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Technology Benefits to Elderly with Infirmities in Functional Maintenance Programs

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Abstract

We report an outcome study involving eight at-risk residents in long-term care facilities across four states. Residents were assessed in spoken and expressive language, memory, mental status, and mood before and after implementation of a Functional Maintenance Program that incorporated on-line interactive tools. Data analyses reveal small but meaningful improvements in expressive language and in memory, trending towards significance. They also show these non-robust participants' mean scores for mood and mental status remained stable. Findings are discussed in the context of stakeholders' considerations, including improving outcomes, conforming operations, securing revenues, and satisfying participants.

Keywords: improved outcomes, on-line technologies, functional maintenance programs, long-term care

Introduction

The United States has an aging population. Although life expectancy for U.S. citizens has grown steadily

since the nation's founding, the rate of increase of adults over 65 – as a percentage of overall population – is currently at a record high, *circa* 0.3% per year. Moreover, it is projected to remain there for two decades. In consequence, older adults, who now comprise about 14% of the U.S. population overall, will, by 2040, grow to roughly 20% of the population, which itself will have increased by 19% in the interim (U.S. Census Bureau, 2014). In short, the United States of the future will contain record high numbers of elderly citizens.

As people age, vitality declines. Effects of decline may appear rapidly or slowly, evenly or unevenly, pathologically or naturally; but over time they are inevitable and ubiquitous, diminishing physical, cognitive, sensory, and other powers. The very range of problems often results in complex interactions between co-occurring health issues that can greatly complicate service delivery for positive outcomes (Kane et al., 2005). Effective maintenance of health in these circumstances assumes great importance (WHO, 2001; Haak, 2002; OHTA, 2008). For its geriatric citizens, the United States has a stake in identifying improved methods to exercise, maintain, strengthen, and even augment functional abilities

across settings.

Arrangements to provide needed supports and interventions for elderly persons with infirmities lie at the heart of long-term care (LTC). The term ‘long-term’ reflects the fact that aging processes remain irreversible, and that provision of such care, once started, is likely to remain in force through end of life. The delivery of LTC is rationalized along a continuum. Where minimal assistance is required, *Home Health* delivers services in place to clients living in their own houses or apartments semi-independently. *Supported Living Communities* serve those who require more assistance, with recipients living in clustered home-like accommodations providing access to communal dining facilities, organized resident activities, and other beneficial services. *Skilled Nursing Facilities* (SNFs) are residential facilities serving those who require yet higher levels of daily assistance in common Activities of Daily Living (ADLs) such as transfer, bathing, dressing, grooming, and also Instrumental ADLs (I-ADLs), such as telephoning, doing laundry, and taking transport. Finally, *Hospice* provides all necessary end-of-life care for those with terminal conditions. Some people move systematically along this continuum, as health conditions change and support needs mount (Harris-Kojetin, Sengupta, Park-Lee et al., 2016).

Organizations that provide LTC may focus on a single tier along the continuum, or they may encompass multiple levels and be vertically integrated. In either scenario, they must focus on key business considerations, including securing revenues, conforming operations (e.g., assuring compliance, standardizing operations, etc.), improving health care outcomes, and strengthening satisfaction. All are important; but in practice, not equally. Revenues are foremost, as businesses must remain profitable to stay open; the other factors – improving outcomes, conforming operations, and increasing satisfaction – will be balanced in conjunction with their associated revenue considerations.

Technological innovations to improve delivery of

services to elderly with infirmities and lower costs are in principle always of interest in LTC operations. In this paper, we report a study conducted by two companies – Hallmark Rehabilitation Services and Lingraphica® – that examined the effects of introducing on-line and technologically advanced interactive language exercise tools into existing operations that employ a *Functional Maintenance Program* (FMP) in LTC facilities.

Target Audience and Relevance

This work is of relevance to individuals and institutions involved in geriatric healthcare, especially LTC facilities, associated reimbursement agencies, assistive technology providers, LTC residents’ family members, other friends, and volunteers. The project was initiated with three related objectives: [i] to explore what is involved, practically, in introducing on-line, interactive speech and language exercises into ongoing LTC operations; [ii] to determine how the technology can enrich FMPs for non-robust residents within such facilities (Haynes & Wheeler, 2015a, b); and [iii] to identify the outcome benefits to stakeholders involved. In this project, *Hallmark Rehabilitation* serves as an example of a contract rehabilitation company that provides skilled personnel and services to SNFs; and *Lingraphica* serves as an example of companies that develop offerings for persons with cognitive and communication deficits (Lingraphica, 2016).

