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Implementation and evaluation of a pilot Match-A-Nurse programme to provide home-based care in Singapore

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ABSTRACT

Background To enable our seniors to age in place and at home, healthcare needs to shift towards delivering care in the community while taking advantage of technology, to enhance the productivity and effectiveness of home-based nursing care. Home-based nursing care is also less expensive, more convenient and as effective as care received in a hospital.

Methods The pilot Match-A-Nurse programme linked discharged patients from two public hospitals in Singapore requiring home-based nursing care to nurses living or working close to them through a mobile application. Patients' requests are listed in the application which was developed by adopting a 'hybrid agile' framework for nurses to 'bid' for jobs. The concept is similar to a taxi booking application. Information on demographics, skills competency, services required, bidding frequency and patient and nurse satisfaction were collected and analysed.

Results The Match-A-Nurse programme was successfully implemented and was received positively by patients and nurses. Patients were satisfied with the time taken to confirm the visit, the quality of care and would recommend the programme to others. Nurses were also satisfied with the usability of the application and the level of support provided to them. In addition, patient's information can be readily accessed through the application.

Conclusions The technical feasibility and practical potential of this programme is evidenced by the nurses' and patients' willingness to participate, their satisfaction with the programme and the ability of the prototype mobile application to secure patient documentation, and the adherence of programme to the legal and insurance employment regulations in Singapore.

INTRODUCTION

Singapore is experiencing a major shift in demographics, and by 2030, one in four Singaporeans will be aged 65 and above. As Singapore's population ages and live longer, more people will be living with chronic conditions. Approximately 4 00 000 years of healthy life were lost due to premature deaths and ill-health in Singapore in 2010, with cardiovascular diseases and cancers, and this accounts for approximately 40% of total disability-adjusted life years.[1] One of the challenges faced by Singapore is to ensure that our seniors with chronic conditions age in place and at home. Home-based healthcare is usually less expensive, more convenient and it is considered just as effective as care that is received in a hospital. This will enable them to age with dignity in a manner that meets their expectations, preference and care needs.[2] Favourable social conditions such as low loneliness, low social isolation and high social support are important predictors of improved disease outcomes in the elderly.[3]

The 'always on' and 'highly portable' smartphone has revolutionised the communication landscape. Their rich multimedia displays have enriched the network lives of their users. They operate with increasing computing power to deliver real-time, on demand personalised communication.[4 5] These smartphones also support third-party applications

(apps), which work flawlessly with other built-in apps, including Short Message Service, Global Positioning System, Maps, email and Calendar apps. This smartphone (or mobile phone, used interchangeably) revolution has offered an extraordinary opportunity to provide medical support to patients and the general public, when and where they need it. These apps currently play a multitude of roles in health and healthcare[6] ranging from drug-referencing tools, education materials in medical and healthcare, to clinical decision support tools, communication and electronic health-record system access.

Home-based healthcare refers to a wide range of healthcare services that can be provided in a patient's home for an injury or illness. Advantages of home-based healthcare include, patients receiving high-quality, personal and compassionate care in the privacy, comfort and convenience of their own home. It allows for a higher sense of independence and dignity (especially for elderly patients), it maintains community ties and familial cohesion, is more affordable than inpatient care and care is tailored to meet the needs of the patient.[7]

Although the overall registered nurse to population ratio was about 7.5 nurses per 1000 population in 2018, comparable to those of Hong Kong, Taiwan and South Korea, it has been projected that there will be nursing shortage with an ageing population in Singapore.[8] The urgent need is not only to increase the pool of nurses and nursing aides. We could also tap on technology to increase productivity of nurses. Traditional home-based nursing care involves a team of full-time nurses travelling from one patient's home to another performing nursing tasks including wound care, urinary catheter changing and nasogastric tube change. This is time consuming and inefficient as half the time is typically spent on travelling, thus wasting expensive professional time. With the widespread use of Uber, the idea of using an application as a communication tool between provider and user of home-based nursing care arose, to enable nurses to perform jobs near their home instead. This could greatly improve productivity of the full-time home nurses by reducing travelling time and increase the informal nursing workforce with the ease of taking up tasks through the mobile application and having flexible working hours.

