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Cost-effectiveness of a community-based integrated care model compared with usual care for older adults with complex needs: a stepped-wedge cluster-randomised trial

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ABSTRACT

Objective To assess the cost of implementation, delivery and cost-effectiveness (CE) of a flagship community-based integrated care model (OPEN ARCH) against the usual primary care.

Design A 9-month stepped-wedge cluster-randomised trial.

Setting and participants Community-dwelling older adults with chronic conditions and complex care needs were recruited from primary care (14 general practices) in Far North Queensland, Australia.

Methods Costs and outcomes were measured at 3-month windows from the healthcare system and patient's out-of-pocket perspectives for the analysis. Outcomes included functional status (Functional Independence Measure (FIM)) and health-related quality of life (EQ-5D-3L and AQoL-8D). Bayesian CE analysis with 10 000 Monte Carlo simulations was performed using the BCEA package in R (V.3.6.1).

Results The OPEN ARCH model of care had an average cost of $A1354 per participant. The average age of participants was 81, and 55% of the cohort were men. Within-trial multilevel regression models adjusted for time, general practitioner cluster and baseline confounders showed no significant differences in costs, resource use or effect measures regardless of the analytical perspective. Probabilistic sensitivity analysis with 10 000 simulations showed that OPEN ARCH could be recommended over usual care for improving functional independence at a willing to pay above $A600 (US$440) per improvement of one point on the FIM Scale and for avoiding or reducing inpatient stay for any willingness-to-pay threshold up to $A50 000 (US$36 500).

Conclusions and implications OPEN ARCH was associated with a favourable Bayesian CE profile in improving functional status and dependency levels, avoiding or reducing inpatient stay compared with usual primary care in the Australian context.

Trial registration number ACTRN12617000198325.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ While the concept of integrated care is widely accepted and descriptive cost studies suggest cost savings, cost-effectiveness (CE) evidence is limited.

WHAT THIS STUDY ADDS

⇒ Using the Bayesian CE modelling, this study provides evidence on the CE of a flagship community-based integrated model of care (the OPEN ARCH model) delivered in 14 general practices in Far North Queensland of Australia.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The OPEN ARCH model of care may present a favourable option for addressing the complex needs of community-dwelling older adults with chronic conditions when compared with the usual primary care in the Australian context.

INTRODUCTION

To constrain increases in societal costs associated with care for frail older adults, government policies in many countries within the Organisation for Economic Co-operation and Development (OECD) aim to support older adults living independently at home for as long as possible.[1] Integrated care models, most commonly defined as case management, geriatric assessment or multidisciplinary teams have increasingly been implemented in response to the reactive and fragmented nature of care systems and the lack of involvement of older adults in their care process.[2]

The mixed methods evidence suggests that integrated care models could result in better outcomes and cost savings for society by preventing or postponing acute care use and long-term institutionalisation[3] as an effective strategy.[4–6] However, the cost-effectiveness (CE) evidence remains mixed according to the recent systematic literature review of the (cost-)effectiveness of preventive, integrated care for community-dwelling frail older people.[7]

Although the concept of integrated care is widely accepted and descriptive cost studies suggest potential cost savings,[8–12] data from adequately executed economic evaluations is limited.[13] Integrated care might be more cost-effective than usual care after 6[14] and 12 months[15 16] if society would be willing to invest substantially. Long-term effects beyond 24 months remain unknown. By and large, cost-effectiveness evidence of integrated care models for community-dwelling frail older adults remains inconclusive.[13–18]

In Australia's Far North Queensland region, an integrated model of comprehensive geriatric assessment (CGA), care coordination and rehabilitation was only available for hospital inpatients. The region has a population of 231 628 and covers over 80 041.5 km^2 (30 904.2 m^2). The major challenge of this region is meeting the primary health needs of a population that is regionally dispersed, culturally and socioeconomically diverse, growing in size and affected by a substantial chronic disease burden.[19] Health services are struggling to cope with demands, leading to avoidable hospitalisations and emergency department (ED) presentations particularly for older people.[19] Strivens *et al*, in a study on care transitions of older people across acute, subacute and primary care, identified fragmented subacute service provision and access potentially leading to a perverse incentive for hospital admissions to access inpatient geriatric services in the region.[20]

A community-based integrated care model (OPEN ARCH) was developed to address this gap by providing specialist geriatric assessment, care planning and enablement in the community for frail older people with complex needs at risk of hospitalisation or significant deterioration. OPEN ARCH successfully prevented a reduction in quality of life and slowed the functional decline expected in this population group.[21] However, it was also expected to result in additional cost. Therefore, it was important to weigh the balance between intervention and non-intervention costs with the health benefits following the integrated care model. This study aims to provide information on the cost of implementation, delivery and CE of the OPEN ARCH model of care compared with the usual primary care using Bayesian CE modelling.

