Supporting Information

Supplementary material

This appendix was part of the submitted manuscript and has been peer reviewed. It is posted as supplied by the authors.

Appendix to: Luscombe GM, Wilson A, Ampt AJ, et al. Health service access and quality of care of the Western NSW Local Health District Virtual Rural Generalist Service: an analysis of linked administrative data. *Med J Aust* 2024; doi: 10.5694/mja2.52528.

Supplementary methods and results

Table 1: New South Wales Emergency Department Data Collection (EDDC) data list

Data Field	Purpose	Definition and codes
Socio-demographic data		
Age (years)	Descriptive	From 'age recode' (age difference in years between birth date and arrival date). Categorised as: 0-17, 18-49, 50-64, 65 or more
	Model confounder	Older people were defined as being 65 years or older if they were non-Aboriginal, or as being 50 years or older if they were Aboriginal. Binary categorisation: younger *v* older.
Sex	Model confounder	Derived from 'sex'. Note, fewer than n=5 presentations were coded other than male or female, i.e. indeterminate / intersex / not stated / unknown, therefore excluded from analysis. Binary categorisation: male *v* female.
Postcode of residence	Model confounder	*Socioeconomic status*: The patient's index of social disadvantage was assigned by linking their residential postcode with the corresponding Index of Relative Socio-Economic Disadvantage (IRSD; 1 [Most disadvantaged] to 5 [Least disadvantaged]) from Australian Bureau of Statistics (2016) *Socio-Economic Indexes for Areas (SEIFA)* www.abs.gov.au/websitedbs/censushome.nsf/home/seifa]. Binary categorisation: Most disadvantaged *v* else
	Model confounder	*Rurality*: assigned using the Modified Monash Model (MMM) scoring. The MMM reference data contains some individual postcodes with multiple suburb names and multiple MMM ratings, as well as some individual suburbs with multiple postcodes and multiple MMM ratings. To ensure accuracy, the postcode was concatenated with the suburb in both the EDDC and the MMM. Exact matches between these two datasets by the concatenated variable resulted in a matching rurality score. Binary categorisation: MM1-5 (metropolitan to small rural towns) *v* MM6-7 (remote, very remote communities).
Presentation clinical data		
Triage category	Model confounder	Binary categorisation: Resuscitation/emergency *v* else
ED referral source	Model confounder	Binary categorisation: Self/family/friends *v* else
Mode of arrival	Model confounder	Binary categorisation: Government transport (State Ambulance vehicle; Police/Correctional Services

Data Field	Purpose	Definition and codes
		vehicle; Air Ambulance Service; Internal ambulance/transport) *v* else
ED visit type	Model confounder	Binary categorisation: Emergency presentation/ disaster *v* else
Urgency related group major diagnostic block	Descriptive	Major diagnostic block categories, derived from SNOMED CT codes for ED presentation, based on the Independent Hospital Pricing Authority Urgency Related Group definitions (https://meteor.aihw.gov.au/content/684509).
Visit COVID-19 related	Model confounder	Derived from SNOMED CT codes for ED presentation: - 840544004 - Suspected disease caused by 2019 novel coronavirus (situation) - 1454671000168104 - History of recent travel to high risk COVID-19 region (finding) - 840539006 - Disease caused by 2019 novel coronavirus (disorder) - 840546002 - Exposure to 2019 novel coronavirus (event). Binary categorisation: ED visit COVID-19 related yes *v* no
Quality of Care Indicators		
Did not wait	Outcome	Derived from 'mode of separation'. Binary categorisation: Did not wait *v* else
Left own risk	Outcome	Derived from 'mode of separation'. Binary categorisation: Left at own risk *v* else
Transfer to another hospital	Outcome	Derived from 'mode of separation'. Binary categorisation: Transferred to another hospital without first being admitted to the hospital transferred from *v* else
Admitted	Outcome	Derived from 'mode of separation'. Binary categorisation: To ward/inpatient unit, not a critical care ward; Admitted: To critical care ward (including HDU/CCU/NICU) *v* else
Departed treatment completed	Outcome	Derived from 'mode of separation'. Binary categorisation: Treatment completed *v* else
Died in ED	Outcome	Derived from 'mode of separation'. Binary categorisation: Died in ED *v* else
Representation within 48 hours	Outcome	Defined as presentation from a VRGS ED to any ED within the WNSWLHD where: - index presentation was coded as treatment completed, did not wait, or left at own risk (from 'mode of separation') - representation was not pre-arranged nor a planned return visit (from 'ED visit type') - representation arrival date time was within 48 hrs of previous departure ready date time