Study Methods

Design

The investigators designed a study that would engage staff, residents, and others in Skilled Nursing Facilities while minimizing disruption to on-going operations. Formally, it is an outcome study in which pre- and post-intervention data come from two complementary sources: (i) the National Outcomes Measurement System (NOMS), from the American Speech-Language-Hearing Association (ASHA, 2003); and (ii) Minimum Data Set measures (MDS), published in the Residential Assessment

Instrument (RAI, 2015a, b). By design, the study incorporated on-line, interactive language exercises into individualized FMPs. While the expertise of a credentialed clinician is required to set up FMPs, the following implementation may be handed off to care extenders such as community volunteers, family members, or activities facilitators (ASHA, 2004). These latter generate either lower costs or no costs at all to LTC facilities, which makes this approach attractive to facilities from a revenue standpoint. In this study, duration of technology use by LTC residents was permitted to vary according to circumstances of facilities and participants.

Participants

The four participating SNFs – three in the Midwest and one in the West – were selected by this article’s third author, Leland Wheeler, Director of Clinical Services at Hallmark Rehabilitation Services (Haynes & Wheeler, 2015a). At each facility, two residents were enrolled in the study, yielding a total sample size of 8. Local staff at each of the sites selected the participants, who were all non-robust. They were chosen on the basis of recent declines in scores on MDS appraisals, the presence of diagnostic risk factors such as cerebrovascular insult or progressive neurodegenerative conditions, and nursing referrals

indicating intervention initiation. Those combined factors suggested these residents were at elevated risk for social and or communicative isolation absent intervention, such as an FMP. Such cases are challenging and usually involve complex interactions between cognitive, sensory, physical, and health management issues (Kane et al., 2005; Kociuba, Davidson, & Doninger, 2014). Table 1 gives detail on these subjects, locations, conditions, areas of particular concern, and length of participation in this study. Inspection shows they comprise a heterogeneous group with regard to diagnoses, deficits, issues, and goals.

Interventions

As Step 1, the clinical SLPs at the facilities used on-line therapy exercises that focused on four communication modalities – listening, speaking, reading, writing – to establish participants’ baseline performance with these tools and materials. The program used was *TalkPath Therapy*, an offering that Lingraphica makes available to all, at no charge, as either an app downloaded onto an iPad, or as a web-based service accessed via a browser on a computer (TalkPath, 2016). The SLPs then initiated individualized treatment sessions with participants, with the dual goals of reducing communicative and

Table 1
Participants

I.D.	State	Diagnosis	FMP Foci	FMP Wks
PD	KS	Dementia, depression	Functional expression	13.0
DR	KS	Dementia, depression	Auditory comprehension, verbal expression	13.0
RS	TX	Dementia, depression	Memory, comprehension	12.0
BH	TX	Hypertension, Intellectual disability	Naming, expression	[missing datum]
JD	CA	Dementia, altered mental status	Social communication, Problem-solving	8.7
LS	CA	Aphasia, chronic	Automatic speech, naming	4.4
DD	MO	Dementia, altered metal status	Problem solving, orientation	13.0
CW	MO	Altered mental status post-CVA	Orientation, reading, comprehension	6.0
<i>Mean (SD)</i>				<i>10.0 (3.7)</i>

cognitive deficits, while concurrently training participants in the use of the technology. Owing to the complex patient sample – many participants' diagnoses included dementia, past CVA, mental status change, depression and/or anxiety – individualized therapy goals were disparate. Foci included, for example, responsive naming, problem solving, memory, and reading comprehension.

When participants demonstrated adequate proficiency in using the technology, SLP activities moved to Step 2 – the transition to individualized FMPs for the eight participants, in accordance with ASHA-specified procedures for FMPs (ASHA, 2004). Once in place, FMPs may be carried out by care extenders such as family members, activity managers, or volunteers, after basic technology training. Importantly, there is no therapeutic dimension to an FMP. The core purpose is not to promote additional improvements over time, but rather to engage recipients in activities designed to help maintain mental sharpness and stave off functional declines that otherwise threaten to occur.