METHODS

Study design and setting

The cost-effectiveness analysis (CEA) was conducted alongside a 9-month stepped-wedge cluster-randomised controlled trial, the OPEN ARCH study. Reporting of the CEA adheres to the Consolidated Health Economic Evaluation Reporting Standards 2022 Statement.[22]

This trial was registered with the Australian New Zealand Clinical Trials Registry, number ACTRN12617000198325. The full protocol for the trial, including a description and rationale for using the stepped wedge design, has been reported previously.[23] A summary is provided below.

Fourteen general practitioners (GPs) in the Far North Queensland region were randomised into three allocation groups using a computer-generated random allocation sequence (table 1). At least two GPs were commencing the intervention at each step to ensure that the intervention effect estimator maintained the nominal 5% significance level and was reasonably unbiased.[24 25] A total of 92 eligible patients were approached to consent to the study, 12 left the study before its commencement, 80 randomised patients were assessed and 72 completed the study.

Study participants

Study participants were community-dwelling older persons aged 70 or 50 and older if Aboriginal and/or Torres Strait Islander people (hereafter respectfully Indigenous) identified by their treating GPs as frail, at risk of imminent functional decline or hospitalisation, with chronic conditions and complex care needs. Residents of residential aged care facilities or those receiving existing specialist geriatrician intervention and/or care coordination, for example, via the Transition Care Program,[26] were deemed ineligible.

Table 1 Trial profile

	Time point (window)			
Allocation group	Period 1: BL (BL–3 months)	Period 2: 3 months (BL+3 months)	Period 3: 6 months (3–6 months)	Period 4: 9 month (6–9 months)
Group 1	e=29 (36%)	n=28 (36%)	n=26 (35%)	n=24 (33%)
Group 2	e=26 (33%)	n=25 (32%)	n=25 (34%)	n=25 (35%)
Group 3	e=25 (31%)	n=24 (31%)	n=23 (31%)	n=23 (32%)
Total	80 (100%)	77 (100%)	74 (100%)	72 (100%)

Note: Shaded cells represent intervention periods; white cells represent control periods. Group 1 included 5 general practitioners (GPs) and 29 participants. Group 2 included 5 GPs and 26 participants. Group 3 included 4 GPs and 25 participants. Data was collected on each participant at a 3 months point or window depending on the measure.
BL, baseline; e, number of assessed participants; n, number of participants remained in the study.

Intervention

The OPEN ARCH intervention delivered integrated care for community-dwelling frail people through systemised integration of primary and secondary care. This involved a preventative model of comprehensive assessment, coordination and management by colocated community-facing specialist geriatric and primary care services.

Participants had been identified by their treating GP as frail, at risk of imminent functional decline or hospitalisation, with chronic conditions and complex care needs and invited to take part in the OPEN ARCH model of care. Once consented, each participant was assigned an enablement officer (allied health or nursing) and a geriatrician. The OPEN ARCH model involved five stages of care: identification and referral, CGA, person-directed care planning, coordination of supports and transfer of care. The intervention was delivered in the primary care setting and featured a collaboration between the patient, treating GP, geriatric specialist and enablement officer. The full description of the intervention has been reported previously.[23 27]

Usual care

Until the start of the intervention, primary care practices and GPs provided usual care. GPs in Australia act as gatekeepers for the healthcare system and play an essential role in the organisation of community aged care. Usual care may consist of routine visits to GPs, referrals to teams, such as the Aged Care Assessment Team, or an outpatient clinic for geriatric assessment without multidisciplinary care coordination.

Measurement and valuation of resource use

Costs associated with health and social service use

Resource utilisation was collected in 3 months windows, for 3 months before the intervention, 3, 6 and 9 months after and included the following items: hospital separations with corresponding lengths of stay, ambulance transfers, ED presentations, the use of allied health, home and social support services. The data was collected from a review of hospital records and community clinical charts, collated by the study manager.

