

Telehealth Intervention Programs for Seniors: An Observational Study of a Community-Embedded Health Monitoring Initiative

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Abstract

Background: Chronic disease in older adults is estimated to account for 84% of annual health care spending in the United States, with many preventable costs expected to rise as the population continues to age.

Introduction: Telehealth Intervention Programs for Seniors (TIPS) is a community-embedded program targeting low-income older adults, providing weekly assessment of vital signs and subjective wellness, and wrap-around aging services.

Materials and Methods: TIPS recruited 765 volunteers over 55 years, who were Medicaid and/or Medicare eligible. Data were collected from 2014 to 2016 [median enrollment 343 days (105–435)] using 12 TIPS sites. This observational study evaluated the efficacy of TIPS by measuring within-subject changes in self-reported hospital visits and <30-day readmissions, before and during TIPS participation. Data of 617 participants (median age 74.3; interquartile range 16) were analyzed.

Results: Self-reported hospital visits were reduced by 28.9% ($p = 0.0013$). Medicare participants benefited the most, with a 50% ($p < 0.0001$) reduction in hospital visits, and a 75.5%

($p = 0.017$) reduction in <30-day readmissions. Multivariate analysis revealed that participants (1) Medicaid-registered (odds ratio [OR] = 2.72, 95% confidence interval [CI] 0.392–1.611), (2) reporting feeling unwell (OR = 1.33, 95% CI 0.118–0.459), and (3) living alone (OR = 2.34, 95% CI 0.115–1.592) were significantly more likely than other participants to experience a hospital visit.

Discussion: TIPS demonstrates that community-embedded health services can reduce rates of hospital visits in older adults.

Conclusion: The success of TIPS highlights the potential of successfully deployed remote patient-monitoring initiatives in reducing the utilization of costly health services.

Keywords: telehealth, older adults, chronic disease, remote patient monitoring

Introduction

The population over 65 years of age in the United States is projected to double within the next 25 years. By 2030, 72 million people, almost one in every 5 Americans, will be 65 years or older.¹ Chronic health conditions increase with age, with over 90% of the over-65 population reported to have at least one chronic health condition, and 73% have multimorbidity.^{1–3} The more chronic health conditions, the greater the health care cost to hospitals, insurers, and the Medicare/Medicaid system.^{2,4,5} Care for those with chronic health conditions in the U.S. accounts for 84% of health expenditure, with 95% of Medicare spending dedicated to patients with multimorbidity.^{3,5} Compared with individuals without chronic disease, health care spending is three times greater for someone with one chronic condition and over seven times greater for someone with three chronic conditions.^{3,6}

Low socioeconomic status and multimorbidity are predictors for hospitalization and increased rate of emergency room (ER) presentation.^{2,4,7} Medicare beneficiaries with multimorbidity are twice as likely to be admitted to the ER or hospital compared with beneficiaries with only one chronic health condition.⁵ Despite the high demand for ER services, many ER admissions are preventable if early intervention measures are taken. However, early intervention is often not an option for many older adults due to financial or logistical barriers related to accessing quality health care services.^{8,9} It is

therefore critical to investigate pragmatic solutions for coordinated community-based health care for financially vulnerable individuals with chronic health conditions.

Remote Patient Monitoring (RPM), which involves the transmission of health care data from the patient to a health care provider (in a different location) for the purpose of assessment or intervention¹⁰ might be one such solution. While RPM trials investigating multimorbidity in a community-based setting are lacking, RPM programs can reduce the costs associated with chronic disease management.¹⁰⁻¹³

Telehealth Intervention Programs for Seniors (TIPS) is a community-embedded health and wellness initiative, developed under the auspices of the Westchester Public/Private Partnership for Aging Services (WPPP). It is an innovative combination of RPM, extensive social wraparound services, care coordination, and intergenerational socialization aimed at improving health care options to assist low-income, high health-risk older adults who live in subsidized congregate housing or attend local community centers for older adults.

The purpose of this study was to determine the effectiveness of TIPS in reducing the incidence of self-reported hospital visits and <30-day readmissions in participating older adults. Features predictive of hospitalization in those with chronic health conditions are also discussed. We hypothesized that there would be a reduction in the incidence of self-reported hospital visits and <30-day readmissions after the implementation of TIPS. We performed secondary analyses relating individual participant characteristics to risk of a hospital visit.

Materials and Methods

ETHICS STATEMENT

All TIPS participants signed an informed consent document, which included a provision allowing their de-identified data to be studied and published. Retrospective approval to publish data collected during TIPS services in New York and Pennsylvania was granted by the Burke Rehabilitation Hospital Committee for Human Rights in Research (IRB approval no. BRC-523). Similarly, The Icahn School of Medicine at Mount Sinai Program for the Protection of Human Subjects reviewed the nature of the de-identified data and made a formal determination that it did not qualify as human subject's data (IRB-17-02553). Researchers received retrospective data from TIPS sites that were run by community organizations or local government officials. As such, researchers were unable to suggest randomization protocols for TIPS sites, or interrogate Medicare/Medicaid claims data to capture each participant's past medical history objectively.

PARTICIPANTS

Volunteers were recruited by advertising through community older adult centers and older adult congregate housing sites in Westchester County, NY and Scranton, PA. Participants were enrolled in TIPS if they were over 55 years old, registered as a Medicare and/or a Medicaid beneficiary, and identified as English or Spanish speaking. Participants were eligible if they lived in Westchester County, NY or Scranton, PA and agreed to voluntarily attend weekly TIPS screening sessions. At intake, each participant was asked to self-report if, to the best of their knowledge, they live with any of the following chronic conditions: hypertension (HTN); chronic obstructive pulmonary disease (COPD); congestive heart failure (CHF); multiple falls; diabetes mellitus (type 1 or 2); depression; obesity; stroke; coronary artery disease (CAD); liver disease; hypoglycemia; hypotension; fractures; renal disease; or Alzheimer's disease/dementia (early stage).

Participants were excluded if caregivers or housing staff reported that they experienced cognitive difficulties that would interfere with their ability to provide informed consent to participate.

INTERVENTION

Local college students from health and computer science departments were employed as Telehealth Technician Assistants (TTAs). The TTAs received training on the telehealth equipment (blood pressure cuffs, pulse oximeters, body weight scales and tablet computers for data entry), Health Insurance Portability and Accountability Act (HIPAA) regulations and certification, and the appropriate referral and provision of wrap-around social services.

During the initial visit, TTAs collected a detailed subjective medical history. The intake information and initial monitoring formed a database of individualized baseline standards for each participant, including objective physiological biomarkers (heart rate, blood oxygen saturation, blood pressure, and body weight), subjective reporting of the number and type of chronic health conditions, and a subjective report of the incidence of (1) ER presentations, (2) single hospitalizations, and (3) readmissions less than 30 days following hospital discharge, in the 12 months before enrollment. Participants were also asked to report their social living environment (living with a caregiver or alone), and their primary language used at home. Following the initial intake, TIPS provided participants with twice-weekly access to TTAs in one of seven community centers in Westchester County, NY, and one of five in Scranton, PA. Participants were asked to visit the TIPS site at least once per week, but they were also permitted to attend twice per week if they wished. At each visit, the objective

health biomarkers were measured and details about the participant's recent medical history using a five-question survey (Table 1) were collected. These metrics were used to determine the individual's perceived health status, self-reported hospital visits, and change in their physiological biomarkers since their last visit.

TTAs used standardized risk-alert trigger levels (Table 1), as per official guidelines provided by the American Heart Association, to inform participants of their "risk level" based on their evaluation results. At each TIPS visit, the results of the objective assessment and subjective wellness questionnaire were transmitted to a secure, HIPAA-compliant data server. The data server was accessed remotely by a team of Registered Nurses (RNs), who viewed all participant data, but only triaged the medium- and high-risk alerts. If the participant's health data were identified as being outside of the pre-determined threshold, they, or their designated contact person (informal caregiver), were contacted by the RN and provided with individualized health management advice, including contacting the participant's primary care practitioner where appropriate.

In addition to RPM, TIPS participants had access to additional wrap-around social services, including National Council on Aging Benefits Checkup Assessments, Livable Communities Speakers Bureau Educational Presentations, Chronic Disease Self-Management Programs, and caregiver support programs.

OUTCOME MEASURES

The joint primary outcome measures were changes in the incidence of self-reported hospital visits (ER presentations+single hospitalizations), and <30-day readmissions, before and during the implementation of TIPS. The data were collected subjectively, as a lack of continuity of care and access to electronic health records prevented a formal collection of this information from hospital or health care provider records.

FOLLOW UP

Participants were asked to visit a TIPS site for remote monitoring at least once per week, and compliance was tracked over time. Individuals who missed more than 4 consecutive weeks of

Table 1. Health Risk-Alert Trigger Levels

HEALTH RISK MEASURE	LEVEL OF ALERT
Blood oxygen saturation levels	
SpO2 <90%	Triggers a high-risk alert
Blood pressure	
Diastolic blood pressure <60 or >90 mmHg	Triggers a high-risk alert
Systolic blood pressure <90 or >170 mmHg	Triggers a high-risk alert
Resting heart rate	
<50 or >100 bpm	Triggers a high-risk alert
Body mass	
Reduction in body mass >5 lbs in the last 7 days	Triggers a high-risk alert
Increase in body mass >3 lbs	Triggers a high-risk alert
Increase in body mass >5 lbs in the last 7 days	Triggers a high-risk alert
Subjective health questions	
1. "Have you changed medications since your last screening visit" (yes [Y] or no [N] response options)	"Yes" triggers a medium-risk alert
2. "Have you changed your medication dosage since your last screening visit" (Y or N)	"Yes" triggers a medium-risk alert
3. "Have you fallen since your last screening visit" (Y or N)	"Yes" triggers a high-risk alert
4. "Have you been hospitalized or had an ER visit since your last screening visit" (Y or N)	"Yes" triggers a high-risk alert
5. "How are you feeling today" ("very well," "good," "feeling OK," "feeling a little down," "not too well" or "terrible" response options)	"Not too well" triggers a medium-risk alert; "Terrible" triggers a high-risk alert

bpm, beats per minute; ER, emergency room; lbs, pounds; mmHg, millimeters of mercury; SpO2, peripheral capillary oxygen saturation.

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TIPS monitoring were contacted by their telehealth nurse to check in and inquire as to why they had stopped receiving TIPS services. Often, this is where telehealth nurses would learn of a hospitalization or a participant's preference to not continue with the TIPS service.

STATISTICAL ANALYSIS

Compliance evaluation. Duration of participation in TIPS was computed by subtracting the most recent visit date in the database from their first ever TIPS visit date. The number of visits was calculated by counting the recorded number of visit dates. Participants were required to be enrolled in TIPS for a minimum of 15 weeks to be included in these analyses.

Univariate analysis. We hypothesized that the incidence of self-reported hospital visits and <30-day readmissions would be reduced after the implementation of TIPS. We compared the number of hospital visits, and <30-day readmissions that TIPS participants reported during the program (TIPS), with the number of hospital visits, and <30-day readmissions reported in the 12 months before joining the TIPS initiative (pre-TIPS). The number of TIPS hospital visits and <30-day readmissions were corrected to account for the fact that not all participants had been engaged in the program for the full year. The study population was then separated into subgroups for analysis of the primary outcome measures pre- and during TIPS. These subgroups included:

- Gender
- Chronic conditions
- Number of chronic conditions (0, 1, 2, 3, 4, >4)
- Type of health care coverage (Medicaid, Medicare, Dual-Eligibility)

A Chi-square test determined the statistically significant difference between the pre-TIPS and TIPS conditions. Missing values in the chronic conditions were treated as if the participant did not have them.

Multivariate analysis. A multivariate analysis evaluated whether demographic characteristics, health status, and the number of chronic health conditions experienced by the participants were associated with increased risk of a hospital visit. The dependent variable was whether a participant reported a hospital visit during the TIPS program. A logistic regression model used to determine whether specific participant characteristics were associated with an increased likelihood of a hospital visit, and identifying odds ratios (OR) for specific covariates that predicted hospital visitation. Variables evaluated in the analysis included: age, physiological bio-

markers, Subjective Health Question responses (*Table 1*), duration of program participation, program compliance, social living environment, primary language (English, Spanish or other), and the type and number of self-reported chronic health conditions.

Results

PARTICIPANTS

This study recruited 765 participants. Data analysis was performed on 617 participants (median age 74.3 years; interquartile range [IQR] 16 years) (*Table 2*), with the remaining 148 participants excluded due to incomplete data collection at intake or because they withdrew from the TIPS program. Participants were enrolled in the TIPS program for a median duration of 343 days (range 105–435; IQR 129 days) from 2014 to 2016. Twenty-nine percent ($n=182$) of the participants had one chronic condition, 32% ($n=197$) were experiencing multimorbidity, and 39% ($n=238$) of the participants did not report any chronic conditions. Seventy-six percent ($n=470$) of the participants primarily spoke English, 20% ($n=125$) were primarily Spanish speaking, and 4% ($n=22$) were listed as Other.

PRIMARY OUTCOMES

Reduction in hospital visits. There was a significant reduction (28.9%, $p=0.0005$) in the incidence of hospital visits in TIPS participants. Females and males experienced a 27.7% ($p=0.0019$) and 23.8% reduction ($p=0.013$) in hospital visits, respectively (*Table 3*).

Impact of TIPS on hospital visits. Participants with one (−34.1%, $p=0.048$) or three (−65.2%, $p=0.0001$) chronic health conditions experienced a significant reduction in hospital visits, but there was no change for participants reporting zero (+4.2%, $p=0.88$), two (−25%, $p=0.26$), four (−36.4%, $p=0.22$), or more than four (−25%, $p=0.20$) chronic health conditions. In addition, Medicare participants experienced a 50% reduction ($p=0.0001$) in single hospitalizations, but Medicaid or dual-eligible participants did not experience any change (*Table 3*).

Participation in TIPS was associated with significant reductions in hospital visits for participants living with HTN, COPD, CHF, diabetes, and CAD. There was no change in the number of hospital visits following the implementation of TIPS for participants reporting multiple falls, depression, and obesity.

Impact of TIPS on ≤30-day readmissions. Participants reporting COPD (−69.9%, $p=0.04$), CAD (−100%, $p=0.029$), or Medicare eligibility (−75.6%, $p=0.017$) experienced a significant

Table 2. Participant Characteristics

	ALL ^a	MALE ^b	FEMALE ^b
Number of participants, <i>n</i> (%)	617 (100)	141 (22.9)	476 (77.1)
Age (years), median ± IQR	74.3 ± 16	74.8 ± 15	74.2 ± 17.5
Time enrolled in program (days), median ± IQR	343 ± 129	327 ± 185	343 ± 129
Chronic health condition, <i>n</i> (%)			
HTN	275 (44.6)	60 (42.6)	215 (45.2)
COPD	66 (10.7)	15 (10.6)	51 (10.7)
CHF	22 (3.6)	8 (5.7)	14 (2.9)
Multiple falls	16 (2.6)	2 (1.4)	14 (2.9)
DM (type 1 or 2)	121 (19.6)	31 (22)	90 (18.9)
Depression	37 (6)	2 (1.4)	35 (7.4)
Obesity	44 (7.1)	5 (3.6)	39 (8.2)
Stroke	31 (5)	9 (6.4)	22 (4.6)
CAD	53 (8.6)	12 (8.5)	41 (8.6)
Number of chronic health conditions, <i>n</i> (%)			
0	237 (38.4)	64 (45.4)	173 (36.3)
1	181 (29.3)	30 (21.3)	151 (31.7)
2	111 (18)	28 (20)	83 (17.4)
3	57 (9.2)	14 (10)	43 (9)
4	19 (3)	3 (2.1)	16 (3.4)
>4	6 (1)	2 (1.4)	4 (0.8)
Health care eligibility, <i>n</i> (%)			
Medicare	288 (46.7)	66 (46.8)	222 (46.6)
Medicaid	122 (19.8)	30 (21.3)	92 (19.3)
Dual eligible	109 (17.7)	15 (10.6)	94 (19.8)
Declined to report	98 (15.9)	30 (21.3)	68 (14.3)

^aPercent of total population.
^bPercent of gender group.
 CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disorder; DM, diabetes mellitus; HTN, hypertension; IQR, interquartile range.

