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Right-Site Care Programme with a community-based family medicine clinic in Singapore: secondary data analysis of its impact on mortality and healthcare utilisation

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ABSTRACT

Objective Stable patients with chronic conditions could be appropriately cared for at family medicine clinics (FMC) and discharged from hospital specialist outpatient clinics (SOCs). The Right-Site Care Programme with Frontier FMC emphasised care organised around patients in community rather than hospital-based providers, with one identifiable primary provider. This study evaluated impact of this programme on mortality and healthcare utilisation.

Design A retrospective study without randomisation using secondary data analysis of patients enrolled in the intervention matched 1:1 with unenrolled patients as controls.

Setting Programme was supported by the Ministry of Health in Singapore, a city-state nation in Southeast Asia with 5.6 million population.

Participants Intervention group comprises patients enrolled from January to December 2014 (n=684) and control patients (n=684) with at least one SOC and no FMC attendance during same period.

Interventions Family physician in Frontier FMC managed patients in consultation with relevant specialist physicians or fully managed patients independently. Care teams in SOCs and FMC used a common electronic medical records system to facilitate care coordination and conducted regular multidisciplinary case conferences.

Primary outcome measures Deidentified linked healthcare administrative data for time period of January 2011 to December 2017 were extracted. Three-year postenrolment mortality rates and utilisation frequencies and charges for SOC, public primary care centres (polyclinic), emergency department attendances and emergency, non-day surgery inpatient and all-cause admissions were compared.

Results Intervention patients had lower mortality rate (HR=0.37, p<0.01). Among those with potential of postenrolment polyclinic attendance, intervention patients had lower frequencies (incidence rate ratio (IRR)=0.60, p<0.01) and charges (mean ratio (MR)=0.51, p<0.01). Among those with potential of postenrolment SOC attendance, intervention patients had higher frequencies (IRR=2.06, p<0.01) and charges (MR=1.86, p<0.01).

Conclusions Intervention patients had better survival, probably because their chronic conditions were better managed with close monitoring, contributing to higher total outpatient attendance frequencies and charges.

Strengths and limitations of this study

- This study used healthcare administrative data from a large consolidated database that covered separate episodes of care across different healthcare settings linked to each individual, eliminating recall errors that would arise from self-reported healthcare utilisation.
- The use of person-level administrative data allowed for selection of controls matched to each patient, which would otherwise not be possible if the administrative data were aggregated at hospital-level or national-level.
- The use of matched controls for comparisons allowed for isolating intervention programme's effects on utilisation frequencies and charges, as it took into account the regression to the mean that could occur in both groups even without intervention.
- The follow-up period of 3 years allowed for the evaluation of the long-term effects of these large-scale real-world programmes, providing relevant evidence for improving integrated care in Singapore and similar health systems.
- The matching of controls was limited by the available information recorded in the administrative database, and so this quasiexperimental study design may not be considered as rigorous as a randomised control trial.

INTRODUCTION

With a rapidly ageing population and increased chronic disease prevalence, there is a rising demand for hospital services and increasing burden on healthcare systems.[1 2] With finite healthcare resources,

optimisation of resources is key in avoiding the crippling of the healthcare system. Without change in the trajectory of demand for hospital resources, or innovative care models to transform how care is delivered, concerns are that the current hospital capacity remains insufficient or inefficient in meeting demand.[3–5] If no active steps are taken to intervene, patients could experience longer wait times[4 6] as well as shorter consultation times with their physicians[7] than current state. This could particularly affect specialist outpatient clinics (SOCs) within hospitals that are providing high volume of postacute or long-term chronic disease management care, leading to increasing waiting time for patients to obtain appointments. Additionally, with the increase in prevalence of patients with multimorbidities, patients would have to shuttle between multiple SOCs and would experience the aforementioned problems multiplied. A shift from hospital-centric care to integrated care with strong community-based care as provided by primary care or family medicine physicians is thus a crucial move needed to cope with the rising healthcare burden.[8]

The addition of community-based care on top of specialist care as part of shared care models have been shown to lead to reduced healthcare costs,[9–11] greater satisfaction[9–11] and comparable if not better patient health outcomes,[9–13] compared with specialist care alone. Primary care physicians anchored in the community have greater accessibility and can have repeated contacts with patients through an extended period of time. They are thus in the best position to establish strong relationships with patients and provide continuity of care which have both been shown to be key in improving patient health outcomes and satisfaction.[14 15] Primary care physicians can be better supported to care for and manage patients with chronic conditions, with increased direct access and tele-consultation with specialist physician colleagues,[16] and appropriate additional training when needed.[17–20] Family medicine clinics (FMCs) that have a care team of primary care physicians, care coordinator, nurse, pharmacist and allied health professionals can be used to divert patients with chronic conditions from the SOCs in the hospitals and potentially help reduce overcrowding and long wait times.[21]

