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ORIGINAL RESEARCH

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Evaluation of a new medical retrieval and primary health care advice model in Central Australia: Results of pre- and post-implementation surveys

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Abstract

Introduction: In February 2018 the Remote Medical Practitioner (RMP)-led telehealth model for providing both primary care advice and aeromedical retrievals in Central Australia was replaced by the Medical Retrieval and Consultation Centre (MRaCC) and Remote Outreach Consultation Centre (ROCC). In this new model, specialists with advanced critical care skills provide telehealth consultations for emergencies 24/7 and afterhours primary care advice (MRaCC) while RMPs (general practitioners) provide primary care telehealth advice in business hours via the separate ROCC.

Objective: To evaluate changes in clinicians' perceptions of efficiency and timeliness of the new (MRaCC) and (ROCC) model in Central Australia.

Design: There were 103 and 72 respondents, respectively, to pre- and post-implementation surveys of remote clinicians and specialist staff.

Findings: Both emergency and primary care aspects of telehealth support were perceived as being significantly more timely and efficient under the newly introduced MRaCC/ROCC model. Importantly, health professionals in remote community were more likely to feel that their access to clinical support during emergencies was consistent and immediately available.

Discussion: Respondents consistently perceived the new MRaCC/ROCC model more favourably than the previous RMP-led model, suggesting that there are benefits to having separate referral streams for telehealth advice for primary health care and emergencies, and staffing the emergency stream with specialists with advanced critical care skills.

Conclusion: Given the paucity of literature about optimal models for providing pre-hospital medical care to remote residents, the findings have substantial local,

national and international relevance and implications, particularly in similar geographically large countries, with low population density.

KEYWORDS

emergency medicine, evaluation, health service delivery, models of care, remote health, retrieval, telehealth

1 | INTRODUCTION

Australians living in remote locations have lower life expectancy, higher preventable hospitalisation rates, higher total burden of disease and less access to health services than people in regional and metropolitan areas.[1] In addition to the provision of effective Primary Health Care (PHC),[2] high quality, timely, emergency care for remote Australians has been an area of both need and innovation.[3]

Central Australia encompasses an area of approximately 1.4 million km^2 and has a population size of approximately 50 000 residents. It includes communities in the Anangu Pitjantjatjara Yankunytjatjara (APY) homelands in Northwest South Australia and some Western Desert cross-border communities in Western Australia (Figure 1). Prior to 12th February 2018, a Remote Medical Practitioner (RMP)-led retrieval model functioned in remote Central Australia. RMPs are doctors with GP qualifications who provide primary care services to remote communities using a variety of different models of care including: residing in community, fly in fly out (FIFO) and providing PHC advice via telemedicine. The RMP-led model involved RMPs providing clinical support and guidance by telephone to remote practitioners, who were mainly Remote Area Nurses and Aboriginal Health Practitioners. RMPs also managed the prioritisation and coordination of evacuations across Central Australia. This involved liaising with the on-call emergency department consultant, the Royal Flying Doctor Service (RFDS) and the on-call retrieval doctor as required. When retrieval was necessary, patients were mostly transported either to Tennant Creek Hospital, a 25-bed community hospital serviced by GPs, or to Alice Springs Hospital (ASH), a larger 200-bed regional hospital.

In February 2018, a new model of care, comprising the Medical Retrieval and Consultation Centre (MRaCC) and the Remote Outreach Consultation Centre (ROCC), was introduced (Figure 2). It aimed to improve the timeliness, clinician efficiency and effectiveness of the retrieval service. It was introduced following a comprehensive system review by key retrieval stakeholders which identified a number of issues in the existing RMP-led model. These issues included: communication and integration issues between clinicians, tasking/aviation agencies, remote area clinicians, clinics and hospitals; lack of consistency in following existing policies, procedures and guidelines; lack of standardised training, competency assessments and performance measures for RMPs; and the absence of a central coordinating agency with a single point of contact, which meant that a number of different organisations and steps were required to undertake a retrieval.[4]

The new model explicitly separated the emergency and primary care consultation pathways, establishing different points-of-contact (phone numbers) for referring emergencies and primary care issues. MRaCC was established as a 24-h, 7-day a week service, with dedicated staffing by specialists with advanced critical care skills. MRaCC staff coordinate medical retrieval services for acute care cases, inter-hospital transfers, and the repatriation of patients

What is already known on this subject

- There is a lack of empirical research about the effectiveness of operational-level strategies for medical retrieval models for patients from geographically remote locations
- Empirical research to date is inconclusive regarding whether better integrated retrieval systems are associated with improved patient outcomes, and this may be related to the heterogeneity of retrieval models

What does this study add

- This study provides new empirical evidence about the effectiveness of a newly introduced model for providing telehealth consultations for both acute and primary health care problems in a geographically remote setting, from the perspective of clinicians using the model
- The new MRaCC/ROCC system was perceived by clinicians to perform better across a range of domains. These included: the timeliness of consultations and retrievals for acute problems; timeliness of primary health care advice and management; and the efficiency of the system for clinicians

FIGURE 1 Area serviced by MRaCC and location of nearest tertiary hospitals (Darwin and Adelaide)

back to country as well as respond to PHC calls received outside of usual business hours. During normal business hours MRaCC operates in parallel with ROCC, which is a telephone consultation service, staffed by RMPs, which provides PHC advice to remote clinicians.

