Brief Report

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Journal of Applied Gerontology
1–7

DOI: 10.1177/0733464820944043
journals.sagepub.com/home/jag
SAGE

Mobile Technology Care Coordination of Long-Term Services and Support: Cluster Randomized Clinical Trial

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Abstract

The purpose of the study was to assess whether the effects of a mobile predictive intervention used by Service Coordinators (SCs) reduce hospital utilization in a Medicaid Long-Term Services and Supports (LTSS) population in Baltimore city during a 5-month intervention. SC participants ($n = 11$) were recruited to treatment or control groups. LTSS clients ($n = 420$) followed their SC randomization assignment. Utilization data were obtained from the Maryland Chesapeake Regional Information System for our Patients (CRISP) Health Information Exchange (HIE) system and linked to service coordination records. Study groups were similar in age, gender, race, and years receiving LTSS. SCs' satisfaction with use of the mobile tool was surveyed. SC perceptions were neutral (mean scores ranged from 2.3 to 3.3 on a 5-point scale). No significant differences between groups were observed for all utilization metrics. The mobile technology software system used in this study did not improve health care utilization for a LTSS population needing ongoing clinical and social services coordinated care.

Keywords

care coordination, technology, Long-Term Services and Supports, Medicaid

Introduction

An increasing population of older adults (65 years and older) live in the community with support from state Medicaid Long-Term Services and Supports (LTSS) programs. Individuals older than 85 years, a rapidly growing cohort, are most likely to need LTSS, including personal assistance, hospital-to-home transition, home accessibility adaptions, and chronic disease monitoring (Centers for Disease Control and Prevention, 2019). This demographic trend will place increasing burden on states to coordinate health and social services in order for older adults to remain in the community. LTSS encompass the broad range of medical and personal care assistance that people may need—for several weeks, months, or years—when they experience difficulty completing self-care tasks (i.e., meal preparation, medication management, grocery shopping) as a result of aging, chronic illness, or disability (Reaves & Musumeci, 2015). Care planning and care coordination services help beneficiaries and families navigate the health system and ensure that the proper providers and services are in place to meet beneficiaries' needs and preferences (Reaves & Musumeci, 2015).

Care coordination is a systematic approach that facilitates communication and the arrangement of services between and among individuals, their caregivers, and health and social service providers (McDonald et al., 2007). Care coordination, including case management, generally include facilitation of care transitions; needs assessment and goal setting; creation of a proactive plan of care; medication management; community resource linkage; and monitoring with follow-up. Systematic reviews and meta-analysis research show that care coordination interventions are associated with small changes in patient-centered outcomes (mortality, quality of

Manuscript received: December 17, 2019; **final revision received:** June 17, 2020; **accepted:** June 26, 2020.

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life, disease-specific health outcomes, avoidance of nursing home placement, and patient satisfaction with care) and quality of care (disease-specific process measures, receipt of recommended health care services, adherence to therapy, missed appointments, patient self-management, and changes in health behavior; Hickam et al., 2013; Kastner et al., 2018). Although some care coordination programs improve resource utilization (hospitalization rates, hospital days, emergency department [ED] use, and number of provider visits), (Hickam et al., 2013; Kastner et al., 2018) there is limited evidence on impact on health care costs. More recently, opportunities to address workforce availability and service delivery efficiency provide evidence on the positive impacts of technology applications on clinical outcomes (Rantz et al., 2010) using sensor-based monitoring, (Alexander et al., 2008) web-based interfaces for use by participants, and family and coordinators address older adult concerns for safety and privacy (Demiris et al., 2004). One way to improve health care costs is through implementation of technology-based interventions.

Significant variation exists in Maryland Medicaid approaches to implement community-based LTSS services (American Association of Retired Persons, 2012, 2017; Burgdorf et al., 2020). In general, Maryland Medicaid contractors work with individual clients through an assigned Service Coordinator (SC) to identify personal goals and motivators, promote self-management skills, advocate for services and supports, and identify community resources to meet individual needs. There exist significant variations in the care coordination utilized by Maryland Medicaid contractors, including the incorporation of assigned SCs. The SC's work includes coordination of community service providers to meet participants' complex social needs with a central focus of reducing unnecessary health service utilization (hospital ED observation or admission and inpatient admission), and coordinate community service provision for complex social needs. However, SCs experience major barriers to care coordination, affecting their effectiveness and efficiency in the current system. These include failure to accurately anticipate needs based on clinical and health-related social indicators, as well as inconsistent communication between unlicensed SC staff and the registered nurse (RN). In current practice, unlicensed staff are trained to interact with their clients and consult the RN when the client reports a change in health. The incorporation of automatic communication between the SC assessment and RN through real-time technology-based assessments and utilization of clinical algorithms can improve decision-making on potential health care needs in medically and socially complex populations.