This paper describes the development and implementation of the pilot Match-A-Nurse programme with the aid of technology via a mobile application to link registered nurses currently working full-time in two public hospitals to patients, in order to deliver home-based nursing care. In addition, the paper also evaluates the effectiveness of the programme. The evaluation criteria for this proof of concept and prototype include the willingness of nurses to participate in this programme, the ability of the mobile application to secure patient documentation, the technical feasibility and adherence of the prototype to the current legal and insurance employment regulations in Singapore.

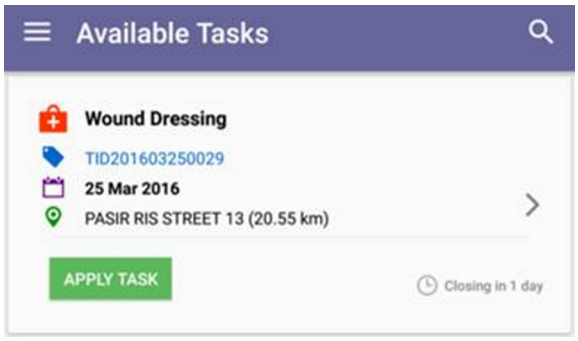

Figure 1 Available tasks listed in the mobile application for bidding.

MATERIALS AND METHODS

Development of Match-A-Nurse mobile application

The pilot Match-A-Nurse programme was launched in April 2016 to link discharged patients requiring home-based nursing care service to nurses living or working close to them. Patients' requests are listed in a mobile application for nurses to 'bid' for the jobs. The concept is similar to a taxi booking application (see figure 1). After the visit, the nurses would document the procedures and observations in the application.

A 'hybrid agile' framework was adopted to develop the software instead of the conventional application development lifecycle as the former approach enabled the development of each release to be expedited and supported the frequent changes in operational requirements. The relevant users were also engaged during the software development process through focus group discussions. Both patient and service provider user groups were consulted for software development (online supplemental annex A).

The application was hosted in the Health Cloud Data Centre (H-Cloud) which is a secured private cloud for healthcare applications in Singapore. In addition to being used as a communication tool between nurses and patients, the application also provided a secure location to store patient information, for example, medical history, care needs and observations, to be recorded and communicated confidentially. Only nurses who were delivering the care are able to access the patient's information.

Participant recruitment and selection

Nurses were recruited through road shows, email and mobile messages from two public tertiary hospitals selected for this pilot. Participation in the programme was voluntary. A geospatial matching was also done on the nurses in the programme and it was noted that there were sufficient nurses staying or working near patients' homes to provide nursing care.

The inclusion criteria for nurses were:

1. Full-time registered nurses who are Singapore citizens or permanent residents (this is due to employment regulations and hospital policy).
2. Completed at least 2 years of service at public tertiary hospitals (labelled Hospital A and B);
3. Competent in performing the home-based nursing care services offered (eg, wound dressing, insertion of nasogastric tube and change of female urinary catheter).
4. Nurses who had not performed any of these procedures for more than 6 months were required to undergo a ward competency assessment prior to conducting home visits.
5. Support and approval of their supervisors to participate in the programme.

It was also stipulated that home visits can only be performed outside of the nurses' duty roster or work schedule and within the hours of 08:00 to 20:00. Home visits were not permitted on nurses' rest days, on any approved or statutory leave and any off-in-lieu for work performed on a public holiday. A limitation of two jobs each week was imposed, so that nurses are not overworked.