Despite considerable variations across Australia in service models for telehealth management and retrieval of acutely unwell patients in remote settings, little is known about optimum system requirements for effective service redesign in this setting.[5–7] For example, a systematic review and meta-analysis in 2013 highlighted conflicting evidence about the effectiveness of increased integration of retrieval systems for patients with major trauma[8]; some studies demonstrated improved patient outcomes,[9–12] for example where professional expertise was concentrated at a designated central hub and care was coordinated centrally; while other studies showed no difference[13] or poorer patient outcomes.[14] Considerable heterogeneity of retrieval models in their structure, policies and procedures contributed to the inconclusive findings of this systematic review. A more recent scoping review focusing on retrieval of patients from geographically remote areas of high-income countries confirmed significant gaps in knowledge relating to how different retrieval service structures and operational processes are associated with system timeliness, efficiency and patient outcomes.[15] Only two 'whole of model' evaluations were found, one of which only investigated safe transport of low-acuity patients, rather than patients of all acuity levels requiring retrieval.[5,16] The other study from South Australia investigated mortality outcomes using administrative data and propensity-matched controls. No existing study evaluates the timeliness and efficiency of a new retrieval model using a 'before and after' study

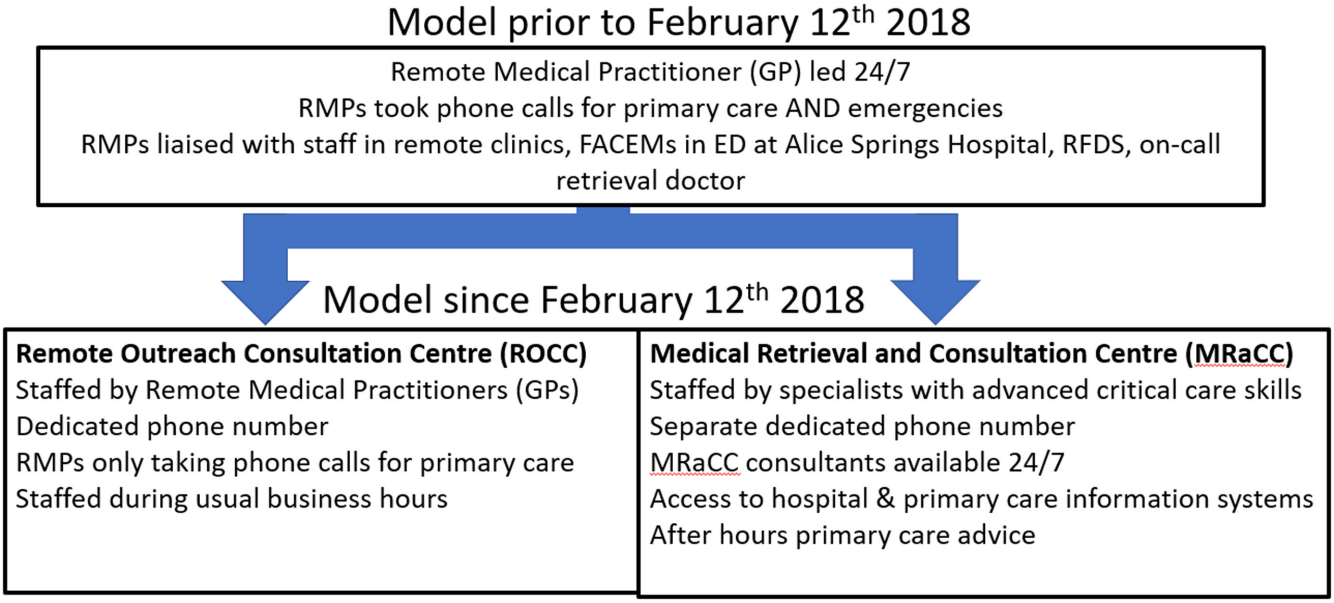

FIGURE 2 Model redesign

design to measure perceptions of clinician users of the system.

Given these gaps in the literature, this pre- and post-implementation study aimed to evaluate associations between clinician perceptions about different structural and operational processes introduced in the Central Australian retrieval system, and the transition from the previous RMP-led model to the current MRaCC/ROCC model and the timeliness and efficiency of services.

2 | METHODS

This study utilised pre- and post-implementation surveys.

2.1 | Data collection

Pre- and post-implementation surveys were adapted from a survey originally developed in Canada.[17] Data collected included demographic characteristics (age, gender) and professional characteristics (location of health care duties, current role and nature of employment) of respondents. The surveys contained thirty questions that collected data across three domains: clinical support and guidance; remote retrieval service; and PHC in the Northern Territory (NT). The post-implementation survey included an additional section comprising eighteen questions for respondents who had experience working under both models of care. In this section, respondents were asked to directly compare various aspects of the different models.

