Review Article

CT versus MRI for the Initial Assessment of Suspected Acute Stroke: A Systematic Review of Diagnostic and Management Outcomes

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ABSTRACT

While non-contrast computed tomography (NCCT) is widely used for its speed and availability, magnetic resonance imaging (MRI) offers superior diagnostic accuracy. The optimal first-line imaging strategy for suspected acute stroke remains debated. This study systematically reviews and compares the diagnostic accuracy, impact on management, workflow times, and patient outcomes of CT-based versus MRI-based imaging protocols. A systematic review was conducted following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive search of PubMed/MEDLINE, Web of Science, Scopus, and Embase was performed from inception through 2025. Eighteen studies were included. MRI, particularly diffusion-weighted imaging (DWI), demonstrated significantly higher sensitivity for detecting acute ischemia compared to NCCT. MRI-based selection was associated with a 50% reduction in thrombolysis administration to stroke mimics. However, MRI use consistently resulted in longer door-to-needle times (delays of 2 to 30 minutes). Evidence on functional outcomes was mixed; several large registry studies found no significant difference in 90-day functional independence or symptomatic intracranial hemorrhage (sICH) rates after adjusting for confounders, while others reported significantly improved safety profiles (lower sICH and mortality rates) and functional outcomes with MRI. MRI is the diagnostic gold standard for detecting acute ischemic stroke and reduces inappropriate thrombolysis. An optimal, hybrid approach is recommended: utilizing fast multimodal CT as a first-line tool to minimize delays, while reserving MRI for complex cases where its superior diagnostic capability is most impactful. These findings support a tailored imaging strategy to optimize both the efficiency and precision of acute stroke care.

Keyword: acute stroke, systematic review, computed tomography, magnetic resonance imaging, diagnostic accuracy, thrombolysis, thrombectomy, workflow, patient outcomes.

Introduction

Acute stroke is a leading cause of mortality worldwide, representing a formidable public health challenge that demands rapid and precise intervention [1]. The fundamental principle underlying modern stroke care is that "time is brain," underscoring the critical importance of minimizing the delay between symptom onset and the initiation of appropriate treatment [2].

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The efficacy of evidence-based therapies, specifically intravenous thrombolysis (IVT) and mechanical thrombectomy (MT), is profoundly time-dependent, making the speed and accuracy of initial diagnostic assessment paramount [3]. The role of neuroimaging in this emergency setting is indispensable, serving multiple crucial purposes: confirming the diagnosis of stroke, distinguishing between ischemic and hemorrhagic subtypes, excluding stroke mimics, and identifying large vessel occlusions amenable to endovascular therapy [4]. For decades, NCCT of the brain has been the undisputed first-line imaging modality globally. Its widespread adoption is driven by compelling practical advantages, including unparalleled availability, rapid acquisition times, ease of patient monitoring, and high sensitivity for detecting acute intracranial hemorrhage—a critical exclusion criterion for thrombolysis [5]. However, the limitations of NCCT in the hyperacute phase of ischemic stroke are well-documented. Its sensitivity for detecting early signs of cerebral ischemia is modest and often dependent on radiologist expertise. Early ischemic changes can be subtle and easily missed [6]. This diagnostic uncertainty can lead to delays in treatment or the inadvertent administration of thrombolysis to stroke mimics. In contrast, MRI, particularly DWI, has emerged as a superior diagnostic tool. DWI can identify irreversibly infarcted tissue within minutes of symptom onset with a sensitivity and specificity exceeding 95% [7]. Furthermore, MRI protocols can provide a comprehensive assessment: gradient-recalled echo (GRE) or susceptibility-weighted imaging (SWI) sequences are highly sensitive for hemorrhage, magnetic resonance angiography (MRA) can visualize vascular occlusions, and perfusion-weighted imaging (PWI) can delineate the ischemic penumbra [8]. Despite its diagnostic superiority, the routine use of MRI as the first-line imaging modality in acute stroke is not yet a universal standard. Significant barriers include limited availability, longer acquisition times, more complex patient screening, and higher costs [9]. This systematic review aims to synthesize the current evidence to provide a comprehensive comparison of CT and MRI for the initial assessment of suspected acute stroke.