Technology Training

Training took place on laptop computers. Each participant had his or her own account set up to access and use the language exercises, which could be adjusted by the supervising SLP clinician. The SLP, in turn, had a stimulus-response tool to use in therapy, a client management system, and data collection and reporting capabilities. The treating therapist used TalkPath Therapy tasks to establish a baseline in the areas of listening, speaking, reading, and writing, and concurrently to consider selection of tools, materials, and methods to be incorporated into the FMP that followed. The care extender could observe this initial treatment phase as well, to become familiarized with the program and consider its uses in the subsequent FMP implementation phase.

Assessments

Outcome measures. Data for the Outcome Measures (OM) came from three domains of the

Adult Functional Communication Measure in the ASHA NOMS, namely: (i) *Spoken Language Comprehension*; (ii) *Spoken Language Expression*; and (iii) *Memory*. Staff speech-language pathologists rated participants using the scale developed by ASHA, which assigns scores ranging from 0 (Most Impaired) to 7 (Normal Functioning). The initial ratings were done immediately before Step 1 of the TalkPath intervention, and the final ratings were done upon completion of activity in Step 2, the FMP program.

Quality measures. We employed two Quality Measure (QM) tools whose results are recorded quarterly in the MDS kept routinely on residents in LTC facilities throughout the United States, namely: (i) *Brief Interview for Mental Status (BIMS)*; and (ii) *Residential Mood Interview (MOOD)*. BIMS provides valuable data for monitoring residents' attention, orientation, and ability to register and recall new information. MOOD screens for symptoms of depression and generates a clinically useful severity score.

Data Analysis

Raw scores were entered into Microsoft Excel v. 14.0.0 running on an Apple MacBook running Mac OS X ver. 10.6.8 for completing statistical calculations. To investigate changes over time, we calculated score means before and after intervention, and used parametric statistics to determine the existence, direction, and magnitude of differences for means at the two points in time, and to establish the statistical significance of those differences using matched t-tests (Hatch & Farhady, 1982; Frattali, 1998). These procedures were used to analyze all pre- and post-interventions data (*i.e.*, *NOMS Expression, Comprehension, Memory, BIMS, MOOD*).

Outcomes and Benefits

From ASHA NOMS

Table 2 shows changes in NOMS outcome measures at the completion of FMP activity.

Table 2
Changes following Period of Technological Intervention

Item	N	Pre-(SD)	Post-(SD)	Δ	p
Auditory Comprehension	7	4.14 (0.69)	4.43 (0.98)	+0.29	0.229
Expression [°]	7	3.43 (0.79)	4.00 (1.53)	+0.57	0.086
Memory [°]	7	1.86 (1.07)	2.43 (1.51)	+0.57	0.086

[°] $p < .10$ (= trend towards statistical significance)

All three NOMS items showed mean positive improvements following the intervention period of this study. The smallest change is in *comprehension*: on the seven-point scale employed by the NOMS, it showed a statistically non-significant outcome improvement of +0.29 points ($p = .229$). Both pre- and post-comprehension scores registered at the NOMS rating level of 4 (4.14 \rightarrow 4.43), a level immediately below that of autonomous functional independence. Overall, spoken language comprehension must be considered effectively unchanged following intervention. The remaining 2 NOMS items – *expression* and *memory* – changed in more complex ways. Specifically: [i] both their means improved by +0.57 points; [ii] the decimal characteristics for both moved up to the next higher NOMS performance level (i.e. 3 \rightarrow 4 and 1 \rightarrow 2 respectively); and, [iii] both outcome improvements trended towards statistical significance ($p = .086$). Given the quantitatively comparable and statistically significant NOMS *expression* improvement ($\Delta = +0.60$, $p = .006$) in an earlier outcome study that ran two weeks longer, enrolled one additional subject, and engaged SLPs rather than volunteers to work with subjects (Steele, Baird, McCall et al., 2014), one might imagine a larger sample size and/or longer intervention period producing improvements of statistical significance. Follow-on research should thus include attention to this issue, among others.