Data Field	Purpose	Definition and codes
		Defined as the subset of representation within 48 hours within WNSWLHD where the representation was to the same VRGS facility. Binary categorisation: Representation within 48 hours yes *v* no
Time to departure less than 4 hours	Outcome	Time from arrival to departure was calculated using time stamps. In some instances, the time stamps reflected illogical values, e.g., departure time occurring before arrival time. Where this occurred, the data were excluded from analysis. Binary categorisation: time from arrival to departure within 4 hours *v* 4 hours or more.

Table 2: New South Wales Admitted Patient Data Collection (APDC) data list

Data Field	Purpose	Definition and codes
Socio-demographic data		
Age (years)	Descriptive	From 'age recode' (age difference in years between birth date and arrival date). Categorised as: 0-17, 18-49, 50-64, 65 or more
	Model confounder	Older people were defined as being 65 years or older if they were non-Aboriginal, or as being 50 years or older if they were Aboriginal. Binary categorisation: younger *v* older.
Sex	Model confounder	Derived from 'sex'. Note, fewer than n=5 presentations were coded other than male or female, i.e. indeterminate / intersex / not stated / unknown, therefore excluded from analysis. Binary categorisation: male *v* female.
Residential postcode	Model confounder	*Socioeconomic status*: The patient's index of social disadvantage was assigned by linking their residential postcode with the corresponding Index of Relative Socio-Economic Disadvantage (IRSD; 1 [Most disadvantaged] to 5 [Least disadvantaged]) from Australian Bureau of Statistics (2016) *Socio-Economic Indexes for Areas (SEIFA)* www.abs.gov.au/websitedbs/censushome.nsf/home/seifa]. Binary categorisation: Most disadvantaged *v* else
	Model confounder	*Rurality*: assigned using the Modified Monash Model (MMM) scoring. The MMM reference data contains some individual postcodes with multiple suburb names and multiple MMM ratings, as well as some individual suburbs with multiple postcodes and multiple MMM ratings. To ensure accuracy, the postcode was concatenated with the suburb in both the EDDC and the MMM. Exact matches between these two datasets by the concatenated variable resulted in a matching rurality score. Binary categorisation: MM1-5 (metropolitan to small rural towns) *v* MM6-7 (remote, very remote communities).