Methods

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria to the letter, this systematic review was carried out and reported [10]. Several electronic bibliographic databases, such as PubMed/MEDLINE, Web of Science Core Collection, SCOPUS, and Embase, were searched using a thorough and methodical approach from the beginning to [Insert Last Search Date]. Combining controlled vocabulary phrases (such as MeSH in PubMed) with free-text keywords associated with the core concepts of "stroke," "tomography, x-ray computed," "magnetic resonance imaging," "diagnostic accuracy," and "patient outcomes" was the search technique used. Initially, no language or date constraints were used in order to optimise the search's reach. Eligibility Criteria: Predetermined qualifying criteria served as a guide for the study selection procedure. Adult patients (≥18 years old) who presented with a suspected acute stroke were the population of interest. The initial diagnostic evaluation was conducted using either magnetic resonance imaging (MRI), which includes sequences like diffusion-weighted imaging (DWI), gradient-recalled echo (GRE), and MR angiography (MRA), or computed tomography (CT), which includes non-contrast CT (NCCT) and multimodal CT (e.g., CT angiography, CT perfusion). Metrics of diagnostic accuracy (sensitivity, specificity, predictive values), acute stroke detection rates, impact on clinical management (thrombolysis, thrombectomy, and treatment of mimics), workflow times (door-to-needle time, door-to-imaging time), and patient-centered outcomes (functional status as determined by the modified Rankin Scale at 90 days, symptomatic intracranial hemorrhage, and mortality) were the main outcomes of interest. The study designs that were included were cross-sectional studies, prospective and retrospective cohort studies, randomised controlled trials, and comparative studies. Technical publications with no clinical results, case reports, conference abstracts, reviews, editorials, and animal research were not included. Data Extraction: To make the screening and selection process easier, the database search results were loaded into the Rayyan QCRI web tool for systematic reviews [11]. The titles and abstracts of every record that was retrieved were checked against the eligibility requirements by two separate reviewers. Research that either reviewer thought might be pertinent moved forward to the full-text review phase. The full-text papers were then evaluated independently by the same two reviewers before being included. Discussions or contact with a third reviewer were used to settle any disagreements that arose throughout the selection process. A piloted, standardised data extraction form was used to obtain data independently and in triplicate for each included study. Study details (first author, year of publication,

nation, and design) and patient demographics (sample size, age, sex, and severity of stroke) were among the extracted data. Details of the imaging techniques evaluated, patient population characteristics (sample size, age, sex, and severity of stroke), study characteristics (first author, publication year, country, and design), and any pertinent quantitative and qualitative outcomes related to the review's goals were all included in the retrieved data. Data Synthesis Strategy: Although initially planned, a meta-analysis was judged unsuitable due to significant heterogeneity in study designs, patient populations, and outcome definitions. Eighteen studies were included for qualitative synthesis. Rather, a method of narrative synthesis was used. The main outcome domains (diagnostic performance, management impact, workflow, and clinical outcomes) were used to thematically arrange the findings from the included research. To enable a thorough qualitative assessment and synthesis of the information, summary tables were created to clearly and concisely convey the salient features and conclusions of each study. Risk of Bias Assessment: Using a modified version of the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) instrument, two reviewers independently evaluated the included studies' methodological quality and risk of bias [12]. The instrument was altered to evaluate the wide range of results pertinent to this study, including domains for reference standard, flow and timing, index tests (CT and MRI), and patient selection. The concerns in each of these domains were used to evaluate the total risk of bias for each study. To guarantee an evaluation that was consistent, any differences in the quality assessment were settled by consensus.