The surveys were distributed in February 2018 (pre-implementation) and March 2020 (post-implementation) to health workers in the NT and cross-border areas in South Australia and Western Australia, who interacted with the retrieval services in Central Australia. Participants included: Aboriginal Health Practitioners (AHPs), Remote Area Nurses and RMPs working in health centres in remote communities (both from Aboriginal Controlled Community Health Organisations (ACCHOs) and government-run clinics); doctors, nurses and paramedics working for RFDS and St John Ambulance (SJA); doctors providing telephone advice (MRaCC consultants and RMPs); and consultant specialist doctors at ASH.

2.2 | Analysis

Unpaired (indirect) comparisons were made between responses to corresponding questions in the pre- and post-implementation surveys. As responses to both surveys were anonymous, paired analysis was not possible. For questions in the additional section of the post-implementation survey only completed by participants with knowledge and experience of both models of care, direct comparisons were performed.

2.3 | Dependent variables

Questions with 5-point Likert scale responses were initially recoded as binary outcomes (Strongly Disagree, Disagree, Neither Disagree nor Agree = 0; Agree, Strongly Agree = 1) or (Not at all satisfied, Not very satisfied, Neutral = 0; Somewhat Satisfied, Very Satisfied = 1). In order to maximise the utility of the available data,

sensitivity analyses were undertaken. Responses with 5-point Likert scale were also coded as ordinal 5-point dependent variables (Strongly Disagree = 1, Disagree = 2, Neither Disagree nor Agree = 3, Agree = 4, Strongly Agree = 5) or (Not at all satisfied = 1, Not very satisfied = 2, Neutral = 3, Somewhat Satisfied = 4, Very Satisfied = 5).

Direct comparison questions with 5-point Likert scale responses were analysed as ordinal 5-point variables (Current system (MRaCC/ROCC) a lot better = 1, Current system (MRaCC/ROCC) a little better = 2, No difference = 3, Previous system (RMP-led) a little better = 4, Previous system (RMP-led) a lot better = 5) or (A lot more often in the current system = 1, A little more often in the current system = 2, No difference between current and previous systems = 3, A little less often in the current system = 4, A lot less often in the current system = 5).

2.4 | Independent variables

The key independent variable used in unpaired analyses was an indicator of whether a response was obtained from the pre-implementation or post-implementation survey.

Analyses also tested for associations with a range of demographic and professional characteristics, which were coded using the following categories: gender (male/female); age in years (<40/40–59/60+); location of work (Alice Springs, remote community Central/Barkly (excluding Alice Springs), remote community non-NT); profession (nurse/midwife/AHP, RMP, retrieval organisation, specialist physician – emergency or retrieval, specialist physician – other); employment type (agency/locum/casual, Permanent/Contract); Years in NT (<3, 3–6, 7–10, 11–14, ≥15).

2.5 | Indirect (unpaired) analyses

The chi-square test and chi-square test for trends were used to assess statistically significant differences in the demographic and professional characteristics of respondents to the pre-implementation and post-implementation surveys. In cases where cell counts were less than 5, Fisher's exact test was used.

Multiple logistic regression was used to test differences in respondents' answers to the pre-implementation and post-implementation surveys. Findings were reported as odds ratios with 95% confidence intervals. Independent variables were included in initial multiple logistic regression models if their simple logistic regression p values were ≤0.25. Backwards stepwise elimination procedures were used to finalise the models, using likelihood-ratio test p values >0.10 to sequentially eliminate variables.

Sensitivity analyses were conducted using multiple ordered logistic regression, also reported as odds ratios with 95% confidence intervals. These regression models included demographic and professional characteristics found to be statistically significant during univariate analysis. The multiple ordered logistic regression models were undertaken to increase the sensitivity of detecting differences in responses than what was possible with multiple logistic regression models, however, had the comparative disadvantage of being less straightforward to interpret than multiple logistic regression models.

2.6 | Direct analyses

The chi-square test for a linear trend in proportions[18] was used to test the extent to which respondents who had knowledge of both systems considered the current (MRaCC/ROCC) system to differ from the previous (RMP-led) system with regards to a range of attributes related to retrieval for urgent health problems and for non-urgent PHC problems. This test uses ordered categories (coded as described above) and tests against the null hypothesis of no trend, which is somewhat akin to undertaking a linear regression. Data were measured using a 5-point Likert scale which were coded as described above (see Outcome variables) and also grouped into three categories for descriptive analysis: (Current system (MRaCC/ROCC) a lot or a little better = 1, No difference between current and previous systems = 2, Previous system (RMP-led) a lot or a little better). We conducted sensitivity analyses to test whether the chi-squared tests for linear trend in proportions for responses to questions about urgent care remained statistically significant if the responses of emergency and retrieval specialists were excluded from analyses.

Analysis of the quantitative data was undertaken using Stata 13 (StataCorp). A level of statistical significance of $\alpha = 0.05$ was used throughout.

