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Closing the gap: Early experience from a new Endovascular Thrombectomy service in regional and rural North Queensland, Australia

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ABSTRACT

Background: Endovascular clot retrieval is the standard of care for acute ischemic stroke caused by large vessel occlusion. However, access to mechanical thrombectomy remains limited in rural and regional areas, where patients often require transfer to urban centres. These delays are directly associated with poorer clinical outcomes. To address this disparity, a mechanical thrombectomy service was established at a regional tertiary hospital in North Queensland, Australia. This study aims to evaluate the safety and clinical outcomes of mechanical thrombectomy in a regional setting.

Methods: A retrospective analysis was conducted on all consecutive patients who underwent mechanical thrombectomy at Townsville University Hospital (TUH), Queensland, Australia, between March 2022 and February 2024. Patients were categorized into two groups—local (TUH) and interhospital transfer—based on their initial presentation. Clinical outcomes, procedural success, and complications were assessed.

Results: A total of 120 patients (mean age: 71 years; 51 % male) underwent mechanical thrombectomy. Of these, 48 (40 %) presented locally, while 72 (60 %) were interhospital transfers. A good functional outcome (mRS 0–2 at 90 days) was achieved in 56 patients (47 %). Procedural success (mTICI score 2b–3) was observed in 106 patients (88 %), while 14 patients (12 %) experienced procedure-related complications.

Conclusion: The establishment of a mechanical thrombectomy service at TUH has significantly improved access to stroke intervention for regional and rural populations in North Queensland. Our early experience demonstrates clinical outcomes comparable to those reported in large multicentre thrombectomy trials, confirming the feasibility and safety of delivering this service in a regional setting.

Introduction

Endovascular clot retrieval is the preferred treatment for acute ischemic stroke caused by large vessel occlusion. Multiple randomized controlled trials have demonstrated the superiority of endovascular therapy over best medical management alone, underscoring its effectiveness in improving patient outcomes[1–4]. The primary goal of mechanical thrombectomy is to achieve early reperfusion, as delays in revascularization are directly associated with worse functional outcomes[5,6].

Despite its status as the gold standard, endovascular thrombectomy in Australia remains largely limited to metropolitan stroke centres[7,8]. Consequently, patients in regional and rural areas often require transfer to metropolitan tertiary hospitals with interventional capability. Transfer times can range from under an hour to several hours, depending on geographic location and mode of transport. According to the Royal Flying Doctor Service (RFDS), the median aeromedical retrieval time for stroke patients in Australia is 238 minutes[7]. These delays significantly hinder timely access to this time-critical intervention[9–11].

Queensland, the second-largest state in Australia, covers 22.5 % of the national landmass, with an area of over 1.7 million square kilometres. Most of its land area is classified as regional or rural, with major

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stroke centres concentrated in two metropolitan cities in the south (Fig. 1). Historically, patients from North and Far North Queensland were transferred to these urban centres for clot retrieval procedures. To reduce the need for ultra-long transfers, a dedicated endovascular thrombectomy service was established in February 2022 at Townsville University Hospital (TUH), a regional tertiary hospital in North Queensland.

This service currently provides 24/7 clot retrieval coverage for North, Far North, and West Queensland, significantly expanding access to life-saving stroke interventions across a large geographic region. The aim of current study is to evaluate the procedural safety and clinical outcomes of a newly established mechanical thrombectomy service in regional Australia.