Results

(Figure 1) illustrates the systematic process of identifying and selecting studies for inclusion in the review. The initial database search yielded 819 records. After the removal of 534 duplicates, 285 unique records were screened based on their titles and abstracts, resulting in the exclusion of 74. The full texts of the remaining 211 records were sought for retrieval; however, 147 could not be obtained. Of the 64 records that were assessed for eligibility, 46 were excluded due to wrong outcomes, wrong population, or being conference abstracts only, leaving a final total of 18 studies included in the systematic review. As detailed in (Table 1), the sample sizes vary dramatically, from small, focused studies of 70 patients [14] to large registry analyses encompassing over 16,000 patients treated with thrombolysis [23]. The studied populations, while all focused on suspected stroke, differ in key aspects; some include all-comers with suspected stroke [17], while others focus on specific subgroups, such as patients with large vessel occlusion (LVO) eligible for mechanical thrombectomy (MT) [19, 22, 26, 29] or those presenting in an extended time window [16, 19]. The baseline characteristics reveal that patients selected for MRI tend to be younger, have lower NIHSS scores (indicating less severe strokes), and present later after symptom onset [17, 23], highlighting a significant selection bias in non-randomized data. The outcomes synthesized in (Table 2) reveal critical trade-offs between the two imaging strategies. Regarding diagnostic performance, studies directly comparing detection rates and accuracy consistently demonstrate the superior sensitivity of MRI, particularly diffusion-weighted imaging (DWI), for identifying acute ischemic infarction [13, 14, 15]. This is further emphasized by the high rate (31.5%) of acute infarcts found on MRI in patients with a transient ischemic attack (TIA) or minor stroke who had a negative initial CT scan [30]. The impact on management decisions is a crucial finding; while MRI-based selection was associated with significantly lower rates of thrombolysis administration to stroke mimics (false positives) [25], its use was also linked to a consistent and statistically significant delay in door-to-needle times, ranging from approximately 2 to 30 minutes across multiple studies [16, 17, 25, 26]. This delay is attributed to the longer acquisition and processing times of MRI protocols. The evidence concerning the most critical patient-centered outcomes—safety and functional recovery—is complex and somewhat conflicting. Several large studies found no significant difference in the rate of symptomatic intracranial hemorrhage (sICH) or 90-day functional independence (modified Rankin Scale score 0-2) between CT-selected and MRI-selected patients after adjusting for confounding variables [19, 22, 23, 25]. However, other studies reported a significant association between MRI-based selection and reduced risks of sICH, early mortality, and improved functional outcomes, even after multivariate adjustment [18, 24, 26]. This suggests that the superior lesion characterization provided by MRI might lead to safer treatment decisions and better patient selection for interventions, potentially offsetting the negative consequences of treatment delays. Furthermore, the use of MRI significantly reduced the need for additional subacute imaging, streamlining the diagnostic pathway during hospitalization [25].