Admission clinical data		
Source of referral	Model confounder	Binary categorisation: Emergency Department *v* else
Admission status	Model confounder	Derived from 'emergency status'. Binary categorisation: Unplanned admissions *v* else
Day-only stay	Descriptive	Derived from same day separation flag and episode length of stay.
Potentially Preventable Hospitalisation	Model confounder	Potentially preventable hospitalisations (PPH) defined per the *National Healthcare Agreement: PI 18-Selected potentially preventable hospitalisations, 2021* (https://meteor.aihw.gov.au/content/740851). Binary categorisation: PPH yes *v* no
Care type	Model confounder	Derived from 'Episode of care type'. Binary categorisation: Acute care *v* else
Episode clinical complexity	Model confounder	Derived from the Australian Refined Diagnosis Related Groups Episode Clinical Complexity Model (www.ihacpa.gov.au/sites/default/files/2022-08/AR-DRG%20Version%2010.0%20Technical%20Specifications_0.pdf). An Episode Clinical Complexity Score (ECCS) for patient episodes is derived from the cumulative effect of assigning a diagnosis complexity level value for each diagnosis within the episode. Binary categorisation: least complex (ECCS 0 to 2) *v* most complex (ECCS >2 to 12.5)
Major diagnostic category	Descriptive	Major diagnosis category (MDC) for the Australian Refined Diagnosis Related Group (ARDRG) and the International statistical classification of diseases and related health problems, 10th revision, Australian modification (ICD 10) codeset.
Quality of Care Indicators		
Hospital Acquired Complication	Outcome	Hospital acquired complications (HAC) defined as per the Australian Commission on Safety and Quality in Healthcare (ACSQHC), Hospital Acquired Complications specification (Australian Commission on Safety and Quality in Health Care – ACSQHC's Hospital Acquired Complication (HAC 1) in release V 3.1: https://www.safetyandquality.gov.au/our-work/indicators/hospitalacquired-complications#hospital-acquired-complications - list). Binary classification: HAC present *v* absent
Transfer to another hospital	Outcome	Derived from 'mode of separation'. Binary classification: Transferred to other hospital *v* else
Discharged at own risk	Outcome	Derived from 'mode of separation'. Binary classification: Discharged at own risk *v* else

In hospital death	Outcome	Derived from 'mode of separation'. Differentiation between palliative care and non-palliative care death based on 'care type'. Binary classification: Died (autopsy)/died (no autopsy) *v* else
Unplanned readmission	Outcome	Unplanned readmission within 28 days was determined by longitudinal linkage to the full WNSWLHD APDC records using the unique patient identifier, arrival and departure dates and times, and facility names. The readmission was defined as being unplanned or not pre-arranged and occurring within 28 days after a previous hospital discharge or discharge at own risk, from a hospital with VRGS services available. Readmission to the same facility using these descriptors was also able to be captured. Binary classification: Unplanned readmission yes *v no*
Length of Stay outlier	Outcome	Length of stay (LOS) was defined as the duration (in days) between the start and end date of an admitted phase/episode, excluding leave days, where the episode of care includes the provision of accommodation and/or residential care as per NSW Health. *NSW Activity Based Funding and Activity Based Management Compendium 2021-22*. (2021). Episode LOS bounds were used to determine whether a patient's hospital stay was longer or shorter than the average LOS for a given Australian Refined Diagnosis Related Group (AR-DRG) class. Episodes were classified into inlier, same day, short or long stay outlier using the upper and lower bounds provided in the IHACPA *National Pricing Model Technical Specifications 2021-22* (https://www.ihacpa.gov.au/health-care/pricing/national-pricing-model-technical-specifications). Binary classification: Length of stay outlier yes *v no*

Table 3: Emergency Department presentations by doctor cohort, presented by facility (2021-2022)

Facility	Total number of Emergency Department presentations July 2021 – June 2022	Only non-VRGS doctor(s) (row %)	VRGS doctor(s) involved (row %)
	N=39 701	n=26 041	n=13 660
ED 1	151	18 (11.9%)	133 (88.1%)
ED 2	204	52 (25.5%)	152 (74.5%)
ED 3	261	123 (47.1%)	138 (52.9%)
ED 4	356	116 (32.6%)	240 (67.4%)
ED 5	445	177 (39.8%)	268 (60.2%)
ED 6	470	215 (45.7%)	255 (54.3%)
ED 7	642	330 (51.4%)	312 (48.6%)
ED 8	662	197 (29.8%)	465 (70.2%)
ED 9	745	258 (34.6%)	487 (65.4%)
ED 10	751	209 (27.8%)	542 (72.2%)
ED 11	812	83 (10.2%)	729 (89.8%)
ED 12	903	697 (77.2%)	206 (22.8%)
ED 13	906	133 (14.7%)	773 (85.3%)
ED 14	913	429 (47.0%)	484 (53.0%)
ED 15	1428	701 (49.1%)	727 (50.9%)
ED 16	1446	260 (18.0%)	1186 (82.0%)
ED 17	1482	904 (61.0%)	578 (39.0%)
ED 18	1513	917 (60.6%)	596 (39.4%)
ED 19	1517	1495 (98.6%)	22 (1.5%)
ED 20	1535	1338 (87.2%)	197 (12.8%)
ED 21	1733	1420 (81.9%)	313 (18.1%)
ED 22	1796	1348 (75.1%)	448 (24.9%)
ED 23	1878	752 (40.0%)	1126 (60.0%)
ED 24	1952	1260 (64.6%)	692 (35.5%)
ED 25	2033	926 (45.6%)	1107 (54.5%)
ED 26	2295	1685 (73.4%)	610 (26.6%)
ED 27	2404	1913 (79.6%)	491 (20.4%)
ED 28	3943	3896 (98.8%)	47 (1.2%)
ED 29	4525	4189 (92.6%)	336 (7.4%)