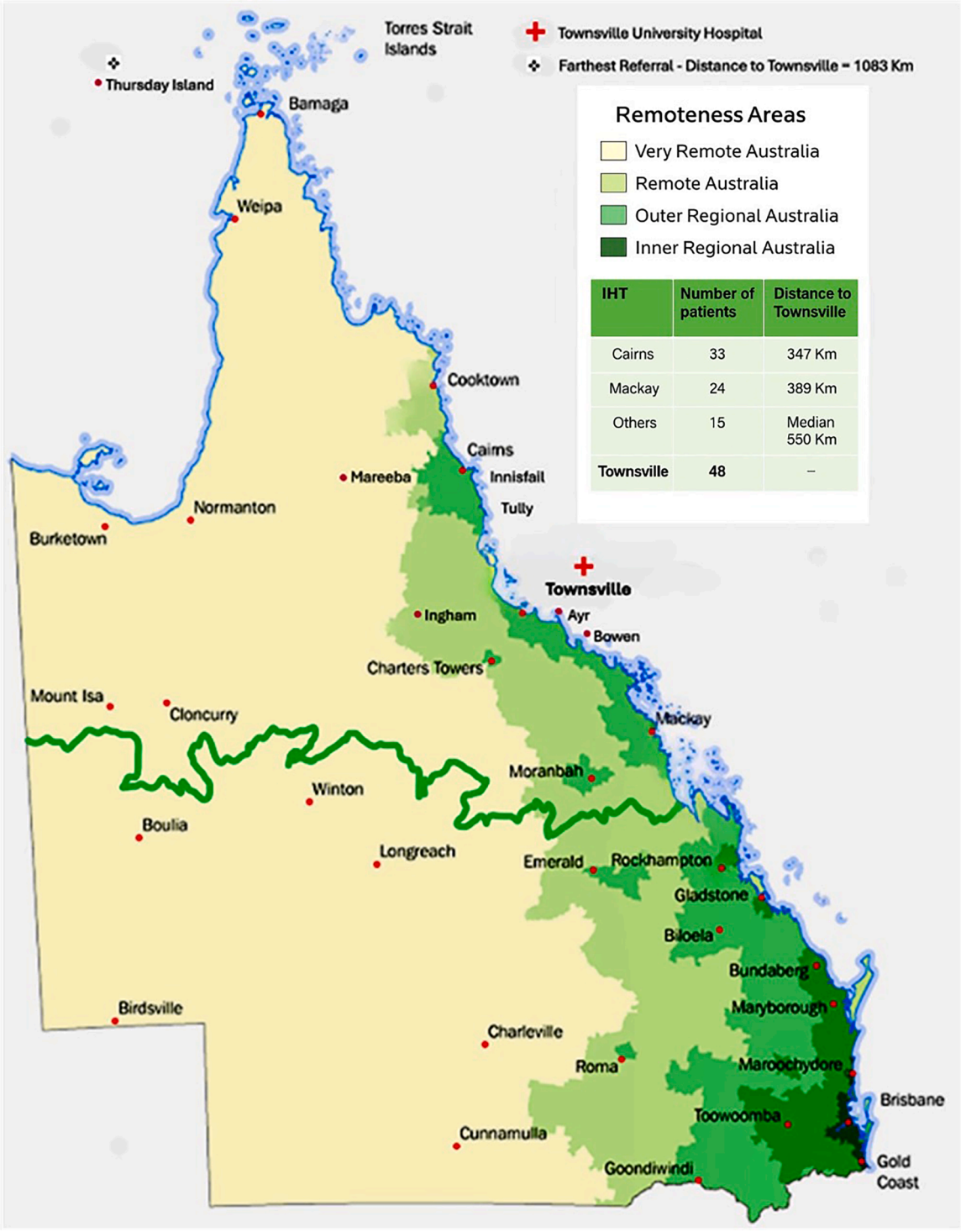

Fig. 1. Map of Queensland identifying regional and metropolitan areas. The region north of green border depicts catchment area serviced by Townsville University Hospital for mechnical thrombectomy including North, Far North and North-West Queensland.

Materials and methods

Catchment area and regional healthcare facilities

Townsville University Hospital (TUH) is the largest tertiary referral centre in North Queensland, offering specialized services including endovascular clot retrieval. The catchment area encompasses North, Far North, and West Queensland, serving a population of over 750,000 across >300,000 km^2. Patients requiring mechanical thrombectomy are referred from eight regional and rural hospitals, including Cairns, Mackay, Mount Isa, and nearby communities. Transfers are coordinated by Retrieval Services Queensland (RSQ), utilizing emergency aeromedical services to ensure timely access to care. Ground transfers, when appropriate, are managed by the Queensland Ambulance Service (QAS).