Singapore is a city-state nation located in Southeast Asia with a total population of 5.6 million in 2017, of which over 3.9 million are citizens and permanent residents.[22] The population has an ethnic composition of 74.1% Chinese, 13.4% Malays, 9.2% Indians and 3.3% Others,[23] and a life expectancy of 82.9 years.[22] The public healthcare system in Singapore was structured as Regional Health Systems (RHS), integrating hospitals with primary and community care partners within a geographical region.[24] The public healthcare system covers about 80% of the total acute inpatient needs, and public hospitals receive government subvention to provide subsidised care to the population of citizens and permanent residents.[25] Patients may receive government subsidies, insurance coverage or funding from safety net programmes, before they pay out-of-pocket for acute care.[25 26] In Singapore, there are about 1700 private primary care physician clinics that cover about 80% of the total primary care demand,[27] but handle about 60% of the chronic disease-related attendances in primary care.[28] The other 20% of primary care demand is covered by public health system with polyclinics, which are large primary care centres in the community. Polyclinics see a large volume of patients during fixed hours of operations each day, without necessarily the same dedicated physician assigned to each patient from visit to visit, and with subsidised rates for citizens and permanent residents.

In 2013, within the National University Health System (NUHS) RHS in Singapore, there were over 600 000 unique attendances at the SOCs in its primary acute hospital, National University Hospital (NUH). This was a significant rise from just under 500 000 unique attendances in 2009.[29] In response to the increasing workload of the SOCs, NUHS RHS launched the Right-Site Care Programme in 2014 with Frontier FMC being the main community partner. The goal of the programme was to improve timely discharge of stable patients with chronic conditions from the SOCs and to provide them with seamless person-centred care. The programme was designed to achieve the objective to have 'right-siting' of healthcare services, that is, to have 'patients treated in the most appropriate locations by medically-competent teams at the lowest possible cost'[30] to achieve the same or better outcomes.

Frontier FMC was developed using a modified version of the National Committee for Quality Assurance's patient-centred medical home (PCMH) model of care to deliver patient-centred care through primary care.[31–33] The PCMH model has been shown to improve patient access to care[34] and the management of chronic diseases in the USA.[35] Patients with chronic conditions that were managed by a PCMH practice were found to have reduced number of hospital emergency department attendances[36–39] and improved medication adherence.[40] Designed as a patient-centred primary care centre anchored in the community to provide comprehensive care for chronic conditions in a single convenient location, Frontier FMC was easily accessible by public transportation. Frontier FMC provided a convenient and accessible 'one-stop shop' for medical services. The Right-Site Care Programme with Frontier FMC was expected to provide patients with shorter appointment wait times and consolidation of care for multimorbidities by reducing the need for multiple appointments to different specialist physicians.

The Right-Site Care Programme received national funding from the Ministry of Health in Singapore since 2014. Before further scaling up of the programme, it would be important to systematically determine the impact of the programme in reducing utilisation of SOCs, and potentially other related hospital-based healthcare services. The aim of the current study was thus to evaluate the impact of the Right-Site Care Programme with

Frontier FMC in reducing mortality, healthcare utilisation frequencies and healthcare utilisation charges.

METHODS

Study design

This is a retrospective quasiexperimental study using secondary data analysis. Comparisons of 3 year pre-enrolment and postenrolment healthcare utilisation frequencies and charges were made for patients that were right-sited to Frontier FMC from January to December 2014, and for their matched controls that were not part of this intervention programme.

Patient and public involvement

Patients and the public were not involved in the designing or conducting of this study.

Setting

The NUHS RHS works with various partners to care for patients in the Western region of Singapore. The primary acute hospital NUH was one of two public tertiary hospitals in Singapore and had close to 700 specialist physicians over 20 specialties.[41] Frontier FMC, which was located in a shopping mall easily accessible by the Mass Rapid Transit train system and public transportation, had a team of three resident primary care physicians. For the time period from which the healthcare utilisation data were extracted (January 2011 to December 2017), NUHS RHS was one of six RHSs in Singapore until January 2017, when the NUHS RHS underwent a merger with the JurongHealth RHS, and is currently one of three RHSs in Singapore.