VRGS = Virtual Rural Generalist Service

Table 4: Emergency Department presentations by remoteness of Western New South Wales Local Health District facility (2021-2022)

Remoteness of facility	All presentations n (column %)	Only non-VRGS doctor(s) n (row %)	VRGS doctor(s) n (row %)
Number of presentations	56 164	26 041	13 660
Inner regional	6081 (10.8%)	3345 (70.0%)	1432 (30.0%)
Outer regional	31 262 (55.7%)	15 476 (68.1%)	7266 (31.9%)
Remote	16 003 (28.5%)	6303 (59.1%)	4366 (40.9%)
Very remote	2818 (5.0%)	917 (60.6%)	596 (39.4%)

VRGS = Virtual Rural Generalist Service

Table 5: Associations between quality of care measures for Emergency Department presentations and receiving care from the Virtual Rural Generalist Service, New South Wales, 2021-2022: adjusted multivariable analyses

	Treating doctor cohort		Adjusted odds ratio (95% confidence interval)	Variables adjusted for in the modelling*
	VRGS	Non-VRGS		
All presentations	13 660	26 041		
Did not wait	190 (1.4%)	104 (0.4%)	3.69 (2.79-4.89)	facility, older, mode of arrival, ED visit type, triage category
Left at own risk	417 (3.1%)	434 (1.7%)	1.90 (1.62-2.22)	facility, sex, older, mode of arrival, triage category
Transferred to another hospital	1023 (7.5%)	2689 (10.3%)	0.66 (0.60-0.72)	facility, sex, older, mode of arrival, triage category
Admitted	1273 (9.3%)	2076 (8.0%)	1.30 (1.19-1.43)	facility, sex, older, level of disadvantage, mode of arrival, triage category
Departed treatment completed	10 690 (78.3%)	20 588 (79.1%)	0.93 (0.87-1.00)	facility, sex, older, mode of arrival, triage category, ED visit type
Died in Emergency Department	6 (<0.1%)	24 (<0.1%)	1.17 (0.46-2.98)	facility, older, level of disadvantage, mode of arrival, triage category
Representation within 48 hours†				
to any WNSWLHD ED	1460 (10.7%)	2358 (9.1%)	1.25 (1.15-1.36)	facility, older, sex, mode of arrival, triage category, ED visit type, COVID-related
to the same ED	946 (6.9%)	1540 (5.9%)	1.42 (1.29-1.57)	facility, level of disadvantage, mode of arrival, triage category
Departed in less than 4 hours	11 247 (82.3%)	21 341 (82.0%)	0.92 (0.86-0.98)	facility, sex, older, source of referral, mode of arrival, ED visit type, triage category

COVID = coronavirus; ED = emergency department; VRGS = Virtual Rural Generalist Service; WNSWLHD = Western New South Wales Local Health District

† representation within 48 hours to any Emergency Department within Western New South Wales Local Health District includes to the same Emergency Department.