3 | RESULTS

The total number of survey respondents for the pre- and post-implementation surveys were 103 and 72, respectively. There was no significant difference between the pre-implementation and post-implementation surveys in respondents' age or gender. There were statistically significant differences with regards to respondents' location of work, profession, employment type, and number of years in the NT (Table 1). Proportionally more respondents to the post-implementation survey worked in Alice Springs and proportionally less worked in Tennant Creek and

TABLE 1 Demographics of respondents to the pre- and post-implementation surveys

	Pre-implementation	Post-implementation	
	Number of respondents (%)	Number of respondents (%)	*p* value
Total survey respondents	103	72	
Sex			
Female	61 (59.22)	45 (62.50)	0.668[a]
Male	41 (39.81)	27 (37.50)	
Not known	1 (0.97)	0 (0.0)	
Age - in years			
<40	27 (26.21)	24 (33.33)	0.527[a]
40–59	53 (51.46)	33 (45.83)	
60+	22 (21.36)	15 (20.83)	
Not known	1 (0.97)	0 (0.0)	
Location of majority of work			
Alice Springs	32 (31.07)	40 (55.56)	0.001[b]
remote (Central/Barkly)	44 (42.72)	25 (34.72)	
remote (non-NT)	7 (6.80)	5 (6.94)	
Tennant Creek	11 (10.68)	1 (1.39)	
Non-NT	9 (8.74)	1 (1.39)	
Profession			
Nurse/midwife/AHP	30 (29.13)	31 (43.06)	0.03[b]
RMP	36 (34.95)	14 (19.44)	
Retrieval organisation	4 (3.88)	9 (12.50)	
Specialist – emergency/retrieval	22 (21.36)	12 (16.67)	
Specialist - other	7 (6.80)	6 (8.33)	
Not known	4 (3.9)	0 (0.0)	
Employment type			
Agency/locum/casual	29 (28.16)	10 (13.89)	0.045[a]
Permanent/contract	74 (71.84)	61 (84.72)	
Not known	0 (0.0)	1 (1.39)	
Number of years working in the NT			
<3	24 (23.30)	9 (12.50)	0.010[c]
3–6	39 (37.86)	28 (38.89)	
7–10	18 (17.48)	10 (13.89)	
11–14	10 (9.71)	4 (5.57)	
≥15	12 (11.65)	21 (29.17)	

[a]Chi-square.

[b]Fisher's exact.

[c]Chi-square for trend.

non-NT locations. Proportionally less respondents to the post-implementation survey were RMPs.

Table 2 compares responses to the post-implementation survey with those of the pre-implementation survey for 30 different questions. Simple logistic regression showed that respondents to the post-implementation survey were more likely (odds ratio [OR] 3.64; 95% confidence interval [CI] 1.13, 11.78) to Agree or Strongly Agree that the response time between placing a call and receiving support for urgent care was generally acceptable compared to respondents to the pre-implementation survey. Adjusting for potential confounders, such as profession of the respondents made little difference to the OR (OR 3.51 [95% CI 1.04, 11.85]). Furthermore, under the new MRaCC/ROCC system the following improvements were perceived: response times between calling and ambulance

TABLE 2 Simple and multiple logistic regression models showing odds ratios for post-implementation survey responses predicting outcomes (ref = pre-implementation responses)

	Simple regression	Multiple regression
	Odds ratio (95% confidence interval)	**Odds ratio[a] (95% confidence interval)**
AHP/NURSE/DOCTOR in remote community and clinical support and guidance		
1. Response time (between placing call and receiving support) is generally acceptable	3.64* (1.13, 11.78)	3.51* (1.04, 11.85)
2. I have consistent access to clinical support and/or guidance by phone when I require it	2.61 (0.99, 6.88)	2.89 (0.88, 9.51)
3. I have immediate access to clinical support when I require it	2.44 (0.64, 6.07)	2.56 (0.71, 9.31)
4. I receive the necessary support and/or guidance to provide appropriate patient care	1.26 (0.40, 4.00)	
5. The health practitioner taking my call usually understands the conditions I work in	1.45 (0.61, 3.46)	
6. The clinical support/guidance systems serve the needs of the Northern Territory	1.82 (0.64, 5.21)	
Involved with SENDING patients from a remote community to Alice Springs Hospital		
7. The response time (between calling and ambulance dispatch) usually acceptable	2.97** (1.31, 6.73)	2.88* (1.23,6.79)
8. I am usually able to have immediate access to clinical advice on patient management	1.78 (0.63, 5.00)	
9. The clinician taking my call usually understands the conditions in which I work	0.95 (0.41, 2.24)	
10. My assessment of the patient's condition and need for evacuation is usually accepted	0.61 (0.24, 1.54)	
Clinicians RECEIVING patients at Alice Springs Hospital from remote communities		
11. The clinical information provided to me on the phone is usually clear and relevant	2.25 (0.69, 7.34)	5.90* (1.35, 25.74)
12. The clinical information accompanying the patient is usually clear and succinct	2.22 (0.73, 6.77)	2.22 (0.72, 6.86)
13. My instructions for clinical management prior to transfer are usually understood and implemented	[b]	
14. The patient pre-transfer and in-transit management is usually appropriate	2.75 (0.53, 14.20)	2.65 (0.51, 13.85)
15. Overall, the medical evacuation system serves the needs of people of the Northern Territory	2.73* (1.15, 6.49)	2.68* (1.12, 6.39)
People involved with air/ambulance evacuations		
16. Can you access the policies and procedures for medical evacuations/retrievals	2.59 (0.69, 9.68)	2.78 (0.73, 10.60)
17. I am familiar with the current policies/procedures for medical evacuations/retrievals in the NT	2.56 (0.95, 6.86)	2.56 (0.95, 6.86)
18. In my opinion, the current policy and procedure on medical retrieval escorts is clear	2.63* (1.17, 5.94)	2.63* (1.17, 5.94)
19. In my opinion, the current policy and procedure on medical retrieval escorts works well	4.95*** (2.18, 11.23)	4.95*** (2.18, 11.23)
Aspects of primary care practice		
20. My ability to remain knowledgeable and current with developments in my field of practice	2.50 (0.67, 9.39)	2.56 (0.58, 11.22)