Study population: inclusion and exclusion criteria

This retrospective, single-centre study included all consecutive patients who underwent mechanical thrombectomy for acute ischemic stroke between March 2022 and February 2024, following the establishment of the regional thrombectomy service. Patients were grouped into Townsville University Hospital (TUH) and Inter-Hospital Transfer (IHT) group based on their initial presentation (Fig. 1). TUH- patients presented directly to Townsville University Hospital and received mechanical thrombectomy treatment locally. While patients in IHT group initially presented to another regional hospitals and subsequently required transfer to Townsville Hospital for mechanical thrombectomy procedure. Since the cohort of patients had different treatment access pathways, they were categorized into separate groups to compare the time metrics, procedural success, clinical outcomes and complications between the groups.

All patients presenting with suspected acute ischemic stroke underwent an initial non-contrast CT brain and CT angiography. CT perfusion imaging was performed where available. Patients with confirmed large or medium vessel occlusion were deemed eligible for thrombectomy.

The decision to proceed with thrombectomy was made jointly by the on-call Neurology consultant and neuro-endovascular physician, based on national thrombectomy guidelines[12]. Upon arrival at TUH, IHT patients underwent formal reassessment. If significant neurological changes were noted (improvement or deterioration), repeat imaging—including CT brain, CT angiography, and optionally CT perfusion—was performed. Patients with large established infarcts, intracranial haemorrhage, or spontaneous recanalization on repeat imaging were excluded from treatment and from the study. Patients with a pre-stroke Modified Rankin Scale (mRS) score ≥3 were also excluded.

Data collection and outcome measures

Institutional review board approval was obtained prior to data collection. Demographic data, clinical parameters including baseline NIHSS, imaging findings, and procedural details were extracted from the Integrated Electronic Medical Record (ieMR) and the Picture Archiving and Communication System (PACS). Operative notes were reviewed to identify procedural complications.

The primary outcome was functional status at 90 days, assessed using the Modified Rankin Scale (mRS). The mRS is a 7-point scale used to measure disability or dependence in daily activities. A score of 0 indicates no symptoms; 1 reflects no significant disability and the ability to carry out all usual activities; 2 indicates slight disability, meaning the patient is independent but unable to perform all tasks; 3 denotes moderate disability, requiring some help but the patient is able to walk unassisted; 4 signifies moderately severe disability, where the patient needs assistance to walk and manage daily activities; 5 reflects severe disability, meaning the patient is bedridden and completely dependent; and 6 corresponds to death[13].

Functional independence was defined as mRS 0–2 at 90 days. Follow-up assessments were performed in clinic or by structured telephone interview by neurology advanced trainees. If follow-up was unavailable, the most recent mRS documented at discharge or prior follow-up was used. Secondary outcomes included procedural success Thrombolysis in Cerebral Infarction (TICI 2b–3) and complications such as vessel dissection, perforation, secondary embolization, and groin site complications. All complications were identified via operative records or post-procedure imaging.

Data analysis

Data were analysed using Statistical Package for the Social Sciences (SPSS) version 21. Categorical variables were summarized using frequencies and percentages. Continuous variables were presented as means ± standard deviation (SD) or medians, depending on normality (assessed using the D'Agostino-Pearson test). Comparisons between TUH and IHT groups were made using the Chi-square or Fisher's exact test for categorical variables, and the t-test for continuous variables. A p-value ≤ 0.05 was considered statistically significant.

Results

Baseline characteristics

During the study period, a total of 148 patients were considered eligible for mechanical thrombectomy. Of these, 28 patients were excluded based on the pre-specified exclusion criteria, resulting in a final cohort of 120 patients who underwent the procedure (Fig. 2). The mean age of the study population was 71 years, and 51 % were male. Among them, 48 patients (40 %) presented from the local Townsville catchment area and were categorized as the TUH group, while 72 patients (60 %) were transferred from regional and rural sites, comprising the Inter-Hospital Transfer (IHT) group.