Intervention

Patients with chronic conditions that were stable as determined by clinical judgement, with at least one NUH SOC appointment in the past year, and were deemed suitable for care to be anchored in the community, may be enrolled under the Right-Site Care Programme with Frontier FMC. Specialist physicians reviewed the patients to identify suitable patients to be enrolled into the programme and directed them to the care coordinators sited in the SOC if they were interested in the programme. Selected suitable patients would meet with the care coordinators who provided information on the programme and Frontier FMC and provided financial counselling. Patients did not receive any financial incentives to enrol in the programme. The increased accessibility and convenience, reduction in number of visits with consolidation of care and potential time and cost savings were highlighted as benefits of the programme. For the patients that were enrolled in the programme, the care coordinators provided a referral memo that was also documented in the common electronic medical records (EMR) system and assisted in booking an appointment with Frontier FMC. The enrolment to this programme was not time-limited and the patients could continue to use the healthcare services provided by Frontier FMC as long as they wished. As with such real-world programmes, patients had the freedom to choose their care and may choose to return to the hospital specialist physicians even after enrolment into the Right-Site Care Programme. In addition, Singapore has a porous healthcare system where patients may seek care at any institution, although the percentage of patients with cross-institution utilisation is low at less than 10%.[29]

The family physician in Frontier FMC managed the enrolled patient either through a 'shared care' model, that is, in combination with relevant specialist physicians but at reduced frequency of visits or a 'fully discharged to primary care' model, that is, fully managed by the family physician. Under the 'shared care' model or any referral of the patients from Frontier FMC back to relevant specialist physicians in NUH SOCs due to worsening or previously undetected conditions, patients would have visits to both Frontier FMC and NUH SOCs. With a common EMR system between the SOCs and Frontier FMC, care teams in the SOCs and at the FMC could easily review care delivered across settings by different providers and monitor patients' conditions over time, to enable care continuity. This is a first for any private FMC to have a common EMR system with a public healthcare institution. The family physician in Frontier FMC was supported by a team of healthcare workers when needed, comprising a care coordinator, a nurse (for chronic disease counselling), a pharmacist and allied health professionals such as a dietician and a psychologist. Regular multidisciplinary case conferences were conducted to allow the Frontier FMC care team to discuss and make necessary and timely adjustments to the patient's care plans.

As a close partner of NUHS, the consultations and multidisciplinary case conferences that the family physicians in Frontier FMC have with the specialist physicians in the SOCs were out of their own time without financial reimbursement for both the family physicians and the specialist physicians. Frontier FMC does not charge the patients differently for their care as part of being in this programme of having been referred from the SOC, but would have more expensive pricing for care provided by the public healthcare sector. However, Singaporean patients with monthly income of less than SGD$1800 receiving care at a private clinic, such as Frontier FMC, were able to use the Community Health Assist Scheme to receive subsidised rates for consultation and clinical lab tests for chronic disease.[26 42] In addition, Singaporean and permanent resident patients that have worked in Singapore and contributed to the Central Provident Fund can also use Medisave to pay for outpatient care in the public and private healthcare system.[43] The programme would hence shift care for these patients to the community with costs similar to specialist care.

Population

Patients enrolled in the Right-Site Care programme and who had an actualised first visit to the FMC between

January 2014 to December 2014 were classified into the intervention group. Patients that already had used Frontier FMC before being referred there as part of this programme were not included in the population cohort used for analyses in this study to reduce any additional unaccountable confounding effects. Only patients referred to the programme from the top five specialty departments of Cardiology, Endocrinology, Gastroenterology, Neurology and Rheumatology were included. This was to limit variability of the study population and to ensure that departments indicative of being in the more nascent stages of implementing this programme were not included. These patients were matched to controls who were patients with at least one SOC attendance in one of these department at NUH from 2011 to 2014 but not enrolled in the programme and without any attendances to Frontier FMC from 2011 to 2017. Matching was conducted with one matched control for every intervention patient selected from the same pool of 11 283 potential controls by propensity score matching (detailed below).

Data sources

This study used data from the Integrated Population Health Management (PHM) database[29] from the National Healthcare Group (NHG) Health Services & Outcomes Research department. The Integrated PHM database included data for over 2.3 million individuals. The database contained data from NUH, Ng Teng Fong General Hospital, Alexandra Hospital and Tan Tock Seng Hospital, which make up four of the seven major public acute hospitals in Singapore. The database also contained data from NHG Polyclinics, which in Singapore make up 10 out of the 19 polyclinics, as well as from Frontier FMC.