TABLE 2 (Continued)

	Simple regression	Multiple regression
	Odds ratio (95% confidence interval)	**Odds ratio[a] (95% confidence interval)**
21. The freedom I have to make clinical decisions that meet my patients' needs	6.00 (0.74, 48.50)	6.29 (0.77, 51.29)
22. The time I have available to spend with each patient	2.42 (0.74, 7.89)	3.13 (0.90, 10.89)
23. Overall experience with practising my profession	4.83 (0.59, 39.6)	4.94 (0.60, 41.03)
24. The level of understanding others have of my scope of practice	1.29 (0.53, 3.15)	
25. I am expected to undertake clinical duties/ perform procedures/ provide treatments outside the scope of practice I am trained for	1.72 (0.26, 11.25)	
26. Non-urgent GP advice is easy to access	3.17* (1.00, 10.00)	3.09 (0.89, 10.70)
27. Non-urgent GP advice is available in an appropriate time frame	3.30* (1.04, 10.47)	3.19 (0.96, 10.55)
28. The non-urgent GP advice I receive is of high quality	3.23 (0.93, 11.18)	6.04* (1.08, 33.67)
29. When GP follow-up is required after initial advice, good continuity of care is maintained	3.54* (1.18, 10.65)	3.18* (1.02, 9.93)
30. Overall, this primary health care system serves the needs of people of the Northern Territory	1.65 (0.75, 3.63)	1.52 (0.68, 3.39)

Note: Final multivariate models adjusted for significant demographic and professional characteristics and an indicator of whether the respondents were supposed to answer the question (where relevant).

Key: *$p < 0.05$ **$p < 0.01$ ***$p < 0.001$.

[a]Odds ratio estimated if $p < 0.25$ in univariate analyses.

[b]All respondents to post-implementation survey agreed or strongly agreed, whereas only 72% of respondents to pre-implementation survey agreed or strongly agreed.

dispatch were more likely to be acceptable (OR 2.88; 95% CI 1.23, 6.79); it was more likely that clinical information provided on the phone to clinicians receiving patients at Alice Springs Hospital was clear and relevant (OR 5.9; 95% CI 1.35, 25.74); it was more likely that health professionals perceived that the medical evacuation system served the needs of people of the NT (OR 2.68; 95% CI 1.12, 6.39); and that policy and procedures on medical retrieval escorts were clear (OR 2.63, 95% CI 1.17, 5.94) and worked well (OR 4.95, 95% CI 2.18, 11.23). Several aspects of PHC advice were also perceived to be more favourable under the new MRaCC/ROCC system: non-urgent GP advice was more likely to be perceived as being of high quality (OR 6.04, 95% CI 1.08, 33.67); and it was more likely that respondents perceived that good continuity of care was maintained when GP follow-up was required after initial advice (OR 3.18, 95% CI 1.02, 9.93).

For each of these outcomes we conducted sensitivity analyses using ordered logistic regression which has greater sensitivity than logistic regression in detecting true differences because the outcome data are more granular (Table 3). Indirect analyses using ordered logistic regression detected an additional seven questions where there were statistically significant differences in perceptions of respondents to the pre- and post-implementation surveys, and one question where there was no longer any statistically significant difference. The additional seven questions where there were statistically significant differences, related to respondents to the post-implementation survey perceiving the following more favourably: health professionals in remote community had both consistent access to clinical support and/or guidance by phone when required; immediate access to clinical support when required; clinical support/guidance systems serving the needs of the people of NT; clinical information accompanying the patient was usually clear and succinct; patient pre-transfer and in-transit management was usually appropriate; non-urgent GP advice was easy to access; and non-urgent GP advice was available in an appropriate time frame. Ordered logistic regression found no difference between pre- and post-implementation surveys in the respondents' perceptions that the non-urgent GP advice they received was of high quality ($p = 0.057$), whereas responses to this question were statistically significant ($p = 0.04$) when analysed using multiple logistic regression analysis.

The numbers of respondents who had experience with both systems and who made direct comparisons between MRaCC/ROCC and the previous RMP-led system was between 22 and 37, with variations in the number of respondents depending on to which group of clinicians the question was directed (Table 4). Testing for linear trends revealed that 12 out of 18 questions had a statistically significant trend favourable to the MRaCC/ROCC system.