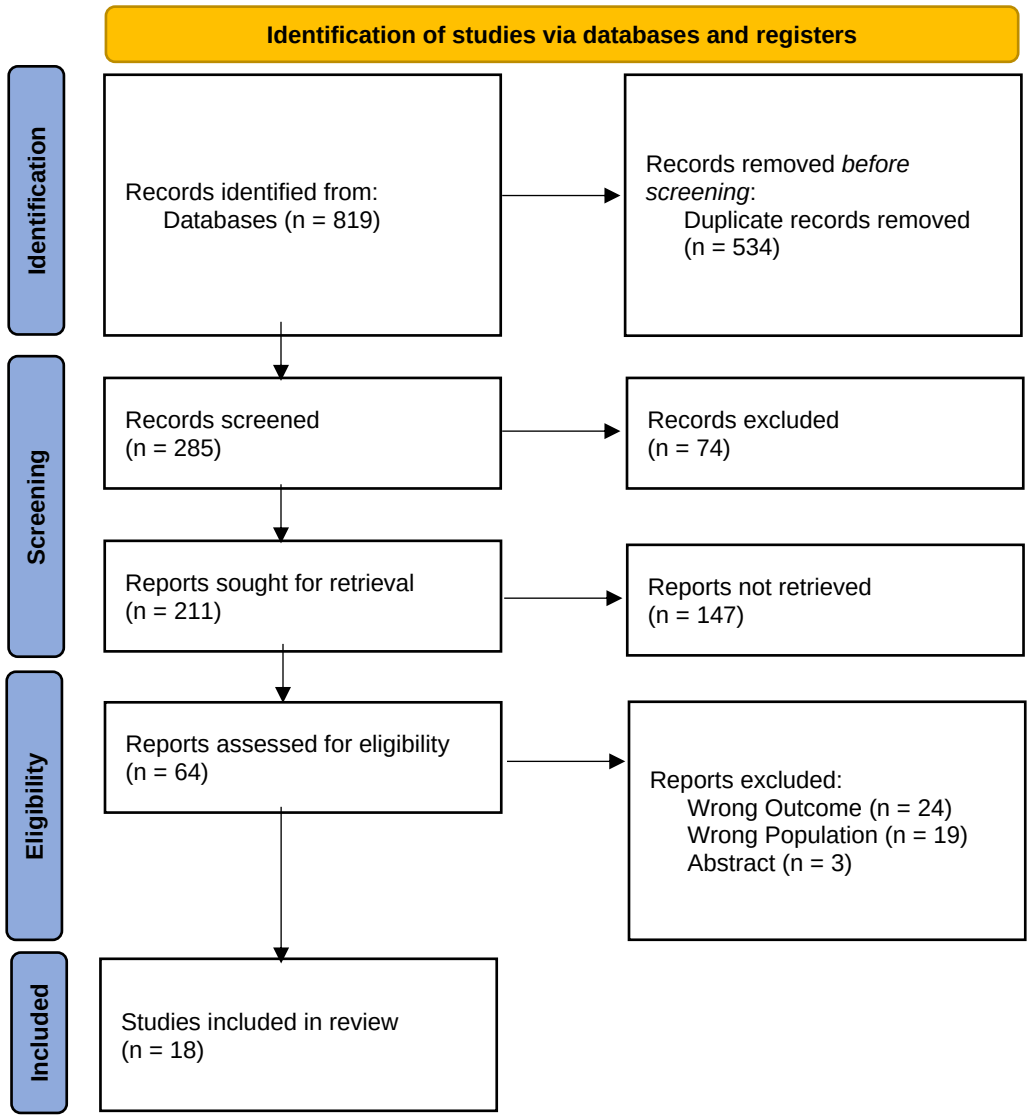

Figure 1: PRISMA Flow Diagram of the Study Selection Process.

Table 1: Characteristics of Included Studies.

Study Author(s) & Year [Ref]	Country	Study Design	Sample Size	Population	Mean Age (Years)	Male (%)	NIHSS (Median/ Mean)	Imaging Modalities Compared
Ahmed et al., 2021 [13]	Pakistan	Prospective Comparative	178	Suspected acute stroke	NM	NM	NM	NCCT vs. MRI (DWI)
Dey et al., 2021 [14]	India	Cross-sectional	70	Suspected acute ischemic stroke	NM	69.8 %	NM	NCCT vs. MRI (DWI)
Junejo et al., 2021 [15]	Pakistan	Cross-sectional Validation	125	Suspected acute ischemic stroke	56.1	58.0 %	NM	CTP vs. MRI (DWI)
Macha et al., 2020 [16]	Germany	Retrospective Cohort (Registry)	184	AIS in extended/unknown time window	75.0	49.5 %	10 (IQR 6-16)	Multimodal CT vs. MRI
Fischer et al., 2022 [17]	Switzerland (Nationwide)	Observational Cohort	11,049	Suspected acute stroke	71.0	56.0 %	CT: 4 (IQR 1-11); MRI: 2 (IQR 0-6)	NCCT ± CTA vs. MRI
Li et al., 2022 [18]	China	Retrospective Cohort	462	AIS treated with IV thrombolysis	66.0	64.3 %	10.0	NCCT vs. MRI
Nguyen et al., 2022 [19]	Multicenter (EU/NA)	Multicenter Cohort	1,604	AIS with LVO in extended window	70.0	47.1 %	NM	NCCT vs. CTP vs. MRI
Vajpeyee et al., 2022 [20]	India	Retrospective Cohort	152	AIS with LVO undergoing MT	54.6	67.1 %	CT: 17; MRI: 16	NCCT+ CTA vs. MRI+MRA
Cabral Frade et al., 2022 [21]	USA	Retrospective Propensity-Matched	246	Hospitalized with AIS	68.0	53.0 %	NM	NCCT alone vs. NCCT+ MRI
Stösser et al.,	Germany (Multicenter)	Prospective Registry	4,638	AIS with LVO	NM	NM	NM	NCCT ± CTA vs. MRI