Patients in the IHT group experienced a significantly longer median door-to-groin puncture time compared to the TUH group (315 minutes vs. 112 minutes; $P = 0.02$), highlighting the delays inherent in inter-facility transfer. The median NIHSS score on presentation was 13 and did not significantly differ between the two groups ($P = 0.35$). Intravenous thrombolysis (IVT) was administered in 58 patients (48 %), with a slightly higher rate in the IHT group (51 %) compared to the TUH group (44 %), though the difference was not statistically significant ($P = 0.17$).

Pre-stroke mRS scores showed a similar distribution between groups. Most patients had a baseline mRS of 0 (55 %), followed by 1 (33 %) and 2 (12 %). The most common occlusion site was the M1 segment of the middle cerebral artery (35 %), followed by the M2 segment (19 %), internal carotid artery (15 %), posterior circulation (13 %), and tandem occlusion (17 %). These distributions were relatively balanced across the TUH and IHT groups (Table 1).

Procedural outcomes and complications

Successful recanalization, defined as achieving a mTICI score of 2b–3, was attained in 106 patients (88 %), with no statistically significant difference between the TUH and IHT groups (87 % vs. 89 %; $P = 0.68$). Most procedures (89 %) were performed under general anaesthesia. The use of general anaesthesia was slightly more frequent in the IHT group (93 %) than in the TUH group (83 %), though this difference was not statistically significant ($P = 0.25$).

Procedure-related complications occurred in 14 patients (12 %) and included secondary embolism ($n = 5$), arterial perforation ($n = 4$), vessel dissection ($n = 2$), and groin access complications ($n = 3$). These complications were similarly distributed between the two groups, with no statistically significant differences observed (Table 2). Post-procedural symptomatic intracranial haemorrhage (sICH) occurred in 7 % of cases, with slightly higher rates observed in the TUH group, although