TABLE 3 Sensitivity analyses – Univariate and multivariate ordered logistic regression models for post-implementation survey responses predicting outcomes (ref = pre-implementation responses)

Question	Univariate	Multivariate
	Odds ratio (95% confidence interval)	Odds ratio[a] (95% confidence interval)
AHP/NURSE/DOCTOR in remote community and clinical support and guidance		
1. Response time (between placing call and receiving support) is generally acceptable	2.85** (1.30, 6.22)	3.19* (1.31,7.80)
2. I have consistent access to clinical support and/or guidance by phone when I require it	2.09 (0.98, 4.44)	3.24* (1.30,8.04)
3. I have immediate access to clinical support when I require it	2.34* (1.10, 4.94)	2.63* (1.17,5.94)
4. I receive the necessary support and/or guidance to provide appropriate patient care	1.84 (0.85, 3.98)	2.08 (0.83, 5.20)
5. The health practitioner taking my call usually understands the conditions I work in	1.16 (0.55, 2.43)	
6. The clinical support/guidance systems serve the needs of the Northern Territory	1.87 (0.83, 4.23)	3.67** (1.56,8.65)
Involved with SENDING patients from a remote community to Alice Springs Hospital		
7. The response time (between calling and ambulance dispatch) usually acceptable	2.59* (1.25, 5.37)	2.51* (1.18,5.33)
8. I am usually able to have immediate access to clinical advice on patient management	1.89 (0.90, 4.01)	1.77 (0.81, 3.90)
9. The clinician taking my call usually understands the conditions in which I work	1.05 (0.51, 2.16)	
10. My assessment of the patients' condition and need for evacuation is usually accepted	0.82 (0.39, 1.73)	
Clinicians RECEIVING patients at Alice Springs Hospital from remote communities		
11. The clinical information provided to me on the phone is usually clear and relevant	2.78 (0.91, 8.53)	13.83** (3.04,62.81)
12. The clinical information accompanying the patient is usually clear and succinct	2.39 (0.88, 6.48)	6.37** (1.75,23.13)
13. My instructions for clinical management prior to transfer are usually understood and implemented	5.12* (1.46, 17.99)	11.98** (2.43,59.07)
14. The patient pre-transfer and in-transit management is usually appropriate	5.73** (1.82, 17.98)	8.17** (2.18,30.67)
15. Overall, the medical evacuation system serves the needs of people of the Northern Territory	4.01*** (2.01, 8.00)	5.02*** (2.34,10.79)
People involved with air/ambulance evacuations		
16. Can you access the policies and procedures for medical evacuations/retrievals?	2.59 (0.69, 9.68)	2.40 (0.60, 9.68)
17. I am familiar with the current policies/procedures for medical evacuations/retrievals in the NT	2.34* (1.13, 4.84)	2.16 (0.98, 4.76)
18. In my opinion, the current policy and procedure on medical retrieval escorts is clear	3.07** (1.42, 6.62)	3.00** (1.36,6.62)
19. In my opinion, the current policy and procedure on medical retrieval escorts works well	3.76** (1.74, 8.13)	3.32** (1.50,7.37)
Aspects of primary care practice		
20. My ability to remain knowledgeable and current with developments in my field of practice	0.80 (0.36, 1.81)	

TABLE 3 (Continued)

Question	Univariate Odds ratio (95% confidence interval)	Multivariate Odds ratio[a] (95% confidence interval)
21. The freedom I have to make clinical decisions that meet my patients' needs	2.09 (0.89, 4.91)	2.24 (0.91, 5.51)
22. The time I have available to spend with each patient	1.78 (0.78, 4.06)	2.11 (0.86, 5.19)
23. Overall experience with practising my profession	1.77 (0.77, 4.11)	2.31 (0.93, 5.77)
24. The level of understanding others have of my scope of practice	0.94 (0.43, 2.04)	
25. I am expected to undertake clinical duties/perform procedures/ provide treatments outside the scope of practice I am trained for.	0.76 (0.32, 1.80)	
26. Non-urgent GP advice is easy to access	4.12** (1.55, 10.95)	3.85* (1.24,11.94)
27. Non-urgent GP advice is available in an appropriate time frame	3.65 (1.36, 9.78)	3.36* (1.08,10.49)
28. The non-urgent GP advice I receive is of high quality	2.35 (0.92, 6.05)	3.21 (0.97, 10.66)
29. When GP follow-up is required after initial advice, good continuity of care is maintained	3.48** (1.38, 8.82)	4.02* (1.26,12.77)
30. Overall, this primary health care system serves the needs of people of the Northern Territory	1.79 (0.87, 3.70)	1.51 (0.70, 3.26)

Note: Final multivariate models adjusted for significant demographic and professional characteristics and indicator (where relevant).

Key: *$p < 0.05$ **$p < 0.01$ ***$p < 0.001$.

[a]Odds ratio estimated if $p < 0.25$ in univariate analyses.

For example, there was a significant trend of respondents being able to get their urgent care work done efficiently with MRaCC/ROCC compared to the RMP-led model ($p < 0.001$). Overall, 62% indicated that MRaCC/ROCC was either a lot better or a little better than the previous RMP-led system in this regard.

