity of presentation	Applicability	Editorial independence	≥ 60%	≥ 30%	Quality evaluation
Society of Neurosurgery of Chinese Medical Association[10]	91.67%	77.78%	72.92%	91.67%	47.92%	87.50%	5	6	A
Chinese Society of Neurology[11]	91.67%	83.33%	77.08%	94.44%	50.00%	100.00%	5	6	A
Hoh *et al*.[13]	100.00%	94.44%	95.83%	100.00%	85.42%	100.00%	6	6	A
Treggiari *et al*.[15]	100.00%	86.11%	95.83%	83.33%	75.00%	58.33%	5	6	A
Shoamanesh *et al*.[18]	94.44%	91.67%	92.71%	97.22%	92.71%	95.83%	6	6	A
Sandset *et al*.[19]	100.00%	83.33%	86.50%	91.67%	52.17%	95.83%	5	6	A
Zhang Tongyu *et al*.[20]	86.11%	63.89%	62.50%	83.33%	43.75%	70.83%	5	6	A
Neurology Branch of the Chinese Medical Association[21]	91.67%	86.11%	67.71%	91.67%	45.83%	100.00%	5	6	A
Cho *et al*.[22]	91.67%	61.11%	70.83%	75.00%	29.17%	70.83%	5	5	A
Steiner *et al*.[23]	100.00%	88.83%	89.67%	100.00%	66.67%	100.00%	6	6	A
Steiner *et al*.[25]	76.19%	47.83%	36.50%	66.67%	12.50%	37.50%	2	5	B

AGREE II, Appraisal of Guidelines for Research and Evaluation II; CI, confidence interval; ICC, intraclass correlation coefficient.

appraisal domains (Table 4).[12,14,16,17] Crucially, the two UpToDate clinical decision entries were incorporated only after passing independent secondary validation to ensure evidence integrity.

Evidence synthesis

Through evidence extraction and synthesis, a summary of evidence on blood pressure management in patients with ruptured IAs was ultimately developed, encompassing 6 core clinical domains, 11 secondary subtopics, and exactly 32 recommendations (Table 1). Among these 32 synthesized recommendations, 23 (71.9%) were based on direct evidence for aSAH and ruptured IAs, forming the primary clinical framework. The remaining 9 (28.1%) were indirect evidence extracted from guidelines on neurocritical care, intracerebral hemorrhage, and acute ischemic stroke to compensate for the lack of disease-specific evidence. According to the JBI evidence grading system,[28] 20 recommendations corresponded to Level 1 evidence, 5 to Level 2, 2 to Level 3, and 5 to Level 5. In terms of recommendation strength, 25 items were rated Grade A and 7 items were rated Grade B.

Discussion

This evidence summary constructs a structured clinical framework for periprocedural blood pressure management in patients with ruptured IAs, synthesized from high-quality evidence across six core clinical domains. Optimal blood pressure control in this patient group cannot rely on static target values alone; it demands dynamic, individualized care delivered by multidisciplinary teams, with nurses taking a central role in daily clinical work. A core principle of safe blood pressure regulation is to balance the prevention of severe rebleeding prior to aneurysm repair and the preservation of cerebral perfusion to lower the risk of secondary ischemia. The

Table 4. Quality appraisal results of expert consensuses (n = 4)

Evaluation criteria	Wang *et al*.[12]		Xu *et al*.[14]		Picetti *et al*.[16]		Picetti *et al*.[17]	
	P1	P2	P1	P2	P1	P2	P1	P2
1. Is the source of the opinion clearly identified?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Does the opinion originate from influential experts in the field?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Are the views presented centered on the interests of the population studied?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4. Are the stated conclusions based on analytical results? Is the expression of the opinion logical?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Is reference made to existing other literature?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Is there any inconsistency between the proposed views and previous literature?	No	Yes	No	No	Unclear	Yes	No	No
Inclusion decision	Included		Included		Included		Included	

Inconsistent ratings on item 6 were generated by two independent reviewers (JZ and HW). Thorough discussion failed to reach a consensus, so a third senior researcher (Xuan Tan) independently reviewed all full texts and provided the final arbitration judgment. All four expert consensus papers were retained following this unified decision.

results presented here help shift routine bedside care from passive response to standardized, evidence-led prevention, offering practical guidance for clinical nurses and facilitating unified blood pressure management strategies for patients with ruptured IAs.

Synthesized evidence indicates that establishing structured interdisciplinary coordination networks and deploying specialized neurocritical care environments form the absolute cornerstone for optimizing systemic hemodynamic profiles. Integrating advanced neurosurgical expertise, emergency triage pathways, and specialized stroke ward monitoring workflows significantly streamlines hyperacute therapeutic decision-making and mitigates critical operational delays. Beyond executing prescribed pharmacological titrations, nursing professionals bridge diverse medical specialties through continuous neurological surveillance, proactive symptom tracking, and structured family communication.