Training was provided for recruited nurses through briefing sessions, to learn more about the programme, hands-on training on how to use the mobile application, and to sign a Supplemental Letter before conducting home visits. The Supplemental Letter contained the terms and conditions of employment participation in home-based nursing care and was prepared after consultation with the Legal department, Ministry of Manpower, Human Resource department, Staff Union and Nursing department. A handbook was also developed to provide information relating to operating procedures, nursing and frequently asked questions.

Suitable patients were identified and recruited by patient navigators during their inpatient stay. Those who were included in the recruitment would not have follow-ups with other home-based care service providers, required home-based nursing services which were offered by the programme, were medically stable and had no known safety concerns in their home environment. Participation was entirely voluntary. Those who participated signed an informed consent form.

Programme evaluation

The quadruple aim was used to assess the effectiveness of the programme. It is an approach to optimising health system performance by focusing on four dimensions: improving the health of populations, enhancing the patient experience of care, reducing the per capita cost of healthcare and improving the work life of healthcare providers.[9 10] The outcome and process measures for the programme are provided in online supplemental annex B.

This study was implemented as a pilot innovation programme. As the intent of the programme is not for research, no ethics application was required. This programme was approved and funded by the Ministry of Health, Singapore.

RESULTS

The demographics, competency and bidding frequency of 177 nurses are presented in table 1. It was observed that only 28.8% of the nurses who participated in the programme had bid for jobs. Although similar proportions of female (28.8%) and male nurses (28.6%) had bid for jobs, a higher proportion of the nurses was of Chinese (31.9%) and Indian ethnicity (30.8%). In terms of competency, a higher proportion of the nurses who bid for jobs were skilled in urinary catheterisation (32.8%) and wound dressing (30.0%) while a lower proportion of the nurses were skilled in wound dressing with paediatrics (10.3%) and insertion of nasogastric tube with paediatrics (9.1%).

The demographics, subsidy status and services provided to 56 patients are presented in table 2. The majority of patients were aged 65 years and above (66.1%), with females accounting for 69.6% of all patients. Patients were mainly of Chinese ethnicity (85.7%). A higher proportion of patients who participated in the programme were discharged from Public Hospital A (85.7%), compared with Public Hospital B (14.3%). In addition, more patients received subsidy (60.7%). In Singapore, the amount of subsidies patients are eligible for are based on their household income levels. Higher subsidies are given to lower-income patients.

The characteristics and status of 198 tasks are presented in table 3. The majority of tasks requested by patients were for wound dressing (62.6%) and 57.6% of all tasks were completed. The remaining tasks were either cancelled (eg, patients' wound had healed, patient had passed away, patient was re-admitted, patient was transferred to other service providers or the task had been rescheduled) or deleted.

There were 44 out of 56 patients who rated the services provided by Match-A-Nurse programme. Most patients would recommend the services to others with 84.1% of patients rating the services as more than satisfactory as provided in table 4. On the other hand, one patient was not satisfied with the service provided (eg, time taken by the nurse to confirm the visit and the nursing procedure).

Most nurses would also recommend the programme to their colleagues with 72.7% of nurses rating the programme as satisfactory (see table 4). They were generally satisfied with the level of support provided by the administrative and nursing team, and the usability of the app. On the other hand, two nurses were not satisfied with the work involved for each home visit.

DISCUSSION

This pilot Match-A-Nurse programme has been successfully implemented and illustrates a successful model of transforming home-based nursing care with the aid of technology. Both patients and nurses were satisfied with the programme. This nurse-led programme was developed with a focus on developing

Table 1 Nurses' demographics, competency and bidding frequency (extraction of the dataset from the period of April 2015 to October 2017)