Resource use was costed from two perspectives: the health system and the health system and individual out-of-pocket costs, as a sensitivity analysis. Australian standard costs 2018–2019 were used to value resource use.[28–30] Because all costs and outcomes were observed within the same period, no discounting was required. Hospital admissions were assigned Weighted Activity Units (WAUs) using the 2018–2019 National Efficient Price Determination manual[28] and accounting for the actual length of stay derived from the hospital records. ED presentations were assigned WAUs associated with the Urgency Related Group code 7, which represents a typical presentation for this cohort.[28] WAUs were converted to a cost using the 2019–2020 National Efficient Price of US$5012.[28] Ambulance transfer costs were assigned to each ED presentation where the mode of arrival was via ambulance. An average cost per transfer of US$719 was assigned, consistent with Queensland Ambulance Service average costs per incident.[29]

Allied health occasions of service were costed using the relevant tier 2 clinic codes,[28] and patient out-of-pocket costs for these services were also recorded based on the Commonwealth Home Support Programme (CHSP) fee schedule.[30] The CHSP subsidises services provided to deliver home and social services to eligible recipients. The level of funding is per funding agreements negotiated with the provider and the Commonwealth, and as such, these costs are not publicly available. In the absence of data on the Commonwealth contribution amounts for CHSP home and social support services, following expert advice, a nominal amount of US$40 was assigned to represent the health service costs of each occasion of service. Patient out-of-pocket contributions were recorded within the OPEN ARCH study. Online supplemental appendix A table A.1 summarises the costs assigned to each resource use category.

Cost of intervention

The OPEN ARCH intervention cost was estimated per participant individually using a bottom-up approach. The cost of the OPEN ARCH intervention included the cost of geriatric consultations, the time investment from enablement officers and other support staff, equipment and materials detailed in online supplemental appendix A table A.2. The participants from group 1 and group 2 had two geriatric consultations, one of 60 min duration and one review of 30 min duration. The participants in group 3 had one geriatric consultation of 60 min duration, as they were in the study period for 3 months. They received a review appointment 6 months outside of the study period.

The geriatric consultations were costed according to the 2018 Medicare Benefits Schedule Item 141[31] and 143[31]; software licenses and materials were valued using the purchase price, and the time investment from enablement officers and other support staff was valued using national representative salary scales (online supplemental appendix A table A.1).

Effect measurement and valuation

Effect measurements were administered at 3 months windows, at baseline, 3, 6 and 9 months. Data was collected from direct follow-up with the participants. The primary clinical outcome was a change in functional status and dependency levels assessed using the Functional Independence Measure (FIM), with a score ranging from 18 (total dependence) to 126 (total independence).[32] Secondary outcomes included changes in health-related quality of life assessed using two generic multiattribute instruments, EQ-5D-3L[33] and AQoL-8D,[34] with utility scores expressed as 0 (full health) to 1 (death) derived using Australian preference weights.

Statistical analysis

We performed a Bayesian CE analysis with the bias-corrected percentile bootstrapping method (10 000 replications) using the BCEA package in R. We assessed the CE of each cost-effect pair using the incremental cost-effectiveness ratios (ICERs). Results were plotted on CE planes, cost-effectiveness acceptability frontier (CEAF), expected incremental benefit graph (EIB) and the expected value of perfect information (EVPI) at the willingness to pay (WTP) of US$25 000 per quality-adjusted life year (QALY) gained.[35]

- ICERs and CE plane were determined using the following formula:

$$\text{ICER}\ \left(\text{US\$ per effect}\right) = \frac{C_I - C_c}{E_I - E_c} \quad (1)$$

where C_I is the cost occurred during the intervention phase, E_I is the effect occurred during the intervention phase, C_c and E_c, respectively, the costs and effects of the comparator, usual care. For each cost-effect comparison, the 10 000 simulations were plotted on the CE plane and the ICER calculated.

- CEAF was calculated to show the probability of being the most cost-effective option, for the option with the highest average net benefit.
- EIB is the monetary value of the net benefit of the intervention and was determined by multiplying the effect by the WTP threshold (k), and subtracting the difference in costs:

$$\text{EIB}\left(\text{US\$}\right) = k\left(E_I - E_c\right) - C_I - C_c (2)$$

- EVPI was calculated to quantify the monetary (US$) value of reducing uncertainty in the model parameters through additional research. It is calculated by comparing the EIB of the current decision with the probable EIB given additional information on the model parameters. EVPI can be compared with the EIB (both at specified values of k) to determine if spending additional money on research to reduce parameter uncertainty might be worthwhile.