* Adjusted odds ratio adjusted for patient characteristics (socio-demographic and clinical) and for facility

Table 6: Episodes by doctor cohort, presented by facility (2021-2022)

Facility	Total number of inpatient episodes July 2021 – June 2022	Only non-VRGS (row %)	Combined group (row %)	Only VRGS (row %)
	N=6328	n=3794	n=1853	n=681
IP 1	22	1 (4.5%)	11 (50.0%)	10 (45.5%)
IP 2	32	9 (28.1%)	20 (62.5%)	3 (9.4%)
IP 3	47	2 (4.3%)	22 (46.8%)	23 (48.9%)
IP 4	53	8 (15.1%)	35 (66.0%)	10 (18.9%)
IP 5	64	19 (29.7%)	36 (56.3%)	9 (14.1%)
IP 6	84	12 (14.3%)	28 (33.3%)	44 (52.4%)
IP 7	116	3 (2.6%)	54 (46.6%)	59 (50.9%)
IP 8	124	46 (37.1%)	61 (49.2%)	17 (13.7%)
IP 9	138	102 (73.9%)	36 (26.1%)	0 (0%)
IP 10	141	4 (2.8%)	42 (29.8%)	95 (67.4%)
IP 11	163	34 (20.9%)	61 (37.4%)	68 (41.7%)
IP 12	165	64 (38.8%)	87 (52.7%)	14 (8.5%)
IP 13	165	104 (63.0%)	54 (32.7%)	7 (4.2%)
IP 14	166	95 (57.2%)	56 (33.7%)	15 (9.0%)
IP 15	192	111 (57.8%)	79 (41.1%)	2 (1.0%)
IP 16	221	44 (19.9%)	134 (60.6%)	43 (19.5%)
IP 17	225	164 (72.9%)	61 (27.1%)	0 (0%)
IP 18	228	162 (71.1%)	57 (25.0%)	9 (3.9%)
IP 19	255	190 (74.5%)	60 (23.5%)	5 (2.0%)
IP 20	300	213 (71.0%)	83 (27.7%)	4 (1.3%)
IP 21	302	193 (63.9%)	84 (27.8%)	25 (8.3%)
IP 22	326	241 (73.9%)	70 (21.5%)	15 (4.6%)
IP 23	326	96 (29.4%)	149 (45.7%)	81 (24.8%)
IP 24	350	344 (98.3%)	6 (1.7%)	0 (0%)
IP 25	354	56 (15.8%)	219 (61.9%)	79 (22.3%)
IP 26	385	294 (76.4%)	79 (20.5%)	12 (3.1%)
IP 27	420	361 (86.0%)	58 (13.8%)	1 (0.2%)
IP 28	427	299 (70.0%)	98 (23.0%)	30 (7.0%)
IP 29	537	523 (97.4%)	13 (2.4%)	1 (0.2%)

VRGS = Virtual Rural Generalist Service

Table 7: Inpatient episodes of care by remoteness of Western New South Wales Local Health District facility (2021-2022)

Remoteness of facility	All episodes n (column %)	Only non-VRGS doctor(s) n (row %)	Combined group n (row %)	Only VRGS doctor(s) n (row %)
Number of episodes	6732	3794	1853	681
Inner regional	972 (14.4%)	740 (76.8%)	201 (20.9%)	22 (2.3%)
Outer regional	3403 (50.5%)	1670 (52.4%)	1064 (33.4%)	454 (14.2%)
Remote	1883 (28.0%)	1090 (60.8%)	509 (28.4%)	193 (10.8%)
Very remote	474 (7.0%)	294 (76.4%)	79 (20.5%)	12 (3.1%)

VRGS = Virtual Rural Generalist Service

Table 8: Associations between quality of care measures for Admitted Patient episodes of care and receiving care from the Virtual Rural Generalist Service *v* non-Virtual Rural Generalist doctor, New South Wales, 2021-2022: adjusted multivariable analyses