Variable	Bid for jobs, n (%)		Total number of nurses on the register (active/suspended)
	Yes	No	
Number of active nurses	51 (28.8)	126 (71.2)	177
Gender			
Female	45 (28.8)	111 (71.2)	156
Male	6 (28.6)	15 (71.4)	21
Race			
Chinese	38 (31.9)	81 (68.1)	119
Malay	8 (22.2)	28 (77.8)	36
Indian	4 (30.8)	9 (69.2)	13
Others	1 (11.1)	8 (88.9)	9
Competency in services			
Insertion of nasogastric tube	48 (28.9)	118 (71.1)	166
Insertion of nasogastric tube with paediatrics	3 (9.1)	30 (90.9)	33
Wound dressing	51 (30.0)	119 (70.0)	170
Wound dressing with paediatrics	3 (10.3)	26 (89.7)	29
Urinary catheterisation	44 (32.8)	90 (67.2)	134
Suture-To-Off	2 (25.0)	6 (75.0)	8
Injection (new service)	3 (20.0)	12 (80.0)	15
Bidding frequency			
Frequent (≥10 bids)	9 (5.1)		
Moderate (5–9 bids)	8 (4.5)		
Low (1–4 bids)	34 (19.2)		
No bids	126 (71.2)		
Jobs successfully bid			
1 job	11 (34.4)		
2–3 jobs	11 (34.4)		
4–5 jobs	3 (9.4)		
6–7 jobs	4 (12.5)		
>7 jobs	3 (9.4)		

detailed processes and ensuring commitment from all stakeholders, including nursing management, human resource department, finance department and insurance as well as the unions. The involvement and support of these stakeholders was crucial and it ensured the success of the programme. The large number of voluntary sign-ups by 177 nurses showed the willingness of nurses to take on tasks beyond their work hours. This pilot programme was inundated with requests from nurses who failed to sign-up within the strict time period imposed for recruitment. This Match-A-Nurse programme can potentially enhance the nursing workforce through the use of sharing economy with mutual benefits for both nurses and patients, where nurses get increased remuneration and patients receive the much needed essential services delivered via home-based nursing care.

The involvement of nurses during the design phase of the application ensured that the system was designed to specifically cater to their requirements. Patient-related information was accessible at all times and nurses could document this information with ease, leading to an improvement of efficiency. This finding was similar to that identified in a Cochrane Review on healthcare workers' perception and experience of using mobile health technologies, which noted that an efficient mobile application improved feedback, speed and workflow.[11] Healthcare workers also appreciate the portability, allowing them to easily access patient's information as required.[11]

Our prototype design incorporated the recommended design features for human–computer interface:[12] simple to access, use and navigate; simple and understandable information displayed assuming that consumers do not have good health literacy; and a simple, up-to-date user interface design familiar to other apps in common use.

The agile method of programming the mobile application adopted in this programme allowed suggestions from nurses to be adopted in a timely manner and incorporated to ensure ease of use. This resulted in the Match-A-Nurse programme being received positively by nurses. Nurses were satisfied with both the usability of the application and the level of support that was provided to them.

Table 2 Patient demographics, subsidy status and services required from nurses (extraction of the dataset from the period of April 2015 to October 2017)

Variable	N (%)
Total number of patients	56
Age	
0 to 18 years	2 (3.6)
19 to 50 years	5 (8.9)
51 to 64 years	12 (21.4)
65 years and above	37 (66.1)
Gender	
Female	39 (69.6)
Male	17 (30.4)
Race	
Chinese	48 (85.7)
Malay	3 (5.4)
Indian	3 (5.4)
Others	2 (3.6)
Service required*	
Insertion of nasogastric tube	16 (28.1)
Insertion of nasogastric tube with paediatrics	1 (1.8)
Wound dressing	23 (40.3)
Wound dressing with paediatrics	1 (1.8)
Urinary catheterisation	16 (28.1)
Discharged from	
Public Hospital A – ward	48 (85.7)
Public Hospital B – ward	8 (14.3)
Received subsidy	
Yes	34 (60.7)
No	22 (39.3)
Means testing level of subsidy received	
80%	20 (35.7)
75%	6 (10.7)
60%	0
55%	0
50%	3 (5.4)
40%	0
30%	4 (7.1)
15%	1 (1.8)
0%	22 (39.3)

*The total number of services required was 57 as one patient required two services.