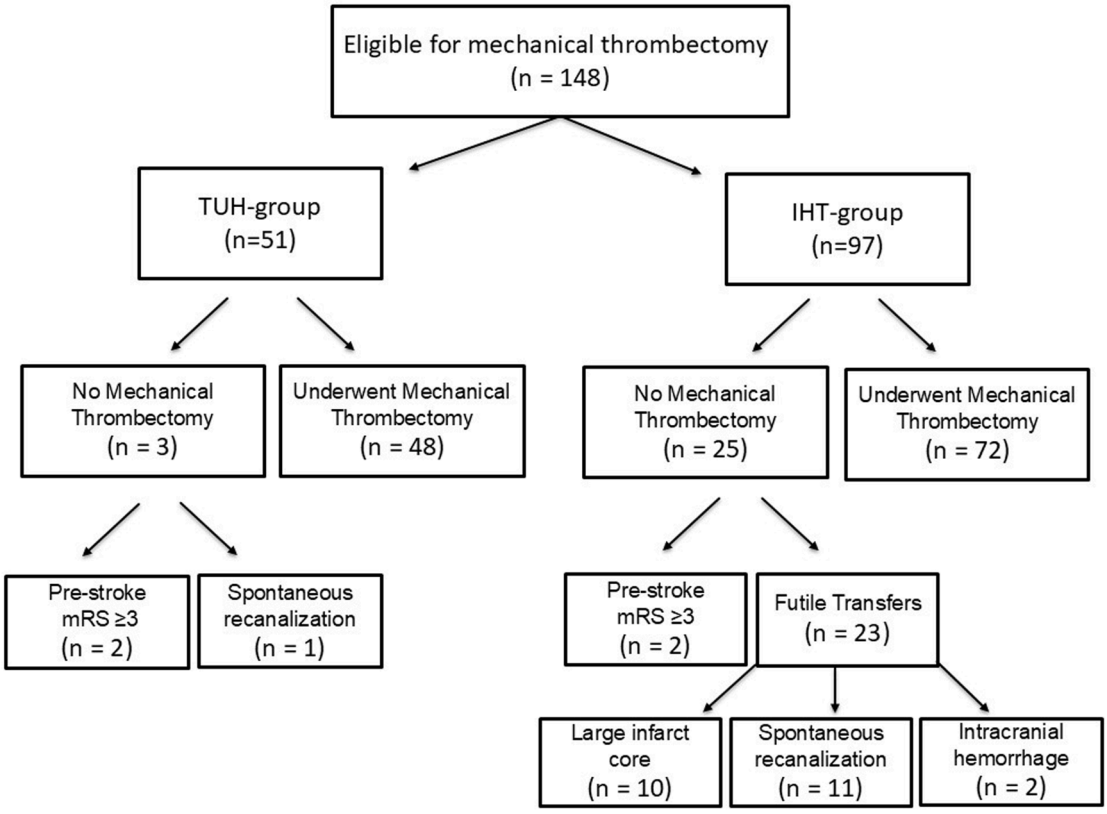

Fig. 2. Flowchart Depicting Patient Inclusion and Reasons for Exclusion from Mechanical Thrombectomy.

Table 1
Baseline characteristics of studied population.

Baseline characteristics	Total	TUH	IHT
Demographic characteristics			
Patient number, n (%)	120	48 (40)	72 (60)
Age (years) mean (SD)	71	70	72
Pre- stroke mRS score, median (IQR)			
0, n (%)	66 (55)	21 (44)	45 (63)
1, n (%)	40 (33)	21 (44)	19 (26)
2, n (%)	14 (12)	6 (12)	8 (11)
Clinical characteristics			
Baseline NIHSS score, mean (SD)	13 (6)	12 (5)	14 (7)
Intracranial occlusion site (first imaging)			
M1 portion of MCA, n (%)	42 (35)	22 (46)	20 (28)
M2 portion of MCA, n (%)	23 (19)	8 (19)	15 (21)
Internal Carotid Artery, n (%)	18 (15)	7 (15)	11 (15)
Basilar artery/Post Circulation, n (%)	16 (13)	5 (10)	11 (15)
Tandem occlusion, n (%)	21 (17)	6 (12)	15 (21)

Table 2
Mechanical thrombectomy procedural outcomes and complications.

	Total	TUH	IHT	*P*-Value
Door-to-Groin Time(minutes), median IQR	234 (109-268)	112 (83-125)	315 (285-416)	0.02*
Intravenous thrombolysis, n (%)	58 (48)	21 (44)	37 (51)	0.17
Successful recanalization (mTICI score 2b–3), n (%)	106 (88)	42 (87)	64 (89)	0.68
General anaesthesia, n (%)	107 (89)	40 (83)	67 (93)	0.25
Mechanical thrombectomy complications, n (%)*	14 (12)	6 (12)	8 (11)	0.53
Secondary embolism, n	5	3	2	
Iatrogenic arterial dissection, n	2	0	2	
Arterial perforation, n	4	1	3	
Groin puncture complication, n	3	2	1	

*Significant.

not statistically significant.

Clinical outcomes

At 90-day follow-up, 56 patients (47 %) achieved a good functional outcome (mRS 0–2). The rate of functional independence was higher in the TUH group (52 %) compared to the IHT group (43 %), though this difference did not reach statistical significance ($P = 0.39$). The overall 90-day mortality rate was 14 %, with slightly higher mortality in the TUH group (17 %) than in the IHT group (13 %) ($P = 0.67$).

Among surviving patients, 21 % had moderate to severe functional dependence (mRS 4–5). The NIHSS score at discharge had a median of 6, with no significant intergroup differences ($P = 0.56$). Day 90 mRS scores were well distributed across the scale, with 14 % achieving an mRS of 0, 24 % scoring 1, and 8 % scoring 2. Scores of 3, 4, and 5 were recorded in 17 %, 14 %, and 8 % of patients respectively, while 14 % had a score of 6, indicating death (Table 3, Fig. 2).