Care at Hand (CAH) developed a mobile set of algorithms shown to decrease hospital readmissions when used for a home health care population recently discharged from acute care encounters, which has previously been described (Ostrovsky et al., 2016). Using CAH web-based application, a health coach conducted a 15-question, 2- to 5-min survey to detect an elevation in risk factors following each participants' encounter (i.e., hospital, telecommunication, in-home visit). If an elevation in risk factors was detected by the system's algorithm, the nurse care manager was automatically alerted in real time (Ostrovsky et al., 2016). While there had been no evaluation in a LTSS population prior to this study, the value of the technology to facilitate ongoing care for this population was considered a potential new use of the technology and evaluation goal of the study reported here. Recent studies have addressed user satisfaction as vital to the adoption and effective use of technology (Graetz et al., 2014; Kooij et al., 2017). The specific research aim of this project was to determine if the addition of technology-based assessment and algorithms would improve health care utilization outcomes in a randomized study of nonlicensed community coordinators (SCs) for an adult Medicaid LTSS community population conducted over a 5-month intervention period. Our hypothesis was that using a technology-directed approach to care coordination would improve clients' health care utilization. In addition, this study was also interested in the participants' satisfaction of the technology-based supports used to coordinate care between the SCs and RN care staff.

Method

Study Setting

The study was conducted in a community-based population of Maryland Medicaid recipients receiving LTSS. The LTSS services were provided by The Coordinating Center, a not-for-profit Maryland Medicaid provider. Medicaid recipients were eligible for coordinated care through one of the three waivered programs: Money Follows the Person, Community First Choice, and the Community Options Waiver. The SC–client relationship was established before the introduction of the study and technology. Participants were enrolled in the study intervention from August through December 2016.

The University of Maryland Institutional Review Board (IRB) reviewed and approved the project protocol as a non-human subject study. The project was intentionally designed so that University of Maryland investigators would receive only de-identified data files from the Maryland Health Information Exchange (HIE) organization, Chesapeake Regional Information System for our Patients (CRISP) for analyses. The study was also approved for data sharing under a CRISP Data Sharing Agreement, meeting CRISP requirements of the use case for IRB-approved research.

Sample

The study procedures cluster-randomized 11 SCs and their clients ($n = 420$) to a control group ($n = 5$ SCs; LTSS coordination as usual care; $n = 195$ clients) or intervention group ($n = 6$ SCs; CAH; $n = 225$ clients). SCs volunteered for the study and were randomly assigned to the control or intervention clusters. SCs were randomized at a 1:1 ratio to the intervention or the control groups using Excel (https://www.microsoft.com/en-us/microsoft-365/business/microsoft-365-apps-for-enterprise, version 1908). LTSS clients followed the randomization assignment of their coordinator.

Intervention

During each in-home and telephonic encounter, the SC used a web-based application, CAH (Care at Hand, 2020) available on tablets. No modifications of CAH, or its algorithms, were implemented for use in this LTSS population. Intervention SCs received in-person training on CAH use. Although we cannot guarantee treatment fidelity, technical support was available through weekly conference calls. SCs and clients interacted on a monthly basis during required and interim contacts (via phone) and/or during on-site home or medical visits.

The CAH algorithm suggested survey questions on a tablet screen to care coordinators in lay language based on the LTSS clients' most likely risk factors for hospitalization. The CAH new client Onboarding Survey offers five questions. Questions 1 through 3 are specific to someone recently hospitalized. The purpose of Questions 4 and 5 is to identify the two most active issues.

1. When was the client admitted to the hospital?
2. When was the client discharged from the hospital?
3. Where was the client discharged to?
4. What is the most concerning active issue for the client? Select one from the list.
5. What is the second most concerning active issues? Select one from the list.

Responses to Questions 4 and 5 launch the subsequent 15-field question survey. The survey is designed to take no more than a few minutes to administer. Examples of field survey questions are the following:

> Ask client: Did you fall or touch the ground since the last visit?
>
> Ask client: Are you able to manage difficult emotions like anxiety or frustration related to your medical condition(s)?
>
> Ask client: In the past week, have you needed assistance with more activities of daily living (ADLs) than usual?