Table 3. Raw Incidence of Reported Hospital Visits (ER Visit or Hospital Admission) for the Pre-TIPS and TIPS Conditions

INCIDENCE OF HOSPITAL VISITS (ER VISIT OR HOSPITAL ADMISSION)	PRE-TIPS (N)	TIPS (N)	% CHANGE	P
All participants	201	143**	-28.9%	0.0005
Male	42	32*	-23.8%	0.013
Female	159	115**	-27.7%	0.0019
Most common health conditions				
HTN	115	87**	-24.3%	0.004
COPD	39	30*	-23.1%	0.012
CHF	17	11*	-35.3%	0.039
Multiple falls	26	27	+3.8%	0.52
DM (type 1 or 2)	60	44**	-26.7%	0.0031
Depression	22	15	-31.8%	0.10
Obesity	17	13	-23.5%	0.37
CAD	23	17*	-26.1%	0.02
Number of chronic health conditions				
0	24	25	+4.2%	0.88
1	44	29*	-34.1%	0.048
2	28	21	-25%	0.26
3	64	32**	-50%	0.0001
4	11	7	-36.4%	0.22
>4	12	9	-25.0%	0.20
Health care eligibility				
Medicare	64	32**	-50.0%	0.0001
Medicaid	30	31	+3.3%	0.25
Dual eligibility	37	31	-16.2%	0.39

p* < 0.05; *p* < 0.005.
 TIPS, Telehealth Intervention Programs for Seniors.

reduction in <30-day readmissions. No other subgroups demonstrated a change in <30-day readmission rate after the implementation of TIPS.

Hospitalization risk prediction. The multivariate model achieved a predictive accuracy of 86% for determining which participants would be hospitalized during TIPS participation, based on which

features were most strongly predictive of hospital visits and <30-day readmission. Participants who were enrolled in Medicaid (with or without dual eligibility; *Table 2*) were almost three times more likely to experience a hospital visit than Medicare enrollees (OR = 2.72, 95% confidence interval [CI] 0.392–1.611). Participants who reported feeling “not too well” or “terrible” experienced greater risk (OR 1.33; 95% CI 0.118–0.459) of a future hospital visit than those who reported “feeling a little down,”

“feeling OK,” “good,” or “very well” in response to the question about their wellness. Finally, participants living alone were more than twice as likely to experience a hospital visit than those who did not live alone (OR = 2.34, 95% CI 0.115–1.592). For all other independent variables, there was either no significant difference from zero or they were continuous variables, making the interpretation of their magnitude meaningless using this model.

Discussion

Given the change in self-reported hospital visits and <30-day readmissions seen in this study, there is potential for community-embedded health and wellness programs, such as TIPS, to reduce costly health service utilization in older adults.

Hospital visits were more markedly reduced in specific subgroups, that is, participants with one or more chronic conditions were more likely to report fewer hospital visits than participants with no chronic conditions. Multimorbidity is associated with increased likelihood of seeking medical advice from multiple providers, having a poor understanding of medical needs^{5,14} taking more medications, and greater risk of medication-related adverse events.¹⁵ TIPS may have provided the single point of health care that has been lacking for those reporting three chronic health conditions, which is consistent with previous RPM literature.¹⁶ The small number of participants with four or more (4%) chronic health conditions may not have been sufficient to demonstrate a change in ER presentations and/or hospitalizations.

Medicare-only participants experienced a significant reduction (50%) in hospital visits compared with Medicaid-only participants, who showed no significant change. Medicare-only participants also experienced greater reductions in <30-day readmissions than Medicaid-only participants. Compared with the privately insured or uninsured population, Medicaid beneficiaries have poorer health even after accounting for age and income,^{17,18} and their presentations to the ER are more likely to involve more than one major chronic health condition.¹⁹

High hospital utilization in the Medicaid-only beneficiary population has been linked to poor accessibility to timely or after-hours urgent care.^{17,18} Also, people of low socioeconomic status prefer hospital care to ambulatory care, with patients perceiving the hospital setting to have greater access (i.e., more affordable, more timely provision of specialty care and investigations, and more options for transportation).²⁰ They also have a greater level of trust in the technical quality of the service provided.²⁰ As a result, the very nature of TIPS intervention (i.e., RPM and community-based social services) may not have provided sufficient access to the urgent medical care that appears to drive the increased hospital utilization in the Medicaid-only beneficiary population.