The list of patients enrolled in the Right-Site Care Programme were collated by the programme's care coordinator team and submitted to the appointed data intermediary, who was a staff in NUHS that was not part of the research team. The data intermediary submitted the list of patients to the Principal Investigator of the Integrated PHM database. Healthcare utilisation data from all 4 hospitals, 10 polyclinics and Frontier FMC were extracted from the database for the time period of January 2011 to December 2017 and passed to the data intermediary. All data were deidentified to a study identification number by the data intermediary before passing to the research team. All electronic files with personal data were password-protected, transferred with password-protected encrypted external hard drives and saved in a folder accessible only within the intranet in NUHS and only by the data intermediary. The above procedures were reviewed and approved by the ethics review board, the NHG Domain Specific Review Board. The use of the deidentified data for research was in accordance with the criteria set out in second, third and fourth schedules of the Personal Data Protection Act in Singapore.[44]

Outcome measures

Attendances to Frontier FMC were calculated for the 3-year period after the point of enrolment (POE). Adherence to the Right-Site Care Programme was assessed by determining if intervention patients had at least one Frontier FMC attendance per year for all 3 years of the postenrolment period. Healthcare utilisation frequencies and charges were calculated for the 3-year period before and after the POE. Healthcare utilisation frequencies were in the metrics of SOC attendances, polyclinic attendances, emergency department attendances, emergency admissions, non-day surgery inpatient admissions, non-day surgery inpatient admissions length of stay (LOS), all-cause admissions, all-cause admissions LOS. Healthcare utilisation charges were in the metrics of the full gross bill amounts charged (comprised of out-of-pocket charges and subsidies) from SOC attendances, emergency department attendances, emergency admissions, non-day surgery inpatient admissions and all-cause admissions.

Survival days were calculated by subtracting the POE from the date of death. Patients who survived beyond 1 year from the POE was assigned the maximal number of 1095 days and were censoring events. Mortality rate for the 3-year period after POE (3-year mortality) was also calculated.

For patients in the intervention group, the POEs were actual enrolment dates into the Right-Site Care Programme, when care coordinators in the SOC discuss with the patients about the programme and successfully refer them to Frontier FMC. For controls, there was no actual POE into the programme (or into a control group like a randomised control trial (RCT)). The first SOC attendance date between January and December 2014 was thus used as a proxy for POE among the controls, in order to more closely mimic the timeline of the event (ie, an SOC attendance) and corresponding date when care coordinators would enrol a patient in the intervention group.

Matching for controls

Propensity score matching[45] aims to reduce bias in treatment effect estimates by reducing covariate imbalance between the intervention patients and control patients from quasi-experimental studies. Matching was conducted using the MatchIt package[46] with R V.3.4.1 to generate a group of matched controls. The approach selected was one-to-one greedy nearest neighbour without replacement, with a calliper of 0.25, in descending order of the intervention patients' propensity scores. Each patient in the intervention group was matched to a potential control patient with the closest propensity score that was within 0.25 SD of the propensity score of that intervention patient. This calliper size was used in Rosenbaum and Rubin[47] and often used by applied researchers.[48] The intervention patients with higher propensity scores were given priority in finding potential control patients as it was more difficult to find good matches for them, with the limited distribution towards high propensity scores

in the pool of potential control patients.[49] Intervention patients without a match from the pool of potential control patients were dropped from further analyses.

The following were the matching variables used to construct the propensity score (online supplementary appendix 1): age at enrolment, gender, ethnicity, residential housing type (as proxy for socioeconomic status),[50 51] comorbidity types at enrolment (from the chronic disease management system)[52] and 3-year pre-enrolment healthcare utilisation frequencies and charges. Covariate balance was assessed by visual inspection of common support and using the absolute standardised mean difference of matching variables. Absolute standardised mean difference values below 0.25 indicate adequate balance.[53]

Data analysis

Statistical analysis was conducted using Stata V.14.2 (Stata, College Station, Texas, USA). Statistical significance was assessed using a threshold of 0.05 for all regression analyses. For 3-year mortality, Cox proportional hazard regression analysis was performed, adjusting for propensity score. The HR of intervention group to control group, with its corresponding 95% CI and p value, are reported.

The healthcare utilisation frequencies data were positive count data with inflation of zero values and a large skew of the right-tail of the distribution. The data could be viewed as belonging to two latent subpopulations—potential non-users, that is, those 'not-at-risk' of incurring any healthcare utilisation in that setting, and potential users, that is, those 'at-risk' of incurring healthcare utilisation in that setting—and thus having utilisation frequencies generated from different distributions.[54 55] As such, zero-inflated negative binomial regression (ZINB) was used to model these postenrolment healthcare utilisation frequencies.[55–58] The ZINB model specified in this paper is a mixture of two parts, with one being a logistic model modelling the probability of excess zero and the other a generalised linear model with log link and negative binomial distribution modelling non-excess zero or non-zero utilisation count data (online supplementary technical appendix). The intervention status and the log-transformed corresponding pre-enrolment healthcare utilisation frequencies with a value of 0.5 added (the addition of 0.5 was added to ensure a valid value obtained without taking the log of zero values)[59] were added to both the zero-inflated and the negative binomial parts of the model. The propensity score was added as a variable to both parts of the model to further control for the variability within each group. The model also included an offset term to account for varying follow-up time due to data censoring event of death.[59] The ORs and the incidence rate ratio (IRR) were generated as the exponential of the beta coefficients for the logistic and the negative binomial parts of the ZINB, respectively, and reported along with their 95% CI and p values. The IRR for the negative binomial part of the ZINB is a rate ratio of the intervention group to the control group.