It is worth recalling here that this study's activities comprise two distinct, complementary phases: (i) an initial, relatively short phase of therapy conjoined with training on the technology; followed by (ii) the longer period of FMP activity, carried out by the care extender using the tools, materials, and methods that had be set in place for the purpose by the SLP

before stepping back. Improvements documented here broadly parallel improvements found from previous comparable therapy research (Aftonomos, Steele, & Wertz, 1997; Aftonomos, Appelbaum, & Steele, 1999; Aftonomos, Appelbaum, Steele et al., 2001; Steele, Aftonomos, & Munk, 2003; Steele, Aftonomos, & Koul, 2010; Steele, Baird, McCall et al., 2014; Des Roches, Balachandran, Ascenso et al., 2015). It would be of value, in future research, to administer additional assessments, for instance, at the transition from Step 1 to Step 2, in order to characterize time courses of improvement vs. maintenance. Various longitudinal profiles are imaginable. The current study design did not generate the data that sheds light on this matter, but it is of potential importance and should be targeted in future research.

From the Residential Assessment Instruments' Minimum Data Set

Mental status. Figure 1 shows the Mental Status ratings of the 8 participants at the beginning and end of the calendar quarter containing most FMP activity.

In the mean, *overall BIMS scores* remained steady during this quarter. Although scores of 5 of the 8 participants went either up or down, the *mean score* at the end of that quarter, 6.63, was identical to the 6.63 mean score at the beginning of the quarter; and it places the participants in this study, generally, within the range of *severe cognitive impairment*. Indeed, visual inspection shows that 6 of the 8 participants received at least one rating of 7 or below, the boundary for severe cognitive impairment. This clearly was a group with challenging cognitive

Figure 1
Mental Status, at Beginning & End of Quarter

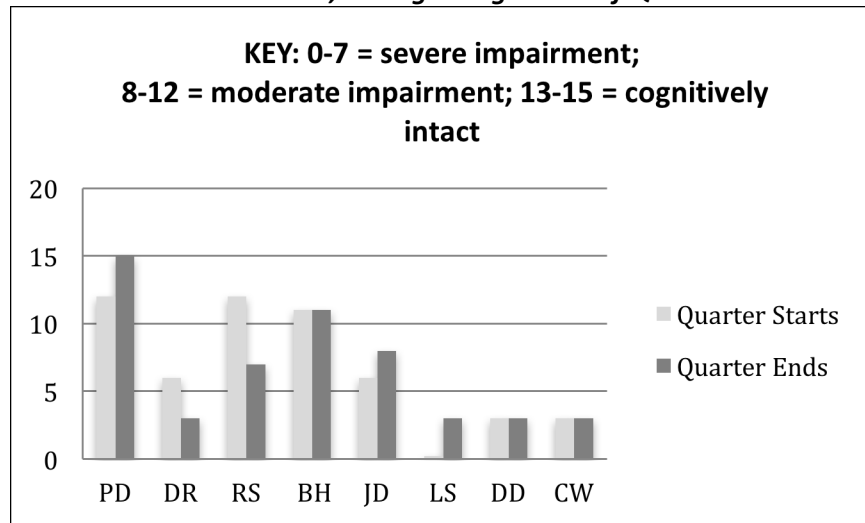
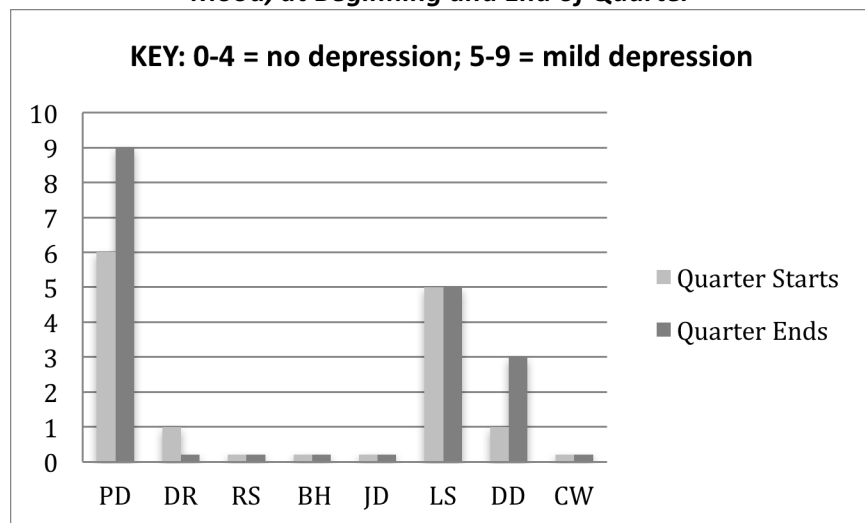


Figure 2
Mood, at Beginning and End of Quarter



issues; and some individual changes were striking. Participant PD improved from *moderate impairment* range to the *cognitively intact* range, and participant JD improved from *severe impairment* to *moderate impairment*; in contrast, participant RD declined cognitively from *moderate impairment* to *severe impairment*. The result was mean overall stability in BIMS scores in the presence of considerable individual variability. To understand how common a pattern this is, and its implications,

future studies will be required.