However, escalated bedside nursing workloads and heterogeneous clinical training levels remain key operational challenges that may constrain the practical efficacy of these structured care models.[29] Future investigative efforts should focus on quantifying the long-term clinical impacts of nurse-led collaborative pathways and exploring artificial intelligence-driven alert systems to support clinical decision entries in low-resource settings. Notably, the operational capacity to implement comprehensive multispecialty teams and dedicated stroke units varies significantly across levels of healthcare in China. In resource-limited primary healthcare institutions, specialized workflows should prioritize the institutionalization of rapid transfer pathways alongside the core competency of nursing staff in executing noninvasive monitoring, basic life support, and structured initial triage. This stratified approach ensures the reliable execution of essential hemodynamic management components under constrained clinical conditions.

Individualized blood pressure targets are essential for implementing these recommendations in clinical practice. Given that a substantial proportion of patients with intracranial vascular rupture present with secondary chronic hypertensive conditions,[7] customizing blood pressure parameters is vital to maintain an intricate equilibrium between preventing paroxysmal re-rupture and safeguarding sufficient cerebral perfusion.[30,31] Grounded in our synthesized evidence framework, the nursing cohort plays an indispensable role in navigating these therapeutic trade-offs. It is worth noting that some underlying guidance within our matrix exhibits dynamic clinical discrepancies or relies on classic historical milestones. While these foundational documents remain valuable for benchmarking baseline neurovascular care, their recommendations regarding hyperacute titration timing and upper boundary alerts must be carefully cross-referenced with modern authoritative updates, such as the 2023 AHA/American Stroke Association (ASA) guidelines, to avoid clinical lag. Furthermore, the overt contradictions between intensive, immediate blood pressure lowering that traditionally derived from spontaneous intracerebral hemorrhage protocols and gradual, stabilized SBP reduction mandated for unoccluded ruptured aneurysms require advanced nursing acumen. Rather than viewing these divergent recommendation lines as overlapping or incompatible, frontline nursing workflows must decipher their heterogeneous pathophysiological rationales. Intensive early titration targets rapid hemostasis to halt hematoma expansion in intraparenchymal bleeding, whereas unsecured aneurysms dictate a controlled, gentle downregulation to protect collateral circulation. Implementing nurse-led, individualized assessment pathways effectively bridges these conceptual conflicts, transforming rigid guideline numbers into precise, dynamic autoregulation-guided bedside surveillance.[32] This deliberate stratification ensures that direct ruptured aneurysm data provides the absolute core framework for baseline care, while indirect items adapted from related neurocritical care contexts serve exclusively as conditional, supplementary guidance when disease-specific literature is absent.

To translate this stratified evidence framework into rigorous bedside practice, systematic physiological monitoring and standardized vasoactive drug titration stand as core components of neuro-intensive nursing care. Utilizing continuous invasive intra-arterial tracking combined with an immediate 15-min tracking frequency during the initial 24 h serves to effectively stabilize hyperacute hemodynamic variability and prevent blind spots in blood pressure detection. Continuous blood pressure surveillance is essential to capture pathological blood pressure variability, which functions as an independent neurovascular risk factor, while rational pharmacological selection dictates a comprehensive appraisal of cerebrovascular selectivity, pharmacokinetic properties, and blood-brain barrier permeability.

In this clinical domain, critical care nursing competencies are dual-faceted. Technically, nurses must master the maintenance of transducer systems, accurately interpret intra-arterial waveform variances, and perform rapid bedside troubleshooting. Clinically, they bear the responsibility for the microtitration of high-alert continuous infusions, ensuring precise rate adjustments by prioritizing short-acting, highly titratable intravenous agents (e.g., nicardipine or labetalol) while routinely avoiding potent cerebral vasodilators such as nitroprusside or nitroglycerin to prevent iatrogenic ICP spikes. Standardized, nurse-led care pathways significantly enhance compliance with target-range protocols and prevent iatrogenic pressure fluctuations secondary to environmental or procedural triggers.[33]

Accordingly, specialized nursing workflows should focus on four areas: (1) executing continuous hemodynamic tracking and distinguishing pathologic waveform alterations; (2) calibrating precise continuous infusion rates of high-alert antihypertensives while proactively screening for systemic hypotension (Items 10–12); (3) institutionalizing systematic nonpharmacological bundles, including strict bed rest, environmental management, and targeted sedation/analgesia to prevent straining; and (4) conducting serial neurological status grading to guide interdisciplinary crisis decision-making. We recommend that clinical institutions establish competency-based training programs addressing these specialized dimensions to elevate advanced nursing performance in invasive monitoring while integrating computerized clinical decision-support architectures to pioneer an integrated "monitoring-alert-intervention" management model.