The healthcare utilisation charges data were considered to be semicontinuous data with inflation of zero values and a large skew of the right-tail of the distribution. Similar to the healthcare utilisation frequencies data, the healthcare utilisation charges data could be viewed as belonging to two subpopulations—those who did not incur any healthcare utilisation and had zero charges and those who incurred healthcare utilisation—and thus belonged to a different distribution of utilisation charges. As such, the two-part model (twopm)[60] was used to model these postenrolment healthcare utilisation charges.[57] For the first part of the twopm, a probit model was specified to model the probability of incurring charges over all patients, and for the second part of the twopm, a generalised linear model with log link and gamma distribution was used to model the healthcare utilisation charges among those who incurred any charges (online supplementary technical appendix). The intervention status, log-transformed corresponding pre-enrolment healthcare utilisation charges with a value of 0.5 added (the addition of 0.5 was added to ensure a valid value obtained without taking the log of zero values) and propensity score were included in the model. The model also included an offset term to account for varying follow-up time due to data censoring event of death. The marginal effects of the first part of the twopm are reported along with their 95% CI and p values. The mean ratio (MR) of the second part of the twopm was generated as the exponential of the beta coefficients.

RESULTS

Baseline

Propensity score matching identified 684 controls for the 756 intervention patients enrolled in the Right-Site Care Programme with Frontier FMC, leading to 72 unmatched intervention patients that were dropped from analyses. Visual inspection of the common support plots for cases, matched controls and unmatched control pool of patients indicated the close distribution of propensity scores of matched intervention and control patients (online supplementary appendix 2). There were no missing values for matching variables and all matching variables had standardised mean difference below 0.25 after matching (online supplementary appendix 1). Demographic information and pre-enrolment hospital utilisation of the two groups are presented in table 1. Three hundred and ninety-four (57.6%) of the 684 intervention patients had at least one Frontier FMC attendance per year for all 3 years of the postenrolment period. Intervention patients had a mean 11.25 Frontier FMC attendances over the 3 years in the programme, while control patients by selection criteria had 0 Frontier FMC attendances (table 2).

Mortality rate

The mortality of the intervention patients was 63% (p<0.01) lower than the control patients.

Table 1 Demographic information and pre-enrolment healthcare utilisation frequencies and charges of patients right-sited to the family medicine clinic (Intervention group) and their matched controls (Control group)

	Intervention	Control
	n=684	n=684
Age, mean (SD)	57.9 (15.6)	57.5 (17.6)
Gender, n (%)		
Female	347 (50.7%)	338 (49.4%)
Male	337 (49.3%)	346 (50.6%)
Ethnicity, n (%)		
Chinese	513 (75.0%)	501 (73.3%)
Malay	69 (10.1%)	75 (11%)
Indian	63 (9.2%)	70 (10.2%)
Others	39 (5.7%)	38 (5.6%)
Housing type, n (%)		
1-room or 2-room	5 (0.7%)	8 (1.20%)
3-room	131 (19.2%)	126 (18.40%)
4-room	223 (32.6%)	228 (33.30%)
5-room/Executive	179 (26.2%)	189 (27.60%)
Private/Others	146 (21.4%)	133 (19.40%)
Pre-enrolment healthcare utilisation frequencies, mean (SD)		
SOC attendances	10.06 (8.85)	9.77 (10.79)
Polyclinic attendances	5.9 (8.17)	6.44 (12.17)
Emergency department attendances	1.26 (1.57)	1.3 (2.57)
Emergency admissions	0.81 (1.23)	0.85 (1.95)
Non-day surgery inpatient admissions	0.89 (1.3)	0.93 (2.06)
Non-day surgery inpatient admissions LOS	4.55 (9.59)	4.45 (12.36)
All-cause admissions	1.26 (1.45)	1.31 (2.28)
All-cause admissions LOS	4.92 (9.64)	4.83 (12.47)
Pre-enrolment healthcare utilisation charges ($), mean (SD)		
SOC attendance charges	1340 (1264)	1307 (2029)
Polyclinic attendance charges	484 (850)	532 (996)
Emergency department attendance charges	390 (497)	393 (785)
Emergency admission charges	4895 (10252)	5297 (37638)
Non-day surgery inpatient admission charges	5701 (11055)	6121 (38006)
All-cause admission charges	6091 (11206)	6522 (38071)

LOS, length of stay; SOS, specialist outpatient clinic attendance.