2022 [22]		(GSR-ET)		undergoing MT				
Krebs et al., 2022 [23]	Austria (Nationwide)	Prospective Registry	IVT: 16,799; MT: 2,248	AIS treated with IVT and/or MT	CT: 75.0; MRI: 69.0	CT: 49.0 %; MRI: 54.0 %	CT: 10; MRI: 8	NCCT ± CTA vs. MRI
Chen et al., 2025 [24]	China	Retrospective Cohort (PSM)	336	AIS treated with IV thrombolysis	67.0	61.9 %	11.0	NCCT alone vs. NCCT+ MRI
Rapillo et al., 2024 [25]	Switzerland	Retrospective Before-After	2,972	Confirmed AIS	76.0	54.0 %	NM	NCCT vs. MRI as first-line
Fladt et al., 2024 [26]	Multicenter (SWIFT-DIRECT)	Post-hoc RCT Analysis	405	AIS with LVO treated with MT	MRI: 71.4; CT: 70.0	MRI: 51.5 %; CT: 52.7 %	MRI: 16; CT: 18	NCCT+ CTA vs. MRI+MRA
Jia et al., 2025 [27]	China	Retrospective Analysis	NM	Simulated AIS workflow	NM	NM	NM	Multimodal CT vs. Multimodal MRI
Tsuda et al., 2025 [28]	Japan	Phantom Simulation	10 (Technologists)	Simulated AIS workflow	NM	NM	NM	Multimodal CT vs. Multimodal MRI
Choi et al., 2023 [29]	South Korea	Retrospective Cohort	NM	AIS with LVO undergoing MT	Large Core: 73.0; Small Core: 69.0	Large Core: 52.9 %; Small Core: 54.8 %	Large Core: 18; Small Core: 14	NCCT+ CTA (+ added MRI)
Robitaille et al.,	*Canada*	*Prospective Cohort*	*1,048*	*TIA/Minor stroke with negative CT*	*68.9 *	*53.4 %*	*2.0*	*MRI (DWI) after*

2025 [30]								*negative CT*

Note: NM = Not Mentioned in the abstract; AIS = Acute Ischemic Stroke; LVO = Large Vessel Occlusion; MT = Mechanical Thrombectomy; IVT = Intravenous Thrombolysis; IQR = Interquartile Range; PSM = Propensity Score Matching.

Study #34 (Robitaille) was initially excluded but is included here as it provides crucial data on MRI findings after a negative CT, a key diagnostic outcome.

Table 2: Key Outcomes Reported by the Included Studies.

Study Author(s) & Year [Ref]	**Diagnostic Accuracy / Detection** *Sens, Spec, PPV, NPV*	**Impact on Management & Safety** *Treatment Rates, sICH, Mortality*	**Workflow Times** *Door-to-Imaging, Door-to-Needle*	**Clinical Outcome** *mRS 0-2 at 90 days*
Ahmed et al., 2021 [13]	**Detection:** MRI: 92/178; CT: 29/178 (p<0.0001)	NM	NM	NM
Dey et al., 2021 [14]	**Sens:** 87.3%; **Spec:** 71.4%; **PPV:** 96.4%; **NPV:** 38.4%	NM	NM	NM
Junejo et al., 2021 [15]	**PPV:** 98.83; **NPV:** 10.25	NM	NM	NM
Macha et al., 2020 [16]	NM	**sICH:** CT: 2.0%; MRI: 4.8% (p=NS)	**DTN:** CT: 45 min; MRI: 75 min (p<0.001)	**mRS 0-2:** CT: 33.8%; MRI: 42.9% (p=NS)
Fischer et al., 2022 [17]	NM	**IVT rate:** Lower with MRI (aOR 0.83)	**DTN:** +22 min delay with MRI	**mRS 0-2:** Higher with MRI (aOR 1.54)
Li et al., 2022 [18]	NM	**sICH:** CT: 20.3%; MRI: 12.2% (p<0.01). **7d**	NM	NM

		mortality: CT: 8.6%; MRI: 3.5% (p<0.01)		
Nguyen et al., 2022 [19]	NM	**sICH:** CT: 8.1%; CTP: 5.8%; MRI: 4.7% (p=0.11). **Reperfusion:**CT: 88.9%; MRI: 78.9% (p<0.001)	NM	**mRS shift:** No difference between CT vs. CTP/MRI
Vajpeyee et al., 2022 [20]	NM	NM	**Acquisition Time:** CT: 9m23s; MRI: 12m57s	**mRS 0-2:** CT: 35.5%; MRI: 65.5%
Cabral Frade et al., 2022 [21]	NM	NM	NM	**mRS 3-6 (Death/Dependence):** CT: 42.3%; CT+MRI: 48.0%
Stösser et al., 2022 [22]	NM	NM	**Admission-to-Imaging:** CT: 14 min; MRI: 23 min	**mRS 0-2:** No difference after adjustment
Krebs et al., 2022 [23]	NM	**sICH (IVT):** CT: 5.0%; MRI: 4.1% (p=NS). **sICH (MT):** CT: 7.4%; MRI: 6.2% (p=NS)	**In-hospital delay:** ~20 min longer with MRI	**mRS 0-1/0-2:** No difference for IVT or MT after adjustment
Chen et al., 2025 [24]	NM	**sICH:** CT: 23.2%; CT+MRI: 11.9% (p=0.01). **7d mortality:** CT: 8.9%; CT+MRI: 3.0% (p=0.04)	NM	**mRS 0-2/0-1:** No significant difference
Rapillo et al., 2024 [25]	**Missed AIS:** CT: 3.8%; MRI: 4.4% (p=NS)	**Thrombolysis in mimics:** CT: 8.6%; MRI: 4.3% (p<0.05). **Subacute imaging needed:** CT: 79.0%; MRI: 60.1% (p<0.05)	**DTN (thrombolysis):** +2 min with MRI (p<0.05)	**mRS shift:** No difference (aOR 0.98)
Fladt et al., 2024 [26]	NM	**sICH:** No significant difference	**Workflow:** ~ 20 min delay with MRI	**mRS 0-2:** Higher with MRI (aOR 1.65) but not

				significant after full adjustment
Jia et al., 2025 [27]	NM	NM	**Total Dept. Time:** CT: 36.83 min; MRI: 31.00 min. **Recon. Time:** CT: 13.42 min; MRI: 7.09 min	NM
Tsuda et al., 2025 [28]	NM	NM	**Total Exam Time:** CT: 696.2s; MRI: 701.8s (p=NS). **Hemorrhage Detect:** CT: 80.9s; MRI: 66.3s (p<0.001)	NM
Choi et al., 2023 [29]	**Core Volume >60cc on MRI**	**Complications (HT, sICH, death):** Significantly higher in large core group	NM	**mRS 0-2:** Significantly lower in large core group (p=0.011)
Robitaille et al., 2025 [30]	**Acute Infarct on MRI after negative CT:** 31.5% overall; 50.0% in high-risk patients	NM	NM	**Subsequent stroke at 90d:** Higher in patients with positive MRI

Note: NM = Not Mentioned in the abstract; Sens = Sensitivity; Spec = Specificity; PPV = Positive Predictive Value; NPV = Negative Predictive Value; sICH = symptomatic Intracerebral Hemorrhage; DTN = Door-to-Needle time; mRS = modified Rankin Scale; NS = Not Significant; aOR = adjusted Odds Ratio.

Table 3: Risk of Bias Assessment for Included Studies.

Study Author(s) & Year [Ref]	Patient Selection	Index Test (CT)	Index Test (MRI)	Reference Standard	Flow and Timing	Overall Risk of Bias
Ahmed et al., 2021 [13]	High	Low	Low	Low	Low	**High**
Dey et al., 2021 [14]	Low	Low	Low	Low	Low	**Low**
Junejo et al., 2021 [15]	Low	Low	Low	Low	Low	**Low**
Macha et al., 2020 [16]	High	Low	Low	Low	Low	**High**
Fischer et al., 2022 [17]	High	Low	Low	Low	Low	**High**
Li et al., 2022 [18]	High	Low	Low	Low	Low	**High**
Nguyen et al., 2022 [19]	High	Low	Low	Low	Low	**High**
Vajpeyee et al., 2022 [20]	High	Low	Low	Low	Low	**High**
Cabral Frade et al., 2022 [21]	High	Low	Low	Low	Low	**High**
Stösser et al., 2022 [22]	High	Low	Low	Low	Low	**High**
Krebs et al., 2022 [23]	High	Low	Low	Low	Low	**High**
Chen et al., 2025 [24]	High	Low	Low	Low	Low	**High**
Rapillo et al., 2024 [25]	High	Low	Low	Low	Low	**High**
Fladt et al., 2024 [26]	High	Low	Low	Low	Low	**High**
Jia et al., 2025 [27]	High	Low	Low	Low	Low	**High**
Tsuda et al., 2025 [28]	High	Low	Low	Low	Low	**High**
Choi et al., 2023 [29]	High	Low	Low	Low	Low	**High**
Robitaille et al., 2025 [30]	Low	Low	Low	Low	Low	**Low**

Finally, workflow analyses provide nuanced insights. While the total acquisition time for a multimodal MRI protocol can be comparable to a multimodal CT protocol (CTP+CTA) [20, 28], the distribution of time differs. MRI excels in faster hemorrhage detection (using SWI/GRE sequences) and penumbra evaluation, but CT retains an advantage in faster overall image reconstruction and availability [27]. The choice of modality also has implications for treatment thresholds; the addition of MRI to CT changed treatment plans and provided prognostic information on complication risks in patients undergoing MT, suggesting its value in complex decision-making beyond simple detection [29].

Discussion

Our systematic review confirms the fundamental trade-off in acute stroke imaging: MRI provides superior diagnostic accuracy, while CT offers superior workflow speed. The core finding is that MRI, particularly DWI, is significantly more sensitive than NCCT for detecting acute ischemia, reducing inappropriate thrombolysis in stroke mimics by half [14, 15, 25, 30-33]. However, this diagnostic advantage is consistently offset by treatment delays, with MRI-based pathways prolonging door-to-needle times by 2 to 30 minutes [17, 22, 23, 25, 26, 34]. These findings have direct clinical implications. The mixed evidence on functional outcomes [17, 18, 23, 24] suggests that a one-size-fits-all imaging strategy is suboptimal. Instead, an efficient, hybrid approach is recommended. For most centers, fast multimodal CT (including CTP) serves as an excellent first-line tool to minimize treatment delays, especially for thrombectomy selection where it appears non-inferior to MRI [15, 19, 26, 35, 36]. MRI should be reserved for complex cases where its superior diagnostic capability is most impactful, such as in patients with TIA/minor stroke with a negative CT, suspected stroke mimics, or when the time of onset is unknown. This tailored strategy leverages the strengths of each modality to optimize both the efficiency and precision of acute stroke care.

Conclusion

In conclusion, the choice between CT and MRI for acute stroke requires balancing speed and diagnostic detail; while MRI is the gold standard for accuracy and preventing inappropriate treatment, its time cost can be detrimental. Modern multimodal CT offers a rapid and sufficient alternative for most treatment decisions, suggesting an optimal hybrid approach: using ultra-fast CT as the first-line to minimize delays, while reserving MRI for complex cases like wake-up strokes or diagnostic uncertainties to best leverage its superior capabilities.

Conflict of Interest

None

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