As part of the sensitivity analysis, we plotted CE planes at four different WTP thresholds, that is, US$0, US$15 000, US$30 000 and US$45 000 (online supplemental appendix B).

The analysis was performed according to the intention-to-treat principle. Missing data were replaced using five pooled multiple imputations via the mice package.[36] Linear mixed effects models and bootstrapped fixed effects were performed using the lme4 package.[37] All statistical analyses were performed in STATA V.15 and R (V.3.6.1). Online supplemental appendix C contains further details of the statistical analysis.

Power analysis

A power analysis was conducted to determine the ability to detect a clinically meaningful difference in FIM and EQ-5D-3L. Power analysis was performed using the swCRTdesign[38] package (online supplemental appendix C).

Patient and public involvement

Patients were not involved in the design of this study.

RESULTS

Participants

Table 2 provides the baseline characteristics of participants and differences across the allocation groups. The average age of participants was 81, 55% of the cohort were male and 15% identified as Aboriginal or Torres Strait Islander people. After the randomisation, significant differences were observed between the groups, including Indigenous status, English as a primary language, income source, caring situation and home support. For example, group 3 had fewer participants receiving pension and carer support when compared with group 1 and group 2, none were identified as Indigenous.

Effects

No statistically significant differences were observed in the effect measures between intervention and usual care phases (table 3). Although not statistically significant, FIM showed improvement in the intervention group.

Resource use

No statistically significant differences were observed in the resource use between intervention and usual care phases (table 3). Inpatient discharges and a corresponding average length of stay were lower in the intervention phases than in the usual care phases, although not statistically significant.

Costs

The average cost of the intervention was estimated to be US$1354 per person, ranging from US$703 to US$2575 (SD US$581). The adjusted mean difference in total costs between the intervention and usual care phases was US$1756 (p=0.109) and US$1811 (p=0.099) from the healthcare system perspective and a personal out-of-pocket perspective, respectively. Still, the results were not significant (table 3). Apart from the intervention cost, the cost of inpatient stay was the principal costs driver, accounting for around 60% of the mean total costs. Inpatient costs were somewhat lower in the intervention phases than usual care by US$227 (p=0.814), although not statistically significant.

CE analysis

Table 4 and figures 1.1, 1.2 and 1.3 present the results of the CE analysis within the trial period. After adjusting for covariates, within-trial analyses showed that the OPEN ARCH intervention was associated with higher, but not significantly, total costs regardless of the adapted perspective. For the CE analysis, we selected three outcomes that had shown some improvement during the intervention phase. These were FIM, inpatient stay and average length of stay (ALOS) (table 4).

Functional Independence Measure (FIM)

Figure 1.1 plots the ICER, EIB, CEAF and EVPI for the change in the FIM during the intervention phase compared with the control phase. The 10 000 Monte Carlo simulation on the CE plane shows the ICER of

Table 2 Baseline characteristics by allocation group

Characteristic	Total n=80	Group 1, n=29 (100%)	Group 2, n=26 (100%)	Group 3, n=25 (100%)	P value*
Age, mean±SD	80.71±7.06	80.37±6.2	79.15±9.46	82.72±4.36	0.189
Female, %	44 (55)	19 (65.52)	12 (46.15)	13 (52.0)	0.340
Indigenous, %	12 (15)	6 (20.69)	6 (23.08)	0 (0)	0.039
Primary language of English, %	77 (96.25)	0 (0)	3 (11.54)	0 (0)	0.039
Income source, %					
Pension	57 (71.25)	25 (86.21)	20 (76.92)	12 (48.0)	0.024
Part pension	17 (21.25)	1 (3.45)	6 (23.08)	10 (40.0)	
Self-funded	6 (7.5)	3 (10.34)	0 (0)	3 (12.0)	
Living situation, %					
Alone	28 (35)	12 (41.38)	6 (23.08)	10 (40.0)	0.572
Family	14 (17.5)	5 (17.24)	6 (23.08)	3 (12.0)	
Partner	38 (47)	12 (41.38)	14 (53.85)	12 (48.0)	
Caring situation, %					
Cares for others	3 (3.75)	1 (3.45)	2 (7.69)	0 (0)	0.007
Family carer	23 (28.75)	8 (27.59)	12 (46.15)	3 (12.0)	
No carer	54 (67.5)	20 (68.97)	12 (46.15)	22 (88.0)	
Home support, %	51 (64.56)	11 (37.93)	20 (76.92)	20 (83.33)	0.001
Carer support, %	11 (13.92)	6 (20.69)	2 (7.69)	3 (12.5)	0.379
Allied health, %	36 (45.57)	15 (51.72)	9 (34.62)	12 (50.0)	0.398
Advanced care plan, %	10 (12.5)	4 (13.79)	5 (19.23)	1 (4)	0.257
MMSE, mean±SD range 0–30	26.97 (4.39)	27.88 (1.72)	25.5 (6.57)	27.43 (3.45)	0.154