Healthcare utilisation frequencies

The OR of excess-zero postenrolment utilisation for emergency department attendances, emergency admissions, non-day surgery inpatient admissions, non-day surgery inpatient admission LOS, all-cause admissions and all-cause admissions LOS were significant less than one, indicating that intervention patients were more likely to potentially incur postenrolment utilisation than control patients at these settings. Among those with potential postenrolment emergency department attendances, emergency admissions or non-surgery inpatient admissions, utilisation did not differ between intervention and control groups.

Among those with potential of incurring postenrolment all-cause admissions and SOC attendances, utilisations were significantly higher in intervention patients compared with control patients. The IRR for SOC attendances was 2.06 ($p<0.01$), indicating that among patients with potential of incurring postenrolment SOC attendances, intervention patients had over twice the SOC attendances compared with the control patients. Among those with potential of incurring of postenrolment non-day surgery inpatient admissions LOS and all-cause admissions LOS, utilisations were significantly lower in intervention patients compared with control patients. Among those with potential of incurring postenrolment

Table 2 Postenrolment mortality rate as number and percentage (%) of deaths and healthcare utilisation frequencies and charges, in 3-year postenrolment for patients right-sited to the FMC (Intervention group) and their matched controls (Control group)

	Intervention	Control		
	N (%)	N (%)	HR* (95% CI)	P value*
3-year mortality	31 (4.50%)	76 (11.10%)	0.37 (0.25 to 0.57)	**<0.01**

			Excess zero part		Non-excess zero part	
	Intervention	Control	(Zero-inflated)†		(Negative binomial)†	
Healthcare utilisation frequencies	Mean (SD)	Mean (SD)	OR (95% CI)	P value	IRR (95% CI)	P value
Frontier FMC attendances	11.25 (9.17)	–	–		–	–
SOC attendances	7.99 (9.45)	4.52	1.23 (0.55 to 2.75)	0.62	2.06 (1.79 to 2.37)	**<0.01**
Polyclinic attendances	4.12 (7.6)	6.61	1.09 (0.78 to 1.52)	0.62	0.60 (0.52 to 0.70)	**<0.01**
Emergency department attendances	1.21 (2.41)	0.81	0.17 (0.03 to 0.94)	**0.04**	1.12 (0.88 to 1.42)	0.36
Emergency admissions	0.62 (1.61)	0.44	0.51 (0.27 to 0.97)	**0.04**	0.91 (0.63 to 1.30)	0.6
Non-day surgery inpatient admissions	0.7 (1.74)	0.47	0.49 (0.26 to 0.92)	**0.03**	0.95 (0.67 to 1.35)	0.79
Non-day surgery inpatient admissions LOS	4.03 (13.37)	3.45	0.48 (0.32 to 0.72)	**<0.01**	0.39 (0.26 to 0.58)	**<0.01**
All-cause admissions	1.14 (2.21)	0.66	0.81 (0.21 to 3.15)	0.76	1.53 (1.13 to 2.08)	**0.01**
All-cause admissions LOS	4.48 (13.48)	3.64	0.11 (0.01 to 1.06)	0.06	0.49 (0.35 to 0.70)	**<0.01**

			Zero part		Non-zero part	
	Intervention	Control	(First part—Probit)‡		(Second part—Gamma)‡	
Healthcare utilisation charges ($)	Mean	Mean	ME (95% CI)	P value	MR (95% CI)	P value
Frontier FMC attendance charges	1466 (1614)	–	–		–	–
SOC attendance charges	1135 (1397)	640	0.09 (0.04 to 0.13)	**<0.01**	1.86 (1.63 to 2.12)	**<0.01**
Polyclinic attendance charges	327 (698)	650	−0.06 (-0.12 to 0.00)	**0.04**	0.51 (0.42 to 0.61)	**<0.01**
Emergency department attendance charges	383 (782)	241	0.11 (0.06 to 0.17)	**<0.01**	1.18 (1.00 to 1.40)	0.05
Emergency admission charges	3866 (11 408)	3329	0.04 (0.00 to 0.08)	0.07	0.88 (0.65 to 1.20)	0.42
Non-day surgery inpatient admission charges	4747 (12 769)	3550	0.05 (0.01 to 0.10)	**0.02**	0.97 (0.73 to 1.28)	0.83
All-cause admission charges	5335 (13 062)	3780	0.10 (0.04 to 0.15)	**<0.01**	1.05 (0.79 to 1.40)	0.72