Our results are consistent with other RPM programs aimed at improving chronic disease self-management and health care utilization. Klersy et al. found RPM was associated with significantly lower hospitalizations and health cost savings for patients with CHF compared with standard care.¹² An RPM service targeting clinically complex patients and implemented at three sites in Florida, reduced inpatient readmissions and ER presentations at all three sites, and the number of inpatient bed days at two sites.¹⁶ Along with our findings, these studies collectively demonstrate that RPM models for people with chronic disease can be feasibly implemented in the community setting and are beneficial in reducing hospital utilization.

The results of the multivariate analysis confirmed previous findings that living alone,^{21–23} reporting poor health,^{24,25} and enrolled in Medicaid^{17,18,26} could predict increased hospital utilization. These results highlight the potential value of a screening tool that can be implemented within community settings and identify at-risk older adults early to facilitate more effective utilization of health services.^{24,27,28}

This study has a number of limitations. First, the self-report nature of the hospital visit data collected in this study may have limited veracity.²⁹ Nonetheless, there is evidence of good concordance between self-report and medical record review.³⁰ Similarly, Lubeck and Hubert³¹ and Dubois et al.,³² reported a perfect to almost perfect correlation between self-reported hospital utilization and ER presentations and medical records in a community sample of older adults. This study is also limited by its inability to classify or verify the disease severity or functional level of the study participants. This limits our capacity to explore the participant and/or environmental factors that may drive the differences in health care utilization demonstrated in this study.

The community- and volunteer-based method of recruitment likely limits the generalizability of the study results. Study advertisements were placed in community centers and adult congregate housing, which may not represent the broader older adult population. The recruitment method also resulted in a large discrepancy between male (22.9%) and female (77.1%) participants. This, however, is not atypical, with males often underrepresented in health promotion studies,³³ and a number of studies reporting gender disparities in recruitment similar to those in TIPS.^{34,35} Furthermore, a higher percentage of females experience multiple chronic health conditions,^{4,36} with previous observational studies showing that older women are more likely than men to use home health³⁷ or primary care services.³⁸

Previous studies indicate that risk of hospitalization is increased with prior hospitalizations.³⁹ Therefore, it is possible that not all TIPS participants were of equal risk, given some

participants did not report hospitalization before TIPS enrollment.

TIPS included an underrepresentation of participants with four or more chronic health conditions. Only 4% of the TIPS participants reported four or more chronic health conditions, which is substantially lower than the 17.4% reported in the 2008 survey of participants in the large Health and Retirement study.⁴⁰ In addition, only 61% of this study population reported one or more chronic conditions, compared with 90% reported in previous studies.¹⁻³ This difference may have been a result of misclassification of missing values as “no” chronic conditions during data collection. Furthermore, it is not unusual to see such differences between studies reporting the prevalence of multimorbidity, with methodological considerations, such as the sample size, geographic setting, recruitment method, and number of chronic health conditions considered likely to be central to the differences.⁴¹ Future RPM studies should aim to obtain patient- and disease-specific data from a sample of older adults representative of the general community, and include a control group to accurately analyze features predictive of increased health care utilization. With the growth of the TIPS initiative to five states in the United States, we have recently launched one site that is linked with a health care system, allowing us to obtain a trusted copy of every participant’s medical record, which will, in turn, allow for a quantitative evaluation of the effect of TIPS in the future.

The success of TIPS highlights the potential of RPM combined with multidisciplinary wrap-around social services in reducing hospital visits and <30-day readmissions for low-income, high health-risk older adults. As a health initiative, TIPS afforded a high number of low-income older adults, who would otherwise have had limited access to health services, the opportunity to access regular RPM and wrap-around health services. In particular, this study demonstrates the effectiveness of an RPM program for people over 65 years, with one to three chronic conditions, and who are enrolled in Medicare in improving health care utilization. This program continues to offer a vital community service by improving access to health care services for low-income, older adults while reducing the demand on hospital ERs. By reducing <30-day readmissions, encouraging compliance with Chronic Disease Self-Management Programs, and increasing awareness of community-based health care services, TIPS may offer a cost-effective solution for a health care system that is currently overburdened. Factors that have the potential to improve health care for those subgroups, where TIPS was not seen to improve health care utilization, should be further investigated.

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Disclosure Statement

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