Mood. Figure 2 shows the Mood ratings of the 8 participants at the beginning and the end of the quarter of most FMP activity.

Mean overall MOOD scores changed only slightly during the quarter during which the study activity took place. The mean score at the start of the quarter was 1.63, indicating minimal depression; by

the end of the quarter, it had increased to 2.13, a non-significant change ($p = 0.16$) occurring about midway within the minimal depression range. This was a largely non-depressed group that stayed that way over the period of FMP activity. The largest movement was in participant PD, whose score rose from 6 – towards the low end of mild depression – to 9 – indicating the mild depression had intensified somewhat. Of note, PD was also the participant whose BIMS status moved to ‘cognitively intact’ by quarter’s end; raising the possibility of her increased lucidity perhaps resulted in a greater awareness of her surroundings and circumstances, potentially causing the observed intensification within mild depression.

It should be noted that only long-term data collection and analysis will reveal the dominant patterns for MDS data that will ultimately be of interest to LTC facilities. These statistical MDS findings represent acceptance of the Null Hypothesis, i.e., that there is no significant difference between mean pre- and post- assessments. And indeed, MDS stability longitudinally will present precisely as periodically repeated absence of statistically significant differences. Only collection and analyses of data on larger scales and over longer periods will allow us to identify the profile properties of stability patterns, while flagging aberrant cases for closer scrutiny.

Satisfaction Feedback

Rather than develop a formal survey to probe participants’ satisfaction for this initial study, the investigators drew on post-investigation observations from the third author, Leland Wheeler, who was Manager of Clinical Services at the participating sites. He retrospectively discussed what he heard from his subordinates on site during conduct of the study, and the full interview is available for audition online. We include quotes below from that source.

Leland reports that incorporation of the technology resulted in improved follow-through in the Functional Maintenance Programs, in part because the

technology was found to be attractively simple to learn and easy to use. A key practical step was to designate an appropriate individual as ‘champion’ for the FMP at each site, who could come from disparate domains: at some facilities, restorative nursing staff supplied them; in others – activities staff; and in yet others – family members or speech pathology students. The important thing was that once the FMP had been set up with goals, procedures, and the customized technologies, any interested person could – following initial training – implement the program in practice. On rate of adoption, Leland says, “Once we established who these key players were going to be, the program really started to take a life of its own. We had a few patients really thrive with it just because of the encounters they were able to get one that skilled therapy had [...] transitioned over [...] to that repetitive stimulation program.” On acceptance by clinicians: “They adapted to it very well, and were really asking ‘Can I do this with more patients?’” And regarding adoption of the technology by all involved, “They really adapted to it extremely quickly. They liked that it was accessible, they liked that it was on different platforms, and ... they had fun because it wasn’t what they were used to doing” (Haynes & Wheeler, 2015c). While anecdotal, these comments do point to certain broad themes – empowerment of non-clinicians, convenience of program structuring, and enjoyment of novel interactions– that merit closer study in future research.

Discussion

This study provides initial documentation that LTC residents of precarious health status can benefit in important ways from strategically integrated online interactive tools that exercise speech and language within a Functional Maintenance Program. The investigation was conducted in LTC settings in four states, following a design that accords with the clinical concerns, usual practices, operational constraints, and patient cohorts of such facilities in general. Study subjects were chosen locally, from among current SNF residents, and were selected on

the basis of recent declines in health status, diagnoses that raised red flags, and rehabilitation nursing referrals. Of practical importance to hosting LTC facilities operationally, no alterations to staff, administrative workloads, or reimbursement procedures were required to conduct the work.