The HR, along with its 95% CI and p value, are presented for the mortality rate. The OR or ME and the IRR or MR are presented for the zero and non-zero parts of the models for healthcare utilisation frequencies and charges, along with their 95% CIs and p values. Significant p values are bolded, and colour-coded, with red indicating HR>1, OR<1, ME<0, IRR>1 or MR>1 and green indicating HR<1, OR>1, ME>0, IRR<1 or MR<1.
*Adjusted for propensity score.
†Adjusted for pre-enrolment healthcare utilisation frequencies, propensity score and survival days (or follow-up time).
‡Adjusted for pre-enrolment healthcare utilisation charges, propensity score and survival days (or follow-up time).
CI, confidence interval; FMC, family medicine clinic; HR, hazard ratio; IRR, incidence rate ratio;LOS, length of stay; ME, marginal effects; MR, mean ratio;OR, odds ratio; SD, standard deviation; SOS, specialist outpatient clinic.

polyclinic attendances, utilisations were significantly lower in intervention patients compared with control patients. The IRR for polyclinic attendances was 0.60 (p<0.01), indicating that among patients with potential of incurring postenrolment polyclinic attendances, intervention patients had less than two thirds of the polyclinic attendances compared with the control patients.

Healthcare utilisation charges

The intervention group was more likely to incur some SOC attendance, emergency department attendance, non-day surgery inpatient admission and all-cause admission charges compared with the control group and less likely to incur some polyclinic attendance charges. Among patients who incurred charges in the respective settings, the intervention group was likely to incur higher SOC and emergency department attendance charges than the control group, and less polyclinic attendance charges. The MR for SOC attendance charges was 1.86 (p<0.01), indicating that among those with any SOC attendance charges, intervention patients had SOC attendance charges that were nearly twice compared with their matched controls, mirroring the SOC attendance rates.

Among patients with non-zero postenrolment polyclinic attendance charges, charges were significantly

lower in intervention patients compared with control patients. The MR for polyclinic attendance charges was 0.51 (p<0.01), indicating that among those with any polyclinic attendances, intervention patients had about half the polyclinic attendance charges compared with the control patients, mirroring the polyclinic attendance rates. In contrast, the postenrolment emergency admissions charges, non-day surgery inpatient admission charges and all-cause admission charges were not significantly different between intervention patients and control patients for those that did have any non-zero charges in the respective settings.

DISCUSSION

Patients enrolled in the Right-Site Care Programme with Frontier FMC had lower 3-year mortality than their matched controls. Patients enrolled in the Right-Site Care Programme were also more likely to have at least one emergency department attendance, emergency admission and non-day surgery inpatient admission. However, for those with at least 1 day of non-day surgery or all-cause admissions LOS, patients enrolled in the Right-Site Care Programme had shorter total duration of stay compared with their matched control patients. These findings suggest that patients enrolled in the Right-Site Care Programme could have had their chronic conditions better managed that led to better survival. This better survival might be due to better access to healthcare services or increased case-finding[61–63] with close monitoring by the family physicians, leading to uncovering of previously undetected problems and appropriate referral of patients back to the hospital. This could have been what led to the increased odds of having any of these hospital-based attendances and admissions, but that when they did, the LOS was lower.

Patients in the Right-Site Care Programme with any SOC attendances also did not have lower 3-year postenrolment SOC attendance frequencies and charges. With the added Frontier FMC attendance frequencies and charges, the mean total outpatient attendances and outpatient attendance charges (comprised of out-of-pocket charges and subsidies) were higher in the enrolled patients compared with their matched controls. For patients with any polyclinic attendances and charges, those enrolled in the Right-Site Care Programme did have lower polyclinic attendance frequencies and charges, indicating that these patients likely now substituted polyclinic attendance with Frontier FMC attendances instead. This reduction in mean polyclinic attendances by enrolled intervention patients, however, did not counter their higher SOC and Frontier FMC attendances.

This study also found that only about half of the patients had consistently gone to Frontier FMC at least once per each of the 3 years after being enrolled in the Right-Site Care Programme. A separate qualitative research study was previously conducted with similar enrolled patients that were 'right-sited' to Frontier FMC during the same time period as patients used in this study.[64] The study found that if the out-of-pocket pricing of Frontier FMC was not competitively lower or similar to the subsidised rates received in the public hospitals, it was unlikely for a patient to continue care in Frontier FMC. Inadequate subsidies for the provisions of services by other members of the primary care team, such as dietary or psychological counselling, could also reduce the willingness of complex patients to continue their care in FMC. Cost was likely to be a main driver of behaviour with the current healthcare financing system, due to the potentially large out-of-pocket component with limited governmental subsidies or reimbursements for community-based care.[64]

Patients also had perceptions generalising that family physicians might not be as well-equipped as specialist physicians in managing their chronic diseases. Additionally, with lack of full comprehension of how the FMC could be advantageous for the management of their chronic conditions, some patients did not view the FMC as a medical home that could provide all their healthcare needs. Though they were satisfied with their care in the FMC, only about a third would go to FMC for a new non-minor health problem, and about a third already sought care for chronic disease elsewhere with hospital specialists or a complementary and alternative medical practitioner. Together with increased case finding, these all could have led to the return to the hospital SOC, generating higher number of attendances and charges as observed in this study.