Synthesized protocols confirm that consistent oral nimodipine administration represents the standard pharmacological baseline to suppress cerebral vasospasm trajectories. However, in higher-grade aSAH patient cohorts where heavy sedation limits serial clinical examinations, the implementation of objective screening tools becomes mandatory. Utilizing transcranial Doppler scans, scheduled daily or every other day during the critical risk window, provides a reliable bedside method to track hemodynamic velocity changes before irreversible tissue ischemia develops. Frontline nursing responsibilities must shift from passive event observation to systematic tracking using validated grading systems, including the Glasgow Coma Scale and the National Institutes of Health Stroke Scale scores. Implementing these standardized nursing tracking tools ensures early detection of microfluctuations in neurological performance, enabling rapid interdisciplinary crisis intervention.

Parallel to this active neurological surveillance, managing circulatory volume represents another vital therapeutic component and requires a strict departure from traditional empirical fluid-loading practices. The routine implementation of prophylactic traditional "3H therapy" is systematically discouraged due to associated cardiopulmonary risks and the lack of clinical benefit in asymptomatic cohorts.[34] Current evidence mandates the maintenance of strict normovolemia to protect cerebral perfusion without triggering intracranial pressure spikes. To achieve this balance, clinical protocols must integrate subjective physical evaluations with objective hemodynamic monitoring parameters. Specialized nursing actions are pivotal in this domain; rather than adhering to rigid, static fluid schedules, critical care nurses must balance fluid inputs and outputs through real-time parameters, preserving the delicate equilibrium between cerebral blood flow and optimal systemic volume.

Once hemodynamic stability is attained and the ruptured aneurysm receives definitive treatment, evidence-based nursing priorities shift from urgent in-hospital intervention to standardized long-term follow-up planning, a vital segment of continuous patient care. Securing the ruptured aneurysm via endovascular coiling or microsurgical clipping does not entirely eliminate the lifetime risk of coil compaction, neck remnants, or de novo aneurysm development. The synthesized evidence establishes a clear, standardized chronological timeline for postoperative neuroimaging follow-up, starting with an initial radiological reassessment at 3 to 6 months. This is followed by serial annual surveillance at years 1, 2, 3, and 5, before safely transitioning to a long-term maintenance window of every 3 to 5 years. Specialized nursing roles should focus on creating formalized outpatient navigation tracks and ensuring reliable family screening, bridging hyperacute critical care with structured long-term neurological health preservation.

Limitations

This study developed a framework for blood pressure management in patients with ruptured IAs based on the current best available evidence; however, several limitations should be acknowledged. First, some recommendations were derived from international guidelines, which may require adaptation to align with local healthcare resources and nursing practice characteristics when applied in China. Second, the literature search was restricted to Chinese and English databases, which may have introduced language bias. Additionally, traditional quality appraisal tools were not independently applied to UpToDate entries due to their dynamically updated nature; however, this system-inherent limitation was rigorously managed by our secondary verification of its referenced source guidelines. Finally, the unique role of nursing in blood pressure management warrants further investigation through original studies. Future research should focus on developing nursing protocols tailored to the Chinese clinical context and rigorously evaluating their effectiveness through well-designed interventional studies, thereby further clarifying the contribution and value of nursing in blood pressure management for patients with ruptured IAs.

Conclusions

This study systematically synthesized 32 items of best evidence to establish a structured, high-density framework for optimizing periprocedural blood pressure management in patients with ruptured IAs. The resulting evidence matrix is broadly aligned with six core clinical domains: establishing multidisciplinary networks, calibrating individualized blood pressure targets, ensuring precision hemodynamic monitoring, executing targeted complication prevention, structuring fluid therapy strategies, and scheduling longitudinal follow-up. Furthermore, this framework helps operationalize the specialized roles of neurocritical care nurses in active clinical triage, real-time arterial tracking, proactive delayed cerebral ischemia surveillance, and long-term surveillance. These synthesized findings provide an evidence-based framework to guide standardized nursing-led blood pressure management protocols, offering an actionable pathway to mitigate rebleeding risks and improve clinical outcomes in this high-acuity patient population.

Acknowledgments

We thank all members of the multidisciplinary team for their valuable contributions to this study.

Funding

This work was supported by the Evidence Translation and Application Program of the Fudan University Center for Evidence-based Nursing (Grant No. Fudanebn202505).

Conflict of interest

YZ has been an Executive Associate Editor of *Neurosurgical Subspecialties* since January 2026. The authors declare that they have no other conflict of interest.

Author contributions

Study conception and design, evidence analysis and summary, and manuscript drafting (HW, JZ, XT, LS), literature search and screening (SZ, LQ, YZ, QH, XW), literature quality evaluation and data extraction (HW, XT, YZ, DL, HP), manuscript review, critical revision, funding acquisition, and resource coordination (XT, LS). All authors read and approved the final manuscript.

Ethical statement

This study constitutes an evidence summary based on existing published literature. As it did not involve human or animal participants, nor entail the collection of primary data, ethical approval was not required. All procedures were performed in accordance with applicable reporting standards and guidelines.

Data sharing statement

The literature search matrices, customized database query formulations, and appraisal dynamics data used to support the findings of this study are included within the supplementary information file(s) (Supplementary File 1). No additional data are available.

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