Sensitivity analyses were conducted to test whether the responses to questions 1–8 about urgent care remained statistically significant if the responses of emergency and retrieval specialists were excluded from analyses (not shown). Even after removing these responses from analyses, we found statistically significant trends favourable to the MRaCC/ROCC system for six of the eight questions: optimal timeliness of transporting acutely unwell patients from remote communities was no longer perceived as being significantly better in the MRaCC/ROCC system. Nor were there any perceived differences between systems in keeping patients in the clinic for observation and avoiding evacuation if the responses of retrieval/ED physicians were excluded.

4 | DISCUSSION

The MRaCC/ROCC system, implemented in February 2018, was perceived by clinicians as performing better across a range of domains compared to the previous RMP-led system. These improvements included: the timeliness of consultations and retrievals for acute problems; timeliness of PHC advice and management; and system and clinician efficiency. Of the 48 survey questions, none were perceived more favourably in the direction of the previous RMP-led system. These findings are critically important as timeliness of pre-hospital treatment has been associated with improved patient outcomes for a range of clinical conditions including trauma,[19] myocardial infarct, stroke,[20] and sepsis.[21] Timeliness is also useful as an intermediate performance measure that reflects overall system efficiency and responsiveness.

Ultimately the overall objective of any health system is to optimise the quality of care and outcomes for patients using available resources.[22] Analysis revealed that clinicians tended to regard the appropriateness of pre-transfer and in-transit management of patients under the new MRaCC/ROCC system more favourably and were more likely to agree that the new medical evacuation system served the needs of the people of NT. Clinicians also perceived that patients with urgent conditions were kept under observation in remote clinics more frequently with the MRaCC/ROCC system, and evacuations were thereby avoided. It is unclear from the survey data whether or not keeping patients under observation for longer in remote communities was perceived as being appropriate and beneficial to patients. A more detailed exploration of this issue is required. Despite the extra PHC human resources that are required to manage and observe patients kept for longer in remote communities there was no difference in perceptions of respondents to the pre- and post-implementation

TABLE 4 Survey respondents' direct comparisons of MRaCC/ROCC with the previous RMP-led model

URGENT CARE problems	Total responses	Current system better *N* (%)	No difference *N* (%)	Previous system better *N* (%)	Chi-2
1. Get my work done efficiently	37	23 (62.16)	7 (18.92)	7 (18.92)	16.23***
2. Get quick advice from Emergency specialist	31	23 (74.19)	4 (12.9)	4 (12.9)	29.11***
3. Getting a high-quality clinical assessment of acutely unwell patients in remote communities	34	27 (79.31)	3 (8.82)	4 (11.76)	38.90***
4. Safely transporting patients from remote communities to hospital, taking into account environmental conditions	34	22 (64.71)	8 (23.53)	4 (11.76)	17.67***
5. Having optimal timeliness of transporting acutely unwell patients from remote communities to hospital	35	21 (60.00)	8 (22.86)	6 (17.14)	12.07***
6. Better health outcomes for patients in remote communities who are acutely unwell	34	21 (61.76)	9 (26.47)	4 (11.76)	18.82***
7. Use of telehealth	29	21 (72.41)	8 (27.59)	0 (0)	20.71***
8. Patients are kept in the clinic for observation, and evacuation is avoided	33	18 (54.55)	11 (33.33)	4 (12.12)	7.58**
URGENT CARE problems	**Total responses**	**Current system more often *N* (%)**	**No difference *N* (%)**	**Current system less often *N* (%)**	**Chi-2**
9. A patient is retrieved who could have been appropriately managed in the remote clinic	33	8 (24.24)	11 (33.33)	14 (42.42)	0.93
10. Remote clinic staff accrue overtime or require time off in lieu of time spent caring for acutely unwell patients in remote communities	24	11 (45.83)	9 (37.50)	4 (16.67)	0.94
11. A doctor in the remote community is called in to assist with an urgent problem	22	4 (18.18)	14 (63.64)	4 (18.18)	0.00
12. A patient is evacuated by road (eg. Half-way meet with St Johns Ambulance)	26	11 (42.31)	11 (42.31)	4 (15.38)	1.95
13. A patient is assessed as requiring evacuation and is evacuated by air	31	7 (22.58)	17 (54.84)	7 (22.58)	0.00
14. A patient is assessed as requiring evacuation and is evacuated by air at night	31	9 (29.03)	11 (35.48)	11 (35.48)	0.08
NON-URGENT primary health care problems	**Total responses**	**Current system better *N* (%)**	**No difference *N* (%)**	**Previous system better *N* (%)**	**Chi-2**
15. Getting my work done efficiently	28	15 (53.37)	11 (39.29)	2 (7.14)	8.93**
16. Getting patients' primary care problems attended to by a GP quicker	26	15 (57.69)	9 (34.62)	2 (7.69)	11.64***

TABLE 4 (Continued)

NON-URGENT primary health care problems	Total responses	Current system better *N* (%)	No difference *N* (%)	Previous system better *N* (%)	Chi-2
17. Quality of clinical care received by patients in remote communities who have non-urgent primary care problems	25	15 (60.00)	9 (36.00)	1 (4.00)	10.00**
18. Health outcomes for patients in remote communities who have non-urgent primary care problems	23	11 (47.83)	11 (47.83)	1 (4.35)	6.11*

Note: Key: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

surveys about the time they had available to spend with their primary care patients. This may be explained by the finding that clinicians perceived that they were able to get their work done more efficiently under the new MRaCC/ROCC system. This, too, can be explored further through interviews with remote PHC clinicians.