Strengths and limitations

For this study, the follow-up period of 3 years allowed for longer-term effects of the programme to be evaluated. The use of healthcare administrative data eliminated recall errors that would arise from self-reported healthcare utilisation, particularly for a long follow-up period. This healthcare administrative data used were on a person-level from a large consolidated database that went beyond just one hospital and covered separate episodes of care across different hospitals and primary care clinics linked to each individual. The use of person-level administrative data also allowed for selection of matched controls, which would otherwise not be possible if the administrative data was aggregated at hospital-level or national-level. The use of matched controls for comparisons allowed for isolating the intervention programme's effects on utilisation frequencies and charges, as it took into account the regression to the mean that could occur in both groups even without intervention.[63 65 66] The use of ZINB and two-part models in the statistical analyses of postenrolment healthcare utilisation frequencies and charges was also a strength to appropriately account for the inflation of zero values and a large skew of the right-tail of the distribution of such healthcare utilisation data. However, as our analyses are based on our assumptions of the distribution of the underlying data, and with results reported separately for each model part, the results must be interpreted in context and with caution.

The traditional 'gold standard' for assessing an intervention programme would conventionally be to conduct a RCT. However, the Right-Site Care Programme was an intervention that patients had to opt in for, and the operational demand and timelines for implementing at scale could not allow for a RCT to be conducted. Although patients were not randomly assigned into intervention and control groups, inherent bias from confounding factors was mitigated with matching. However, the matching of controls could not account for unmeasured confounders such as the health status of the patients and the stability of their conditions as well as attitudes and behaviours that might predominate in patients that agreed to be enrolled in this intervention programme, such as seeking care that has lower cost and improved accessibility and convenience. It may well be that the control patients were indeed not suitable for 'right-siting' to the community.

Implications

The findings highlight to clinicians and policy makers the importance of fully engaging with the patient population and to do so early in the design phases of their services and any intervention programmes. This would ensure adequate alignment of the care to patients' priorities and that processes can be in place to facilitate educating patients on how the services or programmes could better provide care for their chronic conditions. Appropriate healthcare financing models that do not result in higher out-of-pocket costs to patients would also be needed to sustainably transition patients from hospital based care (that is highly subsidised) to community-based primary care providers.

Unanswered questions and future research

Previous findings in general suggested that the PCMH model of care would be able to reduce emergency department attendances.[67] However, like this study, there were also studies that found the PCMH was not able to reduce emergency department attendances[68] and might actually increase overall healthcare utilisation costs.[37 69 70] This could be due to increasing patients' access to care services or increased case-finding[61–63] with close monitoring by the family physicians. The contrasting findings might be due to differences in how the PCMH model of care was deployed, since it is not a single standardised model of care, but a general model of care with guiding principles. Frontier FMC was designed to be patient-centred, as well as convenient and accessible, using a modified version of the PCMH model of care, adapted to the local context. Exploring the implementation fidelity of the Right-Site Care Programme with Frontier FMC is thus important in understanding how the programme implemented was in line with the PCMH model of care, how the programme might have further evolved and matured with time, and how processes could be further refined. It is also worth investigating if differing patient profiles with varying levels of complexities and/or different healthcare utilisation patterns[71] do benefit more or less from such a programme that have the management of chronic disease anchored in the community. Additionally, future work could also use joint modelling to explore the dynamic shifts in healthcare utilisation with and without the intervention and investigate the resultant impact on mortality.

CONCLUSION

Patients enrolled in the Right-Site Care Programme with Frontier FMC had better survival, probably because their chronic conditions were better managed. The better access to healthcare services or increased case-finding with close monitoring could have led to the higher total outpatient attendance frequencies and charges. However, among patients with potential of incurring of polyclinic attendances, those enrolled in the Right-Site Care Programme did have lower polyclinic attendance frequencies and charges, indicating that these patients likely now substituted polyclinic attendance with Frontier FMC attendance. The follow-up period of 3 years in this study allowed for evaluation of long-term effects of these large-scale real-world programmes, providing relevant evidence for improving integrated care in Singapore and similar health systems.

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