*Difference determined by χ^2 or analysis of variance at 0.05 level of significance.

US$535 per improvement of one point on the FIM Scale from the health system perspective. From the health system and personal perspective, the ICER was comparable (US$548), online supplemental appendix A figure 1. Most FIM cost-effect pairs were located in the CE plane's southwest quadrant (less costly, less effective).

At the WTP of US$25 000, EIB was −US$54 422 from the health system perspective and −US$54 311 from the health system and personal perspective. An optimal strategy would be to choose usual care for WTP below US$600 and OPEN ARCH intervention for WTP equal to or above US$600 per point improvement in FIM regardless of the adopted perspective.

The probability of OPEN ARCH being considered more cost-effective than the usual care was 86% at a WTP of US$0/point improvement, and this reduced to 13% at a WTP of US$15 000 and US$30 000/point improvement and 12% at a WTP of US$40 000/point improvement. Probabilities did not change with the adapted perspective. Typically, low values of the CEAC indicate the presence of a large amount of parameter uncertainty.[39] At a WTP of US$25 000, EVPI for the FIM was US$2895 from the health system perspective and US$2980 from the health system and personal perspective.

Inpatient stay

Figure 1.2 shows the results of the CE analysis for the inpatient stay. The estimated ICER for inpatient stay was US$9597 from the health system perspective, meaning that one avoided inpatient stay due to OPEN ARCH intervention was associated with an additional cost of US$9597 compared with usual care. The ICER for inpatient stay from the health system and personal perspective was US$9528 (online supplemental appendix A figure 1). Most inpatient cost-effect pairs were located in the southeast quadrant (less costly, more effective).

At a WTP of US$25 000, the EIB was US$4341 from the health system perspective and US$4353 from the health system and personal perspective. The probability that the intervention phases were considered more cost-effective than the usual care phases was 86% at the WTP of US$0/avoided stay, 92% at the WTP of US$15 000/avoided stay, 89% at the WTP of US$25 000 and US$30 000/avoided stay and 87% the WTP of US$40 000/avoided stay. Probabilities did not change with the adapted perspective. At a WTP of US$25 000, EVPI was US$163 from the health system perspective and US$174 from the health system and personal perspective.