Table 3 Task characteristics and status (extraction of the dataset from the period of April 2015 to October 2017)

Task characteristics	N (%)
Task requested*	198
Insertion of nasogastric tube	40 (20.2)
Insertion of nasogastric tube with paediatrics	2 (1.0)
Wound dressing	124 (62.6)
Wound dressing with paediatrics	2 (1.0)
Urinary catheterisation	30 (15.2)
Task status	
Completed (task performed by nurse)	114 (57.6)
Cancelled (task cancelled and rescheduled by administrator)	67 (33.8)
Deleted (task removed by administrator)	17 (8.6)
Distance from home location to tasks†	
≤3 km	43 (37.7)
>3 to ≤6 km	26 (22.8)
>6 to ≤10 km	12 (10.5)
>10 to ≤15 km	31 (27.2)
>15 to ≤20 km	2 (1.8)

*One patient may have more than one task created for example, three times a week for wound dressing, monthly nasogastric tube changes or urinary catheterisation.
†Eighty-four (42.4%) tasks did not have information on the distance from home location to tasks.

The imposed limit of two jobs per week per nurse meant that some patients who require three or more visits a week would have to see two different nurses. In order to address this situation and not affecting continuity of care to the patient, a group assignment of tasks feature was added to the mobile phone application. The system allowed grouped assignment of tasks to nurses, so that tasks were mainly performed by the same two nurses. There is also continuity of care as most of the patients continue to be cared for by the nurses who work in the same hospital the patients were discharged from. There were instances where nurses were able to contact the surgeons in charge and admit patients for early intervention when there were complications.

The pilot programme illustrated that there is potential to tap on a huge latent marketplace, where nurses are willing to perform home-based nursing care outside of their usual work hours near their homes or workplaces. For a full-time nurse working in home-based nursing, the usual workload is six to eight patients a day. This represents a maximum of 40 patients seen in a 5 day work week. In this pilot, 177 nurses were able to perform 354 tasks a week which is equivalent to the workload of about nine full-time home-based nursing staff.

This service did not affect the nurses' actual working hours as the tasks were mainly performed after working hours. It can potentially further increase nursing capacity by extending this mobile application to nurses from other hospitals or to freelance nurses who prefer to work flexible hours due to personal commitment. Finally, this service may encourage older and more experienced nurses to return to the workforce. This innovative pilot programme thus has the ability to help address the expected nursing shortage in Singapore due to its ageing population.

In view of the positive feedback, the range of services could be expanded to include parenteral medication administration, peripherally inserted central catheter flushing and dressing, hence addressing the needs of a greater group of patients. Shifting of some specialised tasks from a hospital to a home setting could potentially

Table 4 Patient and nurse satisfaction rating service provided by Match-A-Nurse programme for home-based care in Singapore

Questions	Satisfaction rating scale: n (%) 1	2	3	4	5	Total responses
Patient satisfaction						
Patient satisfaction with the overall nursing care service			7 (15.9)	30 (68.2)	7 (15.9)	44 (100)
Patient satisfaction with the time taken by nurse to confirm the visit		1 (2.3)	11 (25.0)	28 (63.6)	4 (9.1)	44 (100)
Patient satisfaction with the punctuality of the nurse visit			13 (29.5)	27 (61.4)	4 (9.1)	44 (100)
Patient satisfaction with the nursing procedure		1 (2.3)	3 (6.8)	28 (63.6)	12 (27.3)	44 (100)
Patient satisfaction with the explanation provided by the nurse on the procedure			7 (15.9)	31 (70.5)	6 (13.6)	44 (100)
Patients would recommend the services to others who require the same care services (Yes/No)						44 (43 respond 'Yes', 1 'No')
Nurse satisfaction						
Nurse satisfaction with the overall experience of the Match-A-Nurse programme			16 (72.7)	6 (27.3)		22 (100)
Nurse satisfaction with regard to the work involved for each home visit (eg, calling patient prior to home visit, filling in the charge form and claim form)		2 (9.1)	12 (54.5)	4 (18.2)	4 (18.2)	22 (100)
Nurse satisfaction on the level of support from programme administrative team			12 (54.5)	9 (40.9)	1 (4.6)	22 (100)
Nurse satisfaction on the level of support from programme nursing team			13 (59.1)	9 (40.9)		22 (100)
Nurse satisfaction on the usability of the Match-A-Nurse app			12 (54.5)	7 (31.8)	3 (13.7)	22 (100)
Nurses would recommend this programme to other nursing colleagues						22 (21 respond 'Yes', 1 'No')

Satisfaction rating scale: Very Poor (1), Poor (2), Satisfactory (3), Good (4) and Excellent (5).

decrease overall healthcare costs by reducing hospital days.

CONCLUSIONS

In summary, our study illustrates the success of a proof of concept and prototype of the Match-A-Nurse programme which includes the mobile application to provide home-based nursing care in Singapore. The technical feasibility and practical potential of this programme is evidenced by the nurses' and patients' willingness to participate, their satisfaction with the programme and the ability of the prototype mobile application to secure patient documentation, and the adherence of programme to the legal and insurance employment regulations in Singapore. The programme also has the potential to address the worldwide shortage of nurses through innovative use of technology as well as tapping onto a sharing economy. This programme will be regularly reviewed to expand the services that can be provided to patients and increasing financial rewards for nurses. The technical aspects of the application will also be continually improved.

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REFERENCES

1 Ministry of Health. *Singapore burden of disease study 2010*, 2014.
2 Landers S, Madigan E, Leff B, *et al*. The future of home health care: a strategic framework for optimizing value. *Home Health Care Manag Pract* 2016;28:262–78.
3 Tomaka J, Thompson S, Palacios R. The relation of social isolation, loneliness, and social support to disease outcomes among the elderly. *J Aging Health* 2006;18:359–84.
4 Heron KE, Smyth JM. Ecological momentary interventions: incorporating mobile technology into psychosocial and health behaviour treatments. *Br J Health Psychol* 2010;15:1–39.
5 Boulos MNK, Wheeler S, Tavares C, *et al*. How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX. *Biomed Eng Online* 2011;10:24.
6 Boulos MNK, Brewer AC, Karimkhani C, *et al*. Mobile medical and health apps: state of the art, concerns, regulatory control and certification. *Online J Public Health Inform* 2014;5:229.
7 Valdmanis VG, Rosko MD, Leleu H, *et al*. Assessing overall, technical, and scale efficiency among home health care agencies. *Health Care Manag Sci* 2017;20:265–75.
8 National Population and Talent Division PMsO. Projection of foreign manpower demand for healthcare sector, construction workers and foreign domestic workers, 2012. Available: https://www.strategygroup.gov.sg/images/Press%20Release%20images/PDFs/occasional-paper-projection-of-foreign-manpower-demand-healthcare-construction-foreign-domestic-workers.pdf
9 Bodenheimer T, Sinsky C. From triple to quadruple aim: care of the patient requires care of the provider. *Ann Fam Med* 2014;12:573–6.
10 Stiefel M, Nolan K. *A guide to measuring the triple aim: population health, experience of care, and per capita cost. IHI innovation series white paper*. Cambridge, Massachusetts: Institute for Healthcare Improvement, 2012.
11 Odendaal WA, Anstey Watkins J, Leon N, *et al*. Health workers' perceptions and experiences of using mHealth technologies to deliver primary healthcare services: a qualitative evidence synthesis. *Cochrane Database Syst Rev* 2020;3:CD011942.
12 Baldwin JL, Singh H, Sittig DF, *et al*. Patient portals and health apps: pitfalls, promises, and what one might learn from the other. *Healthc* 2017;5:81–5.