These findings suggest that mechanical thrombectomy in a regional setting is feasible, with clinical and procedural outcomes comparable to those reported by major stroke centres (Fig. 3).

Discussion

Prior to the establishment of mechanical thrombectomy service at Townsville University Hospital (TUH), patients in regional and rural Queensland requiring endovascular stroke intervention were transferred over 1,500 km to Gold Coast University Hospital (GCUH). These ultra-long transfers were not only time-consuming but also likely introduced a selection bias. Patients with anticipated poor clinical outcomes, such as those with advanced age, multiple comorbidities, poor collateral circulation, or large core established infarct on initial imaging, may not

Table 3
Early and late clinical outcomes.

	Total	TUH	IHT	P-value
Intracranial hemorrhage at 24 hours				
Total, n (%)	18 (15)	6 (12)	12 (17)	0.23
Symptomatic, n (%)	9 (7)	4 (8)	5 (7)	0.15
NIHSS score at discharge, mean (Median)	7 (6)	6 (6)	8 (7)	0.56
Favorable outcome at day 90 (mRS score 0–2), n (%)	56 (47)	25 (52)	31 (43)	0.39
Mortality at day 90, n (%)	17 (14)	8 (17)	9 (12)	0.67
Day 90 mRS score, median (IQR)				
0, n (%)	17 (14)	8 (17)	9 (13)	
1, n (%)	29 (24)	11 (23)	18 (25)	
2, n (%)	10 (8)	6 (13)	4 (6)	
3, n (%)	21 (17)	9 (19)	12 (17)	
4, n (%)	17 (14)	3 (6)	14 (19)	
5, n (%)	9 (8)	3 (6)	6 (8)	
6, n (%)	17 (14)	8 (17)	9 (12)	

be considered suitable for ultralong transfers. Similar findings have been reported in other studies, which highlight the selective nature of patient referrals for thrombectomy in settings where long-distance transfers are necessary[14–16]. Such selection bias is inherent to inter-hospital transfer and likely persisted at TUH during acceptance of mechanical thrombectomy patients, albeit to a lesser degree due to shorter transfer time.

Over a period of two years (March 2020 – Feb 2022), preceding to the establishment of TUH service, only 19 patients from North Queensland underwent mechanical thrombectomy treatment at GCUH. In contrast, during the first two years following the launch of the local service (March 2022 – February 2024), 120 patients were treated at TUH. This sixfold increase in procedure volume is directly attributable to the availability of local service, reduced transfer distances, and improved system responsiveness.

Delayed reperfusion due to long transfer times has a well-established negative impact on stroke outcomes[9,17]. In our study, the median door-to-groin puncture time was significantly longer for the IHT group compared to the TUH group (315 minutes vs. 112 minutes), exceeding the national benchmark of 90 minutes. These delays reflect both the early learning curve of a new regional service and the logistical challenges inherent to interhospital retrieval. The trend toward better outcomes in the TUH group (52 % vs. 43 %, mRS 0–2) may reflect the advantages of shorter treatment times.

Nevertheless, the functional outcomes in our regional cohort align with those reported in multicentre randomized controlled trials[18,19]. Overall, 47 % of patients achieved good functional outcome (mRS 0–2) at 90 days. Although the difference between groups was not statistically significant, the trend toward improved outcomes in the TUH group may be attributable to early access to mechanical thrombectomy. The 90-day all-cause mortality rate was 14 %, with no significant difference between groups.

The complication rate in our cohort was 12 %, consistent with rates reported in larger trials and real-world studies[20,21]. Symptomatic intracranial haemorrhage occurred in 7 % of cases, while groin access complications occurred in three patients.

Among IHT patients, 23 experienced futile transfers. These patients were initially deemed suitable for thrombectomy but were ultimately excluded upon arrival at TUH due to spontaneous recanalization (n = 10), large infarct core development (n = 11), or intracranial haemorrhage (n = 2). Our findings are in line with earlier studies from Australia and New Zealand, where up to 27 % of transferred patients were no longer eligible upon reassessment[14]. Other studies report up to 45 % futile transfers, typically due to clinical improvement or infarct progression during transfer[22].