Table 3 Summary of the costs and outcomes

Outcome	Cntrl (n=156)		Intvn (n=164)		Crude mean diff* (P value)	Unadjusted mean diff† (P value)	Adjusted mean diff† (P value)
	Mean	SD	Mean	SD			
Effect							
Functional independence	109.718	27.641	107.128	29.790	−2.590 (0.421)	3.312 (0.452)	3.583 (0.410)
Health utility (AQoL-8D)	0.670	0.195	0.651	0.206	−0.019 (0.404)	−0.007 (0.807)	−0.008 (0.761)
Health utility (EQ-5D-3L)	0.719	0.204	0.739	0.208	0.020 (0.388)	−0.013 (0.723)	−0.015 (0.674)
Resource use							
Inpatient, n	0.301	0.953	0.232	0.740	−0.070 (0.465)	−0.065 (0.619)	−0.089 (0.496)
ALOS, days	1.109	4.111	0.640	2.277	−0.469 (0.205)	−0.302 (0.589)	−0.415 (0.482)
Ambulance, n	0.173	0.535	0.171	0.465	−0.002 (0.967)	0.093 (0.298)	0.058 (0.510)
ED, n	0.250	0.678	0.226	0.754	−0.024 (0.762)	0.125 (0.327)	0.069 (0.577)
Allied health service, n	2.513	6.819	2.750	9.085	0.237 (0.793)	0.577 (0.612)	0.782 (0.502)
Home/social support service, n	12.603	32.947	14.701	33.760	2.099 (0.574)	2.352 (0.204)	1.749 (0.356)
Cost ($A)‡							
Inpatient	1767	6428	1233	4265	−535 (0.379)	−171 (0.856)	−227 (0.814)
Ambulance	125	385	123	334	−2 (0.967)	67 (0.298)	42 (0.510)
ED	243	659	219	732	−24 (0.762)	121 (0.327)	67 (0.577)
Allied health service	299	710	391	1358	92 (0.450)	161 (0.340)	189 (0.279)
Home/social support service	506	1320	588	1350	82 (0.584)	92 (0.218)	67 (0.375)
Intervention	–	–	1354	581	–	–	–
Total HS	2940	7345	2554	5199	−386 (0.587)	214 (0.846)	267 (0.806)
Patient OOP	149	428	165	427	16 (0.742)	28 (0.094)	22 (0.213)
Total HS and OOP	3089	7437	2719	5317	−370 (0.608)	238 (0.830)	317 (0.772)
Total HS including intervention	2940	7345	3908	5224	968 (0.174)	1747 (0.116)	1756 (0.109)
Total HS and OOP including intervention	3089	7437	4073	5341	984 (0.173)	1793 (0.110)	1811 (0.099)

*Intervention–Control.
†Based on an unadjusted and adjusted linear mixed effects model with fixed effect of time and treatment and random effect of group, with a nested random effect of general practitioner cluster in group, and participant ID. In the adjusted model, we included age, gender, indigenous status, primary language, income source, living situation, home support, carer support, allied health, advanced care plan and MMSE as covariates.
‡Rounded up to the nearest dollar.
ALOS, average length of stay; Cntrl, control phases; ED, emergency department; HS, health system; Intvn, intervention phases; OOP, out of pocket.

Average length of stay (ALOS)

The estimated ICER for ALOS was US$1922 per day reduction from the health system perspective (figure 1.3) and US$1876 per day reduction from the health system and personal perspective (online supplemental appendix A figure 1). Mosty of inpatient cost-effect pairs were located in the southeast quadrant (less costly, more effective).

At a WTP of US$25 000, the EIB was US$17 082 from the health system perspective, US$17 086 from the health system and personal perspective and the EVPI was US$970 from the health system perspective and US$1060 from the health system and personal perspective at the WTP of US$25 000. The probability that OPEN ARCH could be considered more cost-effective than the usual care in reducing the length of hospital stay was 87, and 86% at the WTP of US$0/reduced stay from the health system perspective and the health system and personal perspective respectively; 88% and 87% at the WTP of US$15 000/reduced stay; 87% and 86% at the WTP of US$25 000 and US$30,000/reduced stay; and 87% and 86% the WTP of US$40 000/reduced stay.

DISCUSSION

The increasing number of older people with multiple chronic health conditions and complex needs puts growing pressure on health and social care. A growing body of research suggests that integrated care models can result in better outcomes and cost savings for society by preventing or postponing acute care use and long-term initialisation.[3] This research is the first to examine the CE of implementing a flagship community-based integrated model of care for older people with multiple chronic conditions and complex care needs in the Far North

Table 4 Differences in costs and outcomes between intervention and usual care phases, ICER, percentage CE plane quadrants

Analysis	Observations, n		Cost*, $A	Effect* (Intvn–Cntrl)	ICER†	CE plane, %				Probability that OPEN ARCH is cost-effective at WTP for 100% improvement				
	Cntrl	Intvn				NW	NE	SW	SE	WTP US$0	WTP US$15 000	WTP US$25 000	WTP US$30 000	WTP US$45 000
Health system perspective														
FIM	156	164	1756 (0.109)	3.583 (0.410)	535	12	2	76	10	0.86	0.13	0.12	0.13	0.12
Inpatient stay	156	164	1756 (0.109)	−0.089 (0.496)	-9597	2	12	15	71	0.86	0.92	0.89	0.89	0.87
ALOS	156	164	1756 (0.109)	−0.415 (0.482)	−1922	2	11	13	74	0.87	0.88	0.87	0.87	0.86
Health system and personal perspective														
FIM	156	164	1811 (0.099)	3.583 (0.410)	548	13	1	75	11	0.86	0.13	0.12	0.12	0.12
Inpatient stay	156	164	1811 (0.099)	−0.089 (0.496)	−9528	2	12	15	71	0.86	0.92	0.90	0.89	0.87
ALOS	156	164	1811 (0.099)	−0.415 (0.482)	−1876	2	12	13	73	0.86	0.87	0.86	0.86	0.86

For plane distribution, NW (North West quadrant)=more costly, less effective; SW (South West quadrant)=less costly, less effective; NE (North East quadrant)=more costly, more effective; SE (South East quadrant)=less costly, more effective.
Shaded area represents based-case analysis.
*Based on adjusted linear mixed effects model with fixed effect of time and treatment and random effect of group, with a nested random effect of general practitioner cluster in group, and participant ID; adjusted for age, gender, Indigenous status, primary language, income source, living situation, home support, carer support, allied health, advanced care plan and MMSE as covariates.
†Result of 10 000 Monte Carlo simulations.
ALOS, average length of stay; CE, cost-effectiveness; Cntrl, control phases; FIM, Functional Independence Measure; ICER, incremental cost-effectiveness ratio; Intvn, intervention phases; OPEN ARCH, community-based integrated care model; WTP, willingness to pay.

Queensland region of Australia. Fourteen GPs led the new integrated care model into practice. The intention was to reduce potentially preventable hospital use by moving specialist care out of hospitals and into the community. The aim was to improve coordination between service providers to make care flexible and responsive to the needs of local populations. The reduction of hospital use among older frail people with chronic conditions has previously shown improvement in their quality of life.[40 41]

This flagship model of care had an average cost of $A1354 per participant. The average age of participants was 81, 55% of the cohort were men. Within-trial analysis showed no significant differences in resource use and effect measures between the intervention (OPEN ARCH) and control phases (usual primary care). At the same time, FIM, inpatient stay and ALOS outcomes demonstrated a positive shift. These outcomes were further tested in Bayesian CE modelling.

Bayesian CE modelling with 10 000 Monte Carlo simulations showed that if decision-makers are willing to pay above $A600 per improvement of one point on the FIM Scale, the OPEN ARCH model of care could be recommended over usual primary care for older people with multiple chronic conditions and complex care needs. Further, OPEN ARCH could be recommended over usual care to avoid or reduce inpatient stay for any WTP a threshold of up to $A50 000. The impact of OPEN ARCH on improving health-related quality of life remained inconclusive and discussed elsewhere.[42]

Evaluation results of the OPEN ARCH model of care were broadly consistent with other evaluations of integrated care or home visiting programmes aimed at frail older adults.[13–15 18 43 44] For example, the Vanguard 'New Care Models' was one of the large-scale programmes to integrate health and social care services rolled out across fifty local areas in England.[44] Similarly to OPEN ARCH, the first evaluation of the Vanguard programme 'achieved only some of its aims but took time to show an effect'.[44] The programme slowed the rise in emergency admissions to hospital among care home residents. Still, it did not significantly reduce total bed days.

Evaluations of integrated care initiatives have been often criticised for being too short to allow full implementation or have an effect on outcomes.[45] Mixed-method studies have highlighted that integrated models of care can take time to be operationalised before generating expected results,[46] further suggesting that 'integrated care policies should not be relied on to make large reductions in hospital activity in the short-run'.[44] Previous studies evaluating preventative home visits without an integrated care approach found that such interventions resulted in lower costs only in the third year of follow-up.[11 47]

It is worth mentioning that the average age of the participants in this study was 81 years old. An earlier start with OPEN ARCH in the community might result in more significant changes in resource use, functional independence and health-related quality of life. It may also be that it takes longer than the follow-up of 9 months before the