Some aspects of providing pre-hospital health care did not change with the introduction of the MRaCC/ROCC model. There was no difference, for example, in whether remote clinicians sending patients to Alice Springs perceived that the practitioner taking their call understood the conditions in which they worked, even though this was a concern expressed by clinicians prior to the implementation of the new model. Nor were there any substantial changes in clinicians' familiarity with and access to the policies and procedures documentation for medical evacuations, and retrievals associated with introduction of the new MRaCC/ROCC model. This suggests that there may be room for improvement in the transparency of, and education efforts related to evacuation and escort processes and policies, particularly since a lack of consistency in following existing policies, procedures and guidelines was a problem that was identified in the comprehensive system review in 2016 that led to the implementation of the new model in 2018.

4.1 | Limitations

This evaluation has a strong before and after design and sits within the framework of a comprehensive mixed methods MRaCC/ROCC evaluation. This means that survey findings will later be triangulated with other study data, including the results of quantitative analyses of NT Department of Health and Royal Flying Doctor Service data, patient outcome analysis, cost-effectiveness evaluation and qualitative findings emerging from thematic analysis of in-depth semi-structured interview data.

Notwithstanding these important strengths, we acknowledge a number of limitations related to these survey findings. Surveys did not capture perceptions of patients about the old and new models. The post-implementation survey was also distributed during the initial stages of the COVID-19 pandemic in Australia, and this may have negatively influenced the responses and response rates, although this was mitigated by allowing a longer period for responses to be received to the post-implementation survey. The pre-implementation survey was also distributed immediately prior to the launch of the new MRaCC/ROCC model at a time when there was resistance from some clinicians. This may have influenced who responded to the survey and how they responded and may also explain the significant differences between the pre- and post-implementation surveys in the characteristics of the respondents for some of the measured variables. Although these differences were taken into account in multivariate analyses there may be other (unmeasured) differences that were not adequately accommodated. In addition, with the indirect comparisons in the pre- and post-survey, respondents were anonymous, so it was not possible to pair the data and elucidate how responses of individuals changed over time.

Other limitations included: difficulty with attributing improvements in system efficiency entirely to the introduction of MRaCC/ROCC, as there may have been general system improvements at the remote community health care level occurring at the same time; somewhat low numbers of responses to the post-implementation survey from people who had experience of both models (n = 23–37); the potential for recall bias in the post-implementation survey when respondents were asked to directly compare the new MRaCC/ROCC model with the previous RMP-led model; and survey respondents who were directly or even indirectly involved with one or the other model may have been more likely to respond favourably about the model of which they were a part.

5 | CONCLUSIONS

Overall, the MRaCC/ROCC model was consistently perceived more favourably by clinicians compared to the

previous RMP-led model in terms of timeliness and efficiency for both urgent and non-urgent conditions. This suggests that there are benefits to having separate referral streams for telehealth advice for primary health care and emergencies and to staffing the emergency stream with specialists with advanced critical care skills. The results from this study, however, are based on perceptions and are yet to be triangulated with findings from analyses of qualitative and administrative data. Once this has been undertaken stronger conclusions can be drawn and recommendations made about the effectiveness of the new MRaCC/ROCC model. Given the paucity of literature about optimal models for providing pre-hospital medical care to remote patients, the survey findings nevertheless have substantial local, national and international relevance, particularly in similarly geographically large countries with low population density.

AUTHOR CONTRIBUTIONS

DG: data curation; formal analysis; writing – original draft. DR: formal analysis; funding acquisition; methodology; project administration; supervision; writing – review and editing. YZ: funding acquisition; methodology; supervision; writing – review and editing. SM: funding acquisition; writing – review and editing. MF: writing – review and editing. RJ: conceptualization; funding acquisition; validation; writing – review and editing. DR: validation; writing – review and editing. BH: validation; writing – review and editing. PN: validation; writing – review and editing. ZL: writing – review and editing. GM: conceptualization; data curation; investigation; methodology; project administration; supervision; writing – review and editing. MR: conceptualization; data curation; formal analysis; methodology; project administration; writing – review and editing. JW: conceptualization; data curation; funding acquisition; investigation; methodology; resources; supervision; validation; writing – review and editing.

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CONFLICT OF INTEREST

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DECLARATION OF INTEREST STATEMENT

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ETHICAL APPROVAL

The project was approved by the Central Australian Human Research Ethics Committee (Ref: CA-19-3320), with reciprocal approval by the Human Research Ethics Committee of the Northern Territory Department of Health and Menzies School of Health Research (Ref: 2019–3320).

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