In this initial investigation of modest scope and brief duration, positive outcomes were documented in both the formally designated NOMS Outcome Measures (OM) of the study, as well as in the less tightly associated MDS Quality Measures (QM) for mental status and mood that are collected quarterly on all residents in such settings for Medicare reimbursement purposes. On the OMs, the LTC residents showed outcome improvements at the end of FMP activity with trends towards statistical significance in two of those three domains, namely, oral expression and memory. In each of these latter two, mean improvements were sufficient to advance the group as a whole to a qualitatively higher functioning level on final assessment: in spoken language expression, the group moved to the highest level just below independent functioning; and in memory, the group as a whole moved from being unable to recall anything to being able to recall personal information with requisite structuring and cueing. The third domain – auditory comprehension – was effectively unchanged. On the QMs, participants appeared to be essentially stable, with mental status showing no mean change whatever, and mood registering only a small mean decline that was without statistical significance. This relative QM stability, viewed in light of these participants' deficit etiologies and recent negative status changes, represents the desired finding. It suggests the intervention may contribute to QM status maintenance in such LTC residents.

Use of technological tools in a Functional Maintenance Program, then, appears to hold promise in the LTC domain. Such an approach represents an important opportunity for staff clinicians who have been providing clinically therapeutic interventions that are drawing to an end. Reimbursement for therapy is discontinued when client gains taper off,

at which point SLPs benefit from having a transition option such as an FMP. The SLPs can be reimbursed for setting up the FMP, and the latter can then be handed off to less expensive care extenders – staff, family, or volunteers – for implementation. Once underway, SLPs' re-involvement is not required as long as recipients' functional levels are maintained. The care extenders benefit as well: family members or friends of LTC residents may be personally motivated to share time with the latter, and they crave tools that help them interact enjoyably and beneficially. LTC activity managers want activities that engage enthusiasms, promote social interactions, and help residents avert MDS declines. Community volunteers benefit from tools that are clear, easy and enjoyable to use, and engaging in content.

LTC facilities realize benefits as well. Their staff SLPs capture reimbursement for the skilled services of providing the technology training and associated therapy required to set up an FMP. Subsequently, facility economies are realized when the FMP activities carried out by care extenders who typically work for less or are volunteers. The ability of the treatment technologies to capture use data on servers for subsequent review extends available means of monitoring and managing compliance, and otherwise conforming operations. And the preliminary positive comments of participants reported above suggest user satisfaction levels that could support prolonged effective use. Consequently, means for enhancing revenues, conforming operations (e.g., documenting compliance), improving clinical outcomes, and leveraging user satisfaction have all been preliminarily probed in this initial study.

The study also suggests future work. We note, for instance, that participants' mean Memory scores improved despite the absence in this study of modules that target Memory explicitly: modules here addressed solely language modalities of listening, speaking, reading, and writing. This finding suggests potential additional benefit from the development and inclusion of materials explicitly designed to exercise and strengthen memory functioning.

Opportunities also exist to develop capabilities for tracking and reporting user engagement and success levels in reportable forms. Clinical supervisors within facilities, for example, in principle could review summary reports of who has been using which modules, for how long, with whom, and with what frequencies. In the same vein, summary reports of overall use patterns by facility types, by geographical region, by patient census variations, and the like could be valuable for officers at higher levels of responsibility within geographically distributed networks of facilities. Such capabilities can effectively be used to establish benchmarks, identify best practices, and support continuous quality improvement within such clinical operations.

The research here is preliminary, and conclusions will undoubtedly be subject to refinement after further research. The investigators acknowledge in particular the limitations associated with the study's small sample size. With few participants, intervention effects need to be both relatively large and relatively consistent to achieve statistical significance. This may well account for the finding of *trends* towards – without actual *achievement* of – statistical significance in two of the three outcomes measures (NOMS *expression* and *memory*). Future research should involve larger sample sizes to establish – with greater certainty – the loci, the magnitudes, and the likelihoods of therapeutic benefits to those who participate in this approach.

Outcome studies also have intrinsic limitations that require mention. For one thing, they do not permit the attribution of causality. This is because they do not contain a control group against which to compare change magnitudes and directions. Causality attribution requires a different design, that of a scientifically controlled prospective experimental study. To understand the specific contribution of the interactive technologies to the outcomes documented here, then, would require such a follow-on controlled study. For another thing, outcome studies conducted within ongoing clinical operations will invariably reflect some sort of sample bias. This is

because the study participants will not represent a randomized sample of people in LTC settings, but rather, some specifically selected group – here, for instance, those LTC residents who were identified as vulnerable to declines in QM measures, yet who were willing to participate in the initiative. Again, the work points directions for further targeted research.

Preliminary as it is, this study nonetheless demonstrates the feasibