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ORIGINAL ARTICLE

The impact of interprofessional communication through ICT on health outcomes of older adults receiving home care in Japan – A retrospective cohort study

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Abstract

Background: Information communication technology (ICT) is crucial to modern communication and information sharing. Effective interprofessional collaboration is essential in the care of elderly people. However, little is known about the effects of ICT on care provision for elderly people in a home setting. This retrospective cohort study examines the impact of interprofessional collaboration using ICT on the health outcomes of elderly home care patients.

Methods: The Team® mobile application promotes cooperation in local medical health care. It enables providers to obtain and share patient information within a single, cloud-based platform. We collected and analyzed data from 554 patients from Nagaoka (Niigata prefecture, Japan) who received home care services from 2015 to 2020. We calculated the cumulative hazard ratio (HR) of death or admission to a hospital or nursing home for patients whose information was shared among different professions using the platform, and for those whose information was not shared. We used a Cox proportional hazards model, adjusted for covariates, and applied propensity score matching.

Results: The average age of the study population was 83.5 years; the median follow-up period was 579.0 days. The risk of death or admission to a hospital or nursing home significantly decreased in the information-shared group, compared with the control group (adjusted HR: 0.47 [$p < 0.01$]). Significance remained after propensity score matching (HR: 0.58; $p = 0.01$).

Conclusions: Interprofessional collaboration using ICT may reduce the risk of death or admission to a hospital or nursing home among elderly home care patients in Japan.

KEYWORDS
aged, home care services, information technology, Interdisciplinary communication

Takeru Yoshimoto, Medical student at Tokyo Medical and Dental University

1 | INTRODUCTION

Demand for elderly care is increasing worldwide due to population aging.[1] For providing high-quality care, interprofessional collaboration is crucial, due to the complex needs of clients, geographical separation between different providers, and a high prevalence of multimorbidity in the older population.[2] However, despite the importance of interprofessional communication and collaboration, a number of barriers to its practice exist (e.g., the de-identification of personal records for information sharing, lack of joint monitoring, and feelings of mistrust and insecurity).[3] A majority of home healthcare nurses experience difficulty at the point of care in obtaining clinical information externally.[4] It has been reported that poor information exchange and communication between healthcare workers leads to errors with medication and threatens the safety of patients.[5]

Electronic health records (EHRs) are now common and information and communication technology (ICT) is considered an effective approach to address care management issues and foster social networking, participation, and collaboration among healthcare providers and consumers.[6] To date, ICT initiatives have brought major improvements in coproducing healthcare services, which have benefited both patients and interorganizational practice, despite the challenges to individual and collective capacities.[7] A previous study of a general internal medicine inpatient unit at an acute care hospital reported that EHRs, together with ICT, enabled relevant, real-time patient information sharing and multidisciplinary collaboration that led to improvement and standardization of communication within the care team.[8] Another study reported that an EHR communication tool reduced length of stay and average ventilation time in an intensive care unit.[9] These studies, however, were conducted in hospital settings. Little is known about the effects of interprofessional collaboration using ICT upon the health outcomes of elderly people who receive care in a home setting.

Team® (Allm Inc., Tokyo, Japan) is a mobile application that supports communication between doctors, nurses, care managers, caregivers, and pharmacists by obtaining and sharing patient information within a single, cloud-based platform. The application has been used since 2015 to improve elderly home care in Nagaoka (Niigata Prefecture, Japan). Given Japan's highly industrialized, super-aging society and its national long-term healthcare insurance system, it is an ideal setting to examine the effect of ICT on home care for elderly patients. This study aimed to examine the effects of interprofessional collaboration via ICT on the health outcomes of elderly home care recipients in Japan.

2 | MATERIALS AND METHODS

2.1 | Sample

Since 2015, Nagaoka residents who require long-term care have been able to consent to their health records being exchanged between different professions; if not, their records are limited to the facility providing care. In this retrospective, cohort study, we focused on five facilities in Nagaoka; data from other facilities in the city were not available or was insufficient regarding covariates and outcomes. This study included patients who received care between February 15 2015 (the date that Team was introduced in Nagaoka) and July 17 2020 (the end of the study period). During the study period, 766 patients received care at the five facilities. Their data were anonymized by Allm Inc. for their use in improving operations and used in this study.

We included only patients who survived 30 days from the start of care, to ensure that the effectiveness of information sharing could be assessed. We excluded patients younger than 65 years who had not been assigned a nursing care level under Japanese health insurance law. We also excluded from the analysis patients who stopped receiving care because of recovery, emigration, dissatisfaction, or for no obvious reason ($N = 47$), resulting in a total study population of 554 patients. We censored the patients who continued to receive care until the end of the study period without experiencing any medical event. The participants' details are shown in Figure 1. We used the Power Cox function of Stata version 15.0 (StataCorp, College Station, TX, USA) to estimate the required sample size, assuming a hazard ratio (HR) of ≥0.75. A sample size of ≥423 was estimated to be sufficient (power = 0.9, alpha = 0.05, margin = 10%).

This study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines and was approved by the research ethics committee at Tokyo Medical and Dental University.

2.2 | Exposure

Home nursing and home care providers used tablet computers running the specialized EHR applications Kango and Kaigo[10] to enter patients' personal information, care records, vital signs, daily reports, lesion images, and prescriptions. The data were then transferred to a Team server that could be accessed and updated by doctors, nurses, care managers, home caregivers, and pharmacists. The patients were divided into two groups: an information-shared group and a control group. The information-shared group included patients who agreed to receive care with Team-based interprofessional communication during the study period ($N = 472$). The control group included patients whose information was restricted to the treatment provider ($N = 82$).

2.3 | Outcomes

For survival analysis, the outcome event was defined as death, admission to a hospital, or admission to a nursing home, which all terminated the home care service and implied worsening health status. We only included patients who continued receiving care for more than 30 days from the commencement of care, excluding those who ceased to be a part of the study due to death or other reasons.

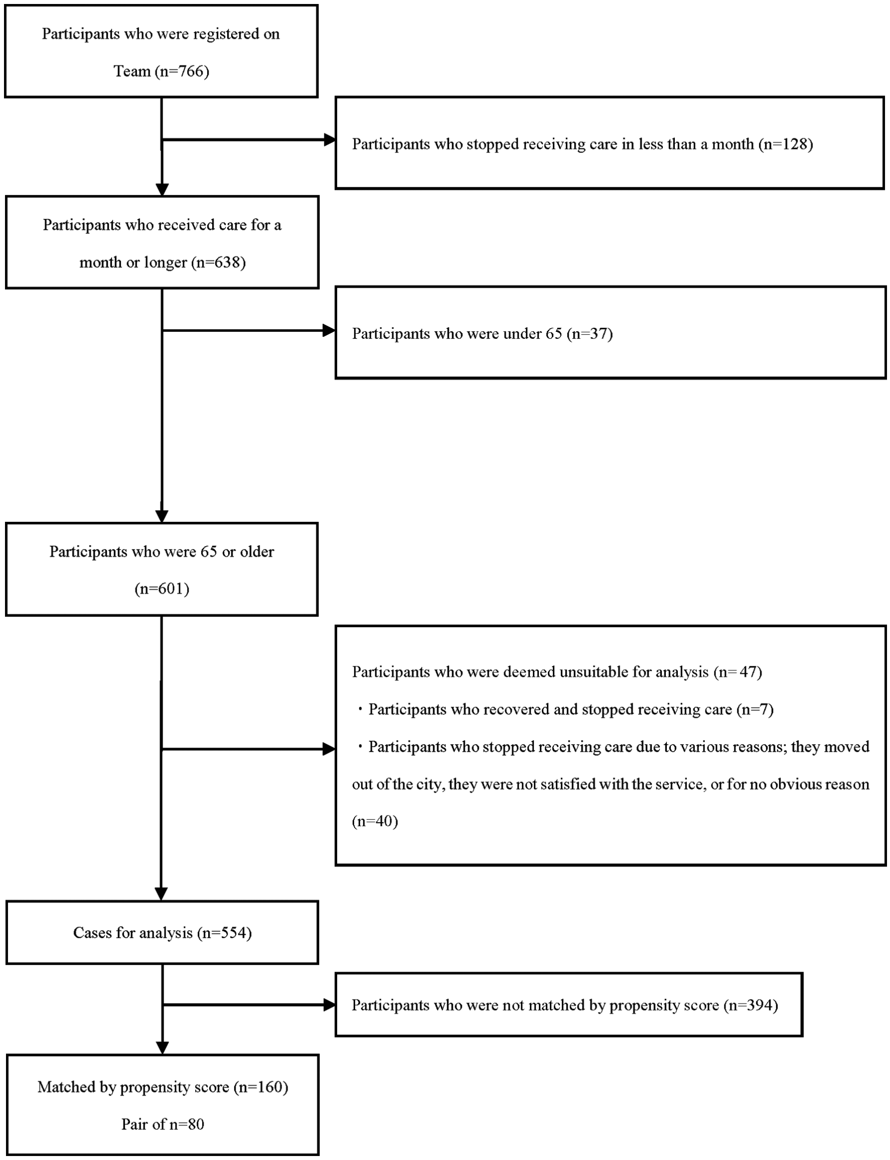

FIGURE 1 Enrollment of study participants. Selection of the study participants was performed based on the criteria shown

Thereafter, we set the 30th day as the start date for follow-up, in order to counter immortal time bias.[11]

2.4 | Covariates

From those available, we selected covariates based on previous studies.[12,13] We considered age, sex, nursing care level, treatment facility, and whether patients lived alone or with others, at home or in a care house. The covariates' variance inflation factors were calculated; all were substantially <5, which indicated non-multicollinearity. All covariates were measured on 15th February 2015, at the point of introduction of the information sharing system. The cloud platform database contained no missing data and was comprehensively managed.

The nursing care level index is assigned to ≥65 year-old adults in Japan and used to determine their financial aid.[14] It comprises seven levels and includes assessments of quality of life and activities of daily living to determine support levels 1–2 and care levels 1–5, from least to most disabled. Hence, it can be a valid indicator of a patient's baseline health status.[15,16]

2.5 | Statistical analyses

Baseline characteristics are presented as numbers and percentages, for categorical variables, and means with standard deviations, for continuous variables. To consolidate the reliability of our findings, two statistical methods were used to estimate the risk of death, admission to a hospital or a nursing home in both the information-shared and control groups. First, we constructed a Cox proportional hazards model to derive a HR and CI, adjusting the model for age, sex, presence of housemate, living environment, nursing care level, and treatment facility. Second, we performed a propensity score matched Cox proportional hazards analysis. For each covariate, propensity scores were estimated from the multivariable model with an area under the curve of 0.7596. Patients with similar propensity scores were matched 1:1 using the nearest neighbor matching approach with a maximum caliper width of 0.01. Comparisons of survival between each pair were used to estimate the overall HR. We confirmed the assumption of proportional hazards by a visual examination of the log minus log plots (Figure S1). All statistical calculations were carried out using Stata.

3 | RESULTS

Table 1 shows the baseline demographics of the study population. The mean age (with standard deviation) was 83.5 (7.3) years. Of the 554 patients, 327 (59.0%) identified as female, 521 (94.0%) were classified as care level ≥1 (requiring at least partial care in daily life due to impairment of activity and cognition), 174 (31.4%) lived with someone, and 520 (93.9%) received care at home. During a median of 579 days of follow-up, 102 (18.4%) patients died, 105 (19.0%) were admitted to a hospital, and 109 (19.7%) were admitted to a nursing home. Thus, 316 (57.0%) patients experienced death or admission to a hospital or nursing home.

Table 2 shows the baseline demographics of the study population before and after propensity score matching. Of the 554 patients, 80 pairs were matched. Prior to matching, patients whose information was shared on the platform were older ($p = 0.028$), more often female ($p = 0.022$), followed-up longer ($p = 0.013$), and had different distribution to care facilities ($p < 0.001$), compared with the control group.

Table 3 shows the risk of adverse outcomes (i.e., death or admission to a hospital or nursing home), comparing those with and without interprofessional communication, prior to and after propensity score matching. The Cox proportional hazards model derived a HR for adverse outcomes of 0.60 (CI: 0.45–0.80; $p < 0.001$) for those who received care with interprofessional communication, compared with those who did not. These associations remained essentially unchanged after adjustment for baseline covariates (HR: 0.47; CI: 0.35–0.64; $p < 0.001$). The conditional Cox proportional hazards model after propensity score matching showed a similar HR of 0.59 (CI: 0.39–0.88; $p < 0.010$). Figure 2 shows the propensity score matched survival curve for the increased risk of adverse outcomes in patients whose information was not shared; this is consistent with the results of the conditional Cox proportional hazards model.

4 | DISCUSSION

This study showed that interprofessional communication using a digital platform significantly decreased the risk of death or admission to a hospital or nursing home in the information-shared group, compared with the control group, after adjusting for age, sex, presence of housemate, living environment, nursing care level, and treatment facility. The effect remained observable after propensity score matching.

TABLE 1 Demographic characteristics of study participants

Variable		Total (*n* = 554) *N* (%) or Mean (SD)
Age (in years)	Mean	83.5 (7.3)
Sex	Male	227 (41.0)
	Female	327 (59.0)
Nursing care level	Not certified	1 (0.2)
	Support level 1	9 (1.6)
	Support level 2	23 (4.2)
	Care level 1	105 (19.0)
	Care level 2	103 (18.6)
	Care level 3	88 (15.9)
	Care level 4	110 (19.9)
	Care level 5	115 (20.8)
Living with someone	Yes	174 (31.4)
	No	380 (68.6)
Living environment	At home	520 (93.9)
	At care house	34 (6.1)
Median follow-up (days) for developing any events or the censor	Median (Q1, Q3)	579.0 (204.0, 1119.0)
Death	Yes	102 (18.4)
	No	452 (81.6)
Admission to hospital	Yes	105 (19.0)
	No	449 (81.0)
Admission to nursing home	Yes	109 (18.7)
	No	445 (80.3)
Experienced any of the events	Yes	316 (57.0)
	No	238 (43.0)
Treatment facility	A	161 (29.1)
	B	229 (41.3)
	C	84 (15.2)
	D	44 (7.9)
	E	36 (6.5)

Previous studies have shown that ICT applications can improve access to clinical information in primary care settings and enhance the perceived quality of care, as perceived by physicians and patients.[17–19] Other previous studies have found no such positive effects on improved ambulatory care.[20] Apart from the qualitative reports derived from subjective assessments based on surveys, several studies have quantitatively reported health outcome improvements, resulting from information sharing in hospitalized patients.[8,9] To date, only case studies have been conducted in home care settings, which have reported the organizational advantages of cloud-based information sharing systems, such as facilitating cooperation, continuous monitoring of patients, and an improved sense of security and confidence.[21–23] Overall, our study is generally consistent with previous literature, in that it demonstrates the clinical

TABLE 2 Demographic characteristics before and after propensity score matching

Variable		Before PS matching (*N*, %)			After PS matching (*N*, %)			
		Control group ($n = 82$)	Information-shared group ($n = 472$)	*p* value	Control group ($n = 80$)	Information-shared group ($n = 80$)	*p* value	Bias (%)
Age (in years)	Mean	81.9 (7.7)	83.8 (7.2)	0.028	82.3 (7.4)	81.4 (7.3)	0.426	12.4
Sex	Male	43 (52.4)	184 (39.0)	0.022	41 (51.3)	47 (58.8)	0.340	15.1
	Female	39 (47.6)	288 (61.0)		39 (48.8)	33 (41.3)		
Nursing care level	Not certified	0 (0)	1 (0.2)	0.648	0 (0)	0 (0)	0.974	
	Support level 1	3 (3.7)	6 (1.3)		3 (3.8)	2 (2.5)		
	Support level 2	4 (4.9)	19 (4.0)		4 (5.0)	3 (3.8)		6.0
	Care level 1	14 (17.1)	91 (19.3)		14 (17.5)	11 (13.8)		9.7
	Care level 2	18 (22.0)	85 (18.0)		18 (22.5)	19 (23.8)		3.1
	Care level 3	15 (18.3)	73 (15.5)		13 (16.3)	17 (21.3)		13.3
	Care level 4	15 (18.3)	95 (20.1)		15 (18.8)	15 (18.8)		0.0
	Care level 5	13 (15.9)	102 (21.6)		13 (16.3)	13 (16.3)		0.0
Living with someone	Yes	25 (30.5)	149 (31.6)	0.846	25 (31.3)	22 (27.5)	0.603	8.1
	No	57 (69.5)	323 (68.4)		44 (68.8)	58 (72.5)		
Living environment	At home	79 (96.3)	441 (93.4)	0.311	77 (96.3)	79 (98.8)	0.311	11.3
	At care house	3 (3.7)	31 (6.6)		3 (3.8)	1 (1.3)		
Median follow-up (days) for developing any events or the censor	Median (Q1, Q3)	408.5 (166.0, 936.0)	605.5 (247.5, 1166.5)	0.013	408.5 (166.5, 954.5)	543 (190.5, 1095.5)	0.199	
Treatment facility	A	42 (51.2)	119 (25.2)	<0.001	40 (50.0)	46 (57.5)	0.569	
	B	6 (7.3)	223 (47.3)		6 (7.5)	6 (7.5)		0.0
	C	16 (19.5)	68 (14.4)		16 (20.0)	18 (22.5)		6.7
	D	12 (14.6)	32 (6.8)		12 (15.0)	6 (7.5)		24.3
	E	6 (7.3)	30 (6.4)		6 (7.5)	4 (5.0)		9.9

TABLE 3 Risk of death, admission to hospital and admission to nursing home as events associated with interprofessional communication through digital platform prior to and after propensity score matching

		Prior to propensity score matching		After propensity score matching	
		Control group ($n = 82$)	Information-shared group ($n = 472$)	Control group ($n = 80$)	Information-shared group ($n = 80$)
Number of death (%)		13 (15.9)	89 (18.9)	13 (16.3)	15 (18.8)
Number of admissions to hospital (%)		26 (31.7)	79 (16.7)	25 (31.3)	15 (18.8)
Number of admissions to nursing home (%)		20 (24.4)	89 (18.9)	20 (25.0)	10 (12.5)
Number of those who were censored (%)		23 (28.1)	215 (45.6)	22 (27.5)	40 (50.0)
HR (95% CI)	Crude	**0.60 (0.45, 0.80)**		**0.59 (0.39, 0.88)**	
	Adjusted[a]	**0.47 (0.35, 0.64)**		**NA**	

Note: Bold indicates $p < 0.05$.

[a]Adjusted for age, sex, living with someone, at home or care house, nursing care level, and treatment facility.

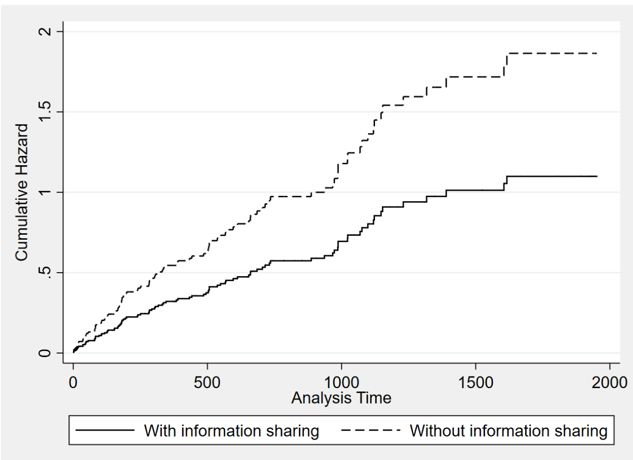

FIGURE 2 Propensity score matched survival curve displaying the cumulative hazard ratios of composite events in the information-shared and control groups. The cumulative hazard of adverse outcome is shown on the y-axis. The x-axis represents the number of days the patient received home care. Lines denote the information-shared group (solid) and control group, without information sharing (dotted)

benefits of information sharing. Yet, this study is innovative in that it provides evidence of improvement in the health status of patients. Furthermore, no previous study has explored the direct effect on health outcomes of interprofessional collaboration using ICT.

The decreased risk of adverse health outcomes in elderly patients receiving home care has several possible explanations. First, the digital platform made available the in-depth health status of care recipients and real-time update of their vital signs and daily care reports. In rural areas, such as the study setting herein, the continued use of conventional technologies (e.g, fax) and systems (e.g., duplicate documentation) in addition to insufficient trust of data hinders smooth sharing of knowledge among health professionals.[24] The introduction of ICT facilitated access to information and increased patient safety by reducing the risk of misplacing patient information.[25] It enabled nurses and caregivers to become more aware of the patient's needs and medical history at the point of care. The platform integrated a tool for the intermittent monitoring of trends in vital signs. According to previous studies, this improves accurate detection of clinical deterioration in patients.[26] Second, information exchange may have led to care plans being better constructed at the upper level of care coordination. Care managers and nurses were more capable of tailoring coordinated care for each patient because of the availability of home health care and medication records, which are often lacking or available in poor quality.[27] Third, accelerated interprofessional collaboration through the use of ICT improved professional practice and, consequently, healthcare outcomes in the care recipients,[6,28] especially regarding contacting collaborators, indicating the level of urgency, and posting comments in daily reports.[29] Finally, ICT supported the transition and continuity of care, which may have contributed to our positive findings. Undesirable outcomes can result from poor communication between home care nurses and hospitals regarding medication regimens, disease severity, hospital discharge management, and home safety procedures. Hence addressing these issues can potentially prevent unnecessary hospital admissions and unplanned readmissions.[30] The continuity of care during the transition from the hospital to home can be optimized by leveraging electronic communications, which reduces readmission rates.[31]

Our study has several limitations. Due to its observational nature, it is possible that the study participants' baseline characteristics differed; a lack of randomization may have had an impact on the observed differences in risk. In an effort to reduce such bias, propensity score matching was performed to adjust for differences in baseline characteristics.[32] During enrollment, patients who stopped receiving care for various reasons were omitted, which may have induced selection bias. Also, we did not investigate the extent to which patient information was shared using the digital platform. Therefore, the associations between information sharing, interprofessional collaboration, and improved health outcomes are of unknown strength. Furthermore, neither the Cox proportional hazard model nor the propensity score matching analysis included some essential factors associated with health outcomes (e.g., multimorbidity, receipt of medication or other ongoing therapy, and socioeconomic status), which were absent in the database we analyzed. Despite our use of nursing care level to approximate patients' baseline health status, the lack of this data might have contributed to the large decrement of risk observed in this study; therefore, it should be considered as exploratory and hypothesis-generating.

This study has several important clinical implications. The ICT system we studied fostered smooth information sharing between the different stakeholders involved in the home care of elderly patients. It is striking that data sharing alone was effective in reducing the risk of adverse health outcomes, which emphasizes its importance in the care of elderly patients. Many other software tools that specialize in data sharing among caregivers and health care providers have been developed, including applications developed for research purposes (e.g., Care Better, Cuidador Acvida, Zirkel) and commercial applications (e.g., Carezone, Jointly, CaringBridge).[33] The results of our study imply that in similar rural areas where there is difficulty in collaborating, the equipping of care facilities with any digital platform that improves information sharing could potentially lead to better health outcomes. The ability to communicate evidence through ICT systems may reduce barriers to their adoption in community care and reduce patient hesitation toward data sharing.[34]

In conclusion, the risk of death or admission to a hospital or nursing home in elderly Japanese home care patients can be reduced by fostering interprofessional collaboration using ICT. The external validity of this study is limited, as it was conducted in a single municipality. Further randomized controlled study is warranted to assess the effectiveness of ICT interventions in home care settings.

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CONFLICT OF INTEREST

Teppei Sakano is the founder and CEO of Allm Inc., Tokyo, Japan and Munenori Uemura was employed by Allm Inc. at the time this study was conducted.

INSTITUTIONAL REVIEW BOARD STATEMENT

This study was approved by the research ethics committee at Tokyo Medical and Dental University.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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