The CAH questions update with each administration of the survey driven by algorithms that predict the most likely risk factors for acute care admission. If the system detects an elevated risk, real-time alerts are generated to an office-based RN care coordinator, also trained on using the system and required to respond to alerts. The RN accessed survey detail by drilling into the alert. The RN added additional assessment information after additional triage with the client. The RN care coordinator subsequently assisted the SC in care coordination and care management within 24 hours of receiving the alert, that is, which may include phone calls to clients or in-person visits to complete the problem assessment. Alerts to the RN varied depending on client need or occurrence of an elevated risk. The intervention was different from study site current (control) practice by using a preset algorithm of survey questions which were updated based on client responses during the interview and over time for follow-up client surveys. Interview tools used by the control group included only self-reported general health updates.

The technology intervention added the ability to proactively and consistently survey and identify those at risk of a hospital encounter based on their most active issues. The key ingredient of the intervention was the technology's algorithms used to customize survey questions and screen for risk for hospitalization. Based on the answers to the survey, there is real-time communication with the office-based RN.

Measurements

The primary outcome was health care utilization (emergency department [ED] visits, hospitalizations, and hospital length of stay over 5 months) obtained from the CRISP HIE and linked to care coordination clinical records. Data for the project were intentionally designed so the University of Maryland investigators would receive only de-identified data files from the CRISP HIE for analyses. Data for the preintervention were obtained for the period March to July, 2016, postintervention were August to December, 2016. A secondary outcome was care coordinators' satisfaction with use of the mobile CAH intervention measured through a survey questionnaire sent at the end of the study period.

The Coordinating Center client records were matched to CRISP statewide acute care admission and discharge encounters. CRISP data analysts performed the de-identification and file linkage with client Coordinating Center records. CAH onboarding data were de-identified to provide client descriptive characteristics.

Statistical Analysis

Patients' characteristics between the two groups (intervention vs. controls) were compared using the *t* test for continuous variables and chi-square for categorical variables. Utilization data were analyzed using generalized linear mixed-effects models, which included randomization group and time (before vs. after randomization) and their interaction as the explanatory variables and accounted for both repeated measurements over time and patients clustered within SCs. Mixed-effects logistic regression was used for binary outcomes (e.g., any hospitalizations over 5 months); mixed-effects Poisson regression was used for count outcomes (e.g., number of hospitalizations over 5 months). For the continuous outcome of cumulative hospitalized days over 5 months, because it was highly skewed with excess numbers of zeros, square root transformation was applied first, then a linear mixed-effects model was used on the transformed data. There were no missing data in the data set for the mixed-effects models. Note that we did not adjust for any confounding variables in the mixed-effects models; hence, missing data had no impact on the results reported in mixed-effects models. All analyses were run in SAS 9.3 (SAS Institute, Inc, Cary, NC) or Stata/SE (Version 15).

Results

In 11 SC clusters, 420 LTSS clients were followed up as control (n = 195) or intervention (n = 225) participants (Table 1). Both study groups were predominantly younger than 65 years, had slightly more female participants, predominately African American, and the majority had received LTSS coordinated care from 2 to 5 years (no statistical difference). The leading active issues identified for care coordination included stroke, fall risk, chronic pain, wound, requires help with ADLs, and hypertension (data not shown).

The majority of SCs (5) had a bachelor's degree; two had a master's degree and had worked at the Coordinating Center for an average of 2 years (data not shown). SCs' perceptions of the CAH averaged from 2.3 to 3.3, a generally neutral range, on a 5-point Likert-type scale, from 1 = *strongly agree* to 5 = *strongly disagree* (Table 2). The strongest assessment was for "the CAH technology was user friendly (intuitive)" (3.3) and "The CAH technology improved efficiency in determining risk factors for rehospitalization" (3.1). One coordinator responded "Not Applicable" for Items 1, 4, and 5. Another coordinator did not respond to Item 6.

There were no significant differences between the control group and the CAH intervention group on all utilization metrics (Table 3). A post hoc power analysis was conducted for the primary outcome of any hospitalization 5 months after randomization. In this study, there were six clusters in the intervention group and five clusters in the control group; the average number of patients per cluster was 37.5 in the intervention group and 39 in the control group; the intracluster correlation (ICC) was 0, and the hospitalization rate was 15.11% in the intervention group and 14.36% in the control group. This sample size achieves 5.5% power to detect the difference between the group proportions of 0.75% (=15.11%–14.36%) using a two-sided Z-test with an ICC of 0 and the significance level of 5%. Assuming the hospitalization rate is 14.36% in the control group, our study would have 80% power to detect the difference between the two groups if the hospitalization rate in the intervention group were less than 6.04% or greater than 25.09%.