Our study has some limitations, mainly due to retrospective nature and absence of a control cohort. During the study period, new trials demonstrated benefits of mechanical thrombectomy in patients with large ischemic core[23,24]. This may have impacted the selection criteria for mechanical thrombectomy candidates during the study period. It is difficult to ascertain this impact as we did not record the ischemic core volume or ASPECT score in our study cohort. There is no record of how many referrals with LVO were not accepted for mechanical thrombectomy procedure at TUH. A selection bias may have occurred when considering ultra-long transfers.

Conclusion

Our findings support the successful implementation of a regional mechanical thrombectomy service at Townsville University Hospital, demonstrating increased access, earlier intervention, and encouraging patient outcomes for populations in North, Far North, and West Queensland. Despite inherent challenges associated with interhospital transfers—particularly delays in treatment initiation—the local availability of endovascular stroke care has significantly enhanced

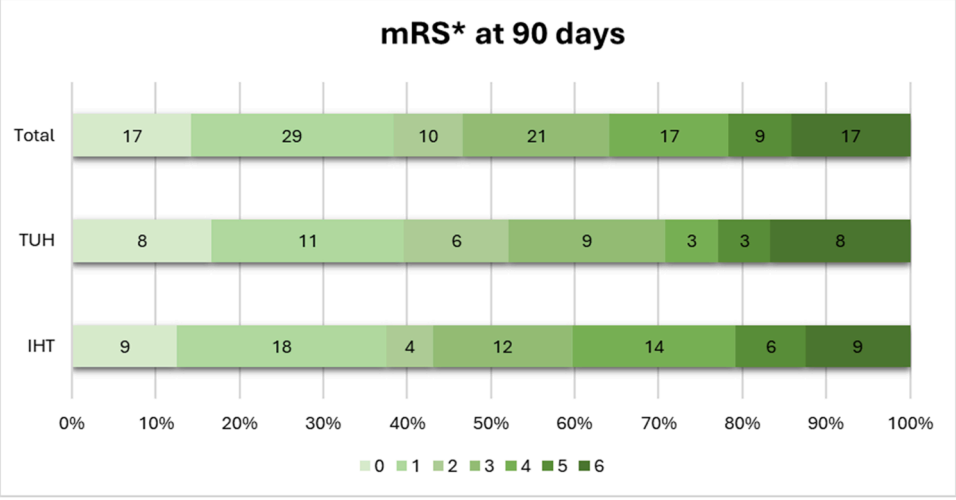

Fig. 3. modified Ranking Scale score at 90 days. mRS*; modified Rankin Scale.

procedural volume and reduced reliance on ultra-long transfers to metropolitan centres.

The feasibility and safety demonstrated in this early experience reinforce the importance of expanding thrombectomy services to underserved regions. These findings provide a foundation for future planning and policy development in regional and rural stroke care delivery. Ongoing investment in workforce training, infrastructure, and prehospital triage systems will be essential to further reduce treatment delays and expand equitable access to life-saving interventions.

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Ethics approval and consent to participate

Formal ethics approval was obtained from the Human Research Ethics Committee (HREC) at Townsville University Hospital (S_1).

CRediT authorship contribution statement

Muhammad Usman Manzoor: Data curation, Formal analysis, Writing – review & editing, Writing – original draft, Project administration, Conceptualization. **Abdul Shaik:** Resources, Formal analysis, Data curation. **Awais Farid:** Formal analysis, Writing – review & editing, Writing – original draft, Visualization, Methodology. **Ramon Luis Navarro Balbuena:** Writing – review & editing, Methodology, Investigation, Data curation. **Ravindra Urkude:** Project administration, Conceptualization. **Yasir Khattak:** Visualization, Methodology. **Nerida Myers:** Validation, Investigation, Data curation. **Lori Mackay:** Investigation, Formal analysis, Data curation. **Firas Alnidawi:** Resources, Investigation. **Rufus Corkill:** Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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