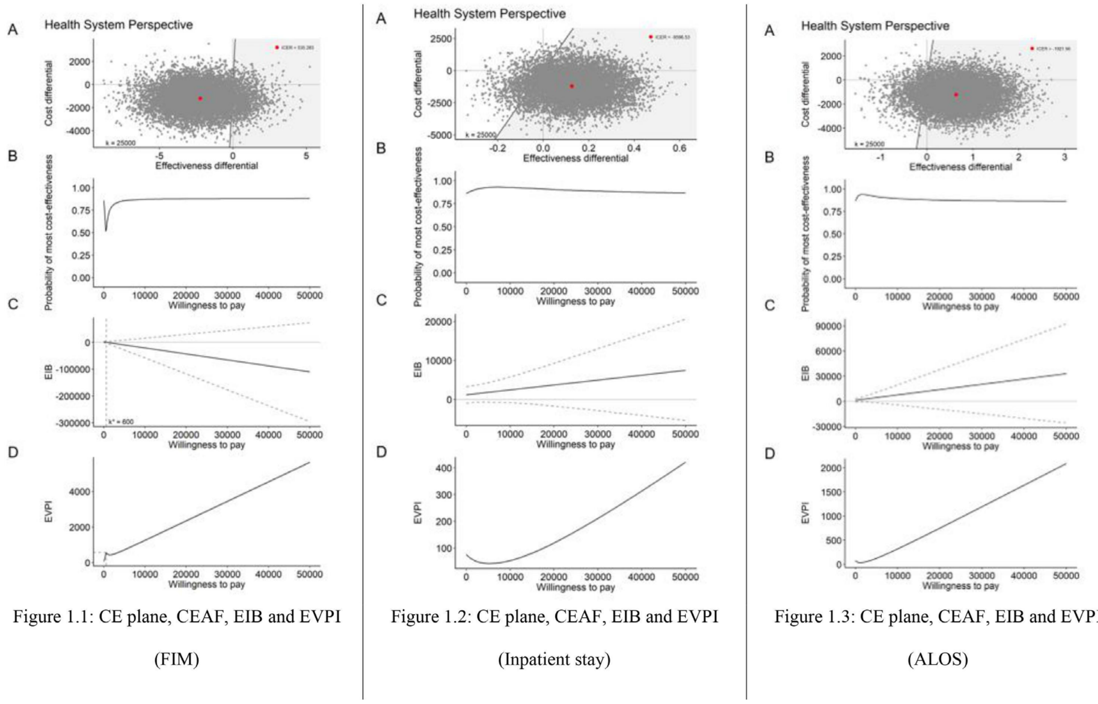

Figure 1 Cost-effectiveness (CE) plane, cost-effectiveness acceptability frontier (CEAF), expected incremental benefit graph (EIB) and expected value of perfect information (EVPI) from health system perspective Note: (A) CE plane. Each point represents the result of a simulation. The line in the plot represents the willingness-to-pay threshold, with slope equal to the value of US$25 000. Points below the line are cost-effective while those above it are not. (B) EIB; (C) CEAF; (D) EVPI.

development of local networks, the building of expertise, and the use of preventative actions as initiated within the model lead to clinical effects and cost savings. Increasing the impact of a care model depends not only on the effectiveness of its components but also on the extent and quality of its implementation.[48] These assumptions are speculative and require empirical testing. A discussion of other potential reasons had been provided elsewhere.[42]

Some limitations should be considered when interpreting the results of this study. Despite positive feedback from participants and their carers, the OPEN ARCH trial achieved a non-statistically significant effect on healthcare utilisation, functional status and quality of life.[21] We followed recommendations for presenting non-significant results in practice[49] and applied Bayesian CE modelling to further examine the impact of the intervention with 10 000 simulations. Model-based CEA is ideally positioned to explain how well an intervention could work.[48] A long-term mixed methods evaluation of OPEN ARCH is warranted to confirm its CE profile. If GP practice randomisation is employed in future evaluations, greater attention should be paid to the participant recruitment process to reduce selection bias.

CONCLUSIONS AND IMPLICATIONS

We conclude by acknowledging that Bayesian modelling demonstrated the potential CE of the OPEN ARCH model of care compared with usual primary care for older people with multiple chronic conditions and complex care needs. The CE profile resonated with qualitative findings obtained from participants and their carers.[21]

Improving care for older patients with complex care needs and multimorbidity is a high priority worldwide. Developing evidence-based integrated care programmes for people at high risk that are effective and cost-effective is crucial. This study echoes the challenges in evaluating complex interventions designed for older people. It contributes to the growing work in evaluating health and social care services using a pragmatic stepped-wedge cluster-randomised trial design and model-based CE analysis as an evaluation tool in advancing this priority.

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