Table 1. Demographic Characteristics of Participants Enrolled in LTSS, n = 420.

Characteristic	Control (n = 195)	Intervention (n = 225)	p value
Age (years), n (%)	56 (28.7)		.50
<50	70 (35.9)	51 (22.7)	
50–64	26 (13.3)	89 (39.6)	
65–74	27 (13.9)	26 (11.6)	
75–84	16 (8.2)	33 (14.7)	
≥85		26 (11.6)	
Gender, n (%)			.80
Female	112 (57.4)	132 (58.7)	
Male	83 (42.6)	93 (41.3)	
Race (among those with CRISP data), n (%)			.94
African American	25 (71.4)	23 (67.7)	
White	8 (22.9)	9 (26.5)	
Other	2 (5.7)	2 (5.9)	
LTSS Care Coordination Duration (years), n (%)			.12
≤1	28 (14.4)	24 (10.7)	
2–5	145 (74.4)	161 (71.6)	
≥5	22 (11.3)	40 (17.8)	

Data Source. Control group, Coordinating Center; Intervention group, intervention onboarding data.
Note. CRISP = Chesapeake Regional Information System for our Patients; LTSS = Long-Term Services and Supports.

Discussion

To our knowledge, this is one of the first large, randomized studies of a mobile intervention for coordination assessment of Medicaid LTSS recipients. Although the mobile intervention had prior positive results in a home health services population (Ostrovsky et al., 2016), in this LTSS population, we found no difference in ED use or readmissions. These results may be due to applying a technology designed for one purpose (to provide care coordination after hospital discharge) to a much different care coordination population. The technology algorithm was originally designed to be administered at least weekly, primarily over a short period of transition (usually 30 days postdischarge). The LTSS population in this study was less likely to have had a recent hospitalization, and their intervention frequency (and delivery of CAH) was limited due to less frequent encounters by the SCs. Future studies should evaluate whether a weekly interaction of SCs using the technology intervention shows different results in an LTSS population. Furthermore, focusing on new admissions to a care coordination program may provide new insights into the impact of the intervention. Additional studies over a longer period and additional analysis of population variables may provide better insight into care transitions (Hirschman et al., 2020; Kansagara et al., 2011; Verhaegh et al., 2014). Although

Table 2. Care Coordinator Users' Perceptions of the CAH Intervention[a], $n = 7$.

Question	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree	*M*	*SD*
1. By using the CAH technology, I was better able to provide service coordination.[b]	1 (17%)	2 (33%)	2 (33%)	0 (0%)	1 (17%)	2.7	1.2
2. The prompts on the CAH technology were relevant to the client conditions/situation.	0 (0%)	2 (29%)	3 (43%)	1 (14%)	1 (14%)	3.1	1.0
3. The CAH technology improved efficiency in determining risk factors for re-hospitalization.	0 (0%)	3 (43%)	1 (14%)	2 (29%)	1 (14%)	3.1	1.1
4. The CAH technology was easy to use during client phone contacts.[b]	1 (17%)	1 (17%)	2 (33%)	1 (17%)	1 (17%)	3.0	1.3
5. The CAH technology was easy to use during client visits.[b]	0 (0%)	4 (67%)	1 (17%)	1 (17%)	0 (0%)	2.5	0.8
6. The CAH technology was user friendly (intuitive).[b]	0 (0%)	1 (17%)	2 (33%)	3 (50%)	0 (0%)	3.3	0.7
7. I would recommend the use of CAH technology to the routine provision of service coordination.	2 (29%)	2 (29%)	2 (29%)	1 (14%)	0 (0%)	2.3	2.3

Note. CAH = Care at Hand.
[a]Data source: Coordinating Center Satisfaction Survey. [b]Responses missing; one coordinator responded "Not Applicable" for Items 1, 4, and 5. Another coordinator did not respond to Item 6.

Table 3. Health Care Utilization of Participants Before and After Randomization, n = 420.

Utilization metrics	Control (n = 195)	Intervention (n = 225)	Model-based intervention effect[a]	
Binary outcomes	n (column %)	n (column %)	OR [95% CI][b]	p value
Have any hospitalizations				
5-month before randomization	35 (18.2)	34 (15.1)	0.74 [0.36, 1.52]	.415
5-month after randomization	28 (14.4)	34 (15.1)	1.07 [0.51, 2.23]	.858
Have any ED visits				
5-month before randomization	61 (31.3)	56 (24.9)	0.56 [0.26, 1.17]	.124
5-month after randomization	48 (24.6)	56 (24.9)	0.98 [0.46, 2.09]	.95
Count outcomes	M (SD)	M (SD)	IRR [95% CI][c]	p value
Number of hospitalizations				
5-month before randomization	0.3 (0.6)	0.3 (0.7)	0.9 [0.53, 1.53]	.696
5-month after randomization	0.2 (0.5)	0.3 (0.8)	1.24 [0.71, 2.17]	.441
Number of ED visits				
5-month before randomization	0.6 (1.2)	0.6 (1.6)	0.89 [0.56, 1.4]	.606
5-month after randomization	0.6 (1.7)	0.6 (1.3)	0.83 [0.52, 1.32]	.438
Continuous outcomes	M (SD)	M (SD)	Difference [95% CI][d]	p value
Number of cumulative hospitalized days				
5-month before randomization	1.6 (4.8)	1.4 (5.1)	−0.07 [−0.32, 0.17]	.558
5-month after randomization	1.3 (4.9)	3.1 (16.2)	0.17 [−0.07, 0.42]	.173

Note. OR = odds ratio; CI = confidence interval; IRR = incidence rate ratio; ED = emergency department.
[a]The explanatory variables include the randomization group (intervention vs. control), time (before vs. after randomization), and their interaction. The control group is the reference group. [b]Results were obtained using mixed-effects logistic regression. [c]Results were obtained using mixed-effects Poisson regression. [d]Results were obtained using linear mixed-effects regression on the square root transformed data.

the cluster-randomized design in the study reported here strengthens the research design, it is possible defining clusters differently, that is, clusters of multiple provider settings and prespecifying the cluster control group care coordination approach, would further strengthen study design and outcome interpretation.

SCs' perceptions of satisfaction using the mobile intervention were generally neutral. This finding may be a reflection of technical problems experienced by the SCs which, although these issues were resolved, may have influenced usability. Only seven coordinators were surveyed which affects overall average assessments. Also, coordinators in the study were well educated and had experience in coordinating services for the LTSS population which may have limited the opportunity to detect significant differences, although experienced coordinators in this study thought the mobile platform with coordination assessment questions was an added value. More specific measurement of SC use of the technology after each care coordination episode with a comparative measure of control group care coordination episodes may provide new information to detect differences.

Limitations

Implementing a technology-based intervention has challenges, including translation of intended use to a new population, acceptance into established workflow, and addressing technical problems. We attempted to address the issues of workflow and adoption by having a clinical site champion and biweekly study calls which included addressing any technical issues. We expected to have more client-specific data to describe or explain differences between the study groups but were limited to state required LTSS data. The study follow-up period was 5 months which limited the likelihood of observing hospitalizations and ED visits, especially if the goal of coordinated care was to prevent acute care encounters. There are other factors that could influence hospital readmission and length of stay, including the amount of interaction between the SC and the client.

Conclusion

As the LTSS population increases and becomes more diverse, state and federal governments and private stakeholders will be challenged to find innovative ways to coordinate, deliver, and finance high-quality, person-centered LTSS in the most appropriate care setting while at the same time reducing unnecessary health care costs. Although previous studies provide evidence suggesting technology-based assessments may reduce unnecessary health care utilization and improve health care decision-making, as demonstrated in this study, prior to technology adoption, detailed evaluations are needed to improve fit and efficacy for the planned population and use. Technology is not one size fits all.

Acknowledgments

We appreciate the Coordinating Center Adult Community Services Director, Service Coordinators, and Nurse Consultant for implementing the mobile technology intervention and the Chesapeake Regional Information System for our Patients (CRISP) for providing de-identified data files.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The project was funded by a competitive application to the Maryland Industrial Partnerships (MIPS) program, through the University of Maryland, an initiative of the University of Maryland School of Engineering's Maryland Technology Enterprise Institute (http://www.mips.umd.edu/). Technology utilized during this study was donated. The funder of this project had no role in the design, methods, subject recruitment, data collections, analysis, or preparation of this article.

IRB Approval

The University of Maryland Institutional Review Board (IRB) approved the project protocol. Approval No.: HP 00070003, exempt by letter. The research took place in Baltimore, MD. The study was also approved for data sharing under a statewide Maryland Health Information Exchange (HIE) organization, Chesapeake Regional Information System for our Patients (CRISP) Data Sharing Agreement, meeting CRISP requirements of the use case for IRB-approved research.

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