	Treating doctor cohort		VRGS only *v* non-VRGS	
	VRGS only	Non-VRGS only	Adjusted odds ratio (95% confidence interval)	Variables adjusted for in the modelling
Number of patients	681	3794		
Hospital acquired complication†	0	29 (0.8%)	-	facility, rurality, source of referral, complexity
Transferred to another hospital	90 (13.2%)	600 (15.8%)	0.80 (0.60-1.01)	facility, sex, rurality, source of referral, admission status, PPH, care type, complexity
Discharged at own risk	29 (4.3%)	62 (1.6%)	3.33 (1.98-5.61)	facility, older age, sex, complexity
In hospital death	23 (3.4%)	157 (4.1%)	0.78 (0.48-1.28)	facility, older age, sex, source of referral, admission status, PPH, care type, complexity
Palliative care	10 (1.5%)	54 (1.4%)	1.10 (0.50-2.43)	facility, sex, rurality, source of referral, admission status, PPH, complexity
Non-palliative care	13 (1.9%)	103 (2.7%)	0.78 (0.42-1.44)	facility, older age, sex, PPH, complexity
Unplanned readmission within 28 days‡				
to any WNSWLHD facility	96 (14.1%)	489 (12.9%)	1.15 (0.88-1.49)	facility, source of referral
to same facility	72 (10.6%)	312 (8.2%)	1.60 (1.17-2.19)	facility, older age, level of disadvantage, source of referral
DRG-based long stay outlier*	41 (6.0%)	421 (11.1%)	0.51 (0.35-0.74)	facility, older age, sex, rurality, source of referral, PPH, care type, complexity

† Frequency of hospital acquired complication too small for modelling

‡ unplanned readmission within 28 days to any facility within Western New South Wales

* DRG-based LOS outlier: if the total length of stay was greater than the upper bound of stay for the Australian Refined Diagnosis Related Group version 10 (AR-DRGv10) assigned to the hospital admission

PPH, potentially preventable hospitalisations.

Table 9: Associations between quality of care measures for Admitted Patient episodes of care and receiving combined care (Virtual Rural Generalist Service & non-Virtual Rural Generalist Service doctor) *v* non-Virtual Rural Generalist doctor only, New South Wales, 2021-2022: adjusted multivariable analyses

	Treating doctor cohort		Combined *v* non-VRGS	
	Combined VRGS & non-VRGS	Non-VRGS	Adjusted odds ratio (95% confidence interval)	Variables adjusted for in the modelling
Number of patients	1853	3794		
Hospital acquired complication	21 (1.1%)	29 (0.8%)	1.34 (0.80-2.24)	facility, rurality, source of referral, complexity
Transferred to another hospital	414 (22.3%)	600 (15.8%)	1.41 (1.21-1.65)	facility, sex, rurality, source of referral, admission status, PPH, care type, complexity
Discharged at own risk	41 (2.2%)	62 (1.6%)	1.53 (0.99-2.35)	facility, older age, sex, complexity
In hospital death	95 (5.1%)	157 (4.1%)	1.21 (0.91-1.61)	facility, older age, sex, source of referral, admission status, PPH, care type, complexity
Palliative care	34 (1.8%)	54 (1.4%)	1.34 (0.80-2.24)	facility, sex, rurality, source of referral, admission status, PPH, complexity
Non-palliative care	61 (3.3%)	103 (2.7%)	1.15 (0.81-1.63)	facility, older age, sex, PPH, complexity
Unplanned readmission within 28 days‡				
to any WNSWLHD facility	206 (11.1%)	489 (12.9%)	0.86 (0.72-1.04)	facility, source of referral
to same facility	123 (6.6%)	312 (8.2%)	0.88 (0.69-1.12)	facility, older age, level of disadvantage, source of referral
DRG-based LOS outlier*	375 (20.2%)	421 (11.1%)	2.10 (1.74-2.53)	facility, older age, sex, rurality, source of referral, PPH, care type, complexity

‡ unplanned readmission within 28 days to any facility within Western New South Wales

* Diagnosis Related Group-based LOS outlier: if the total length of stay was greater than the upper bound of stay for the Australian Refined Diagnosis Related Group version 10 (AR-DRGv10) assigned to the hospital admission

PPH, potentially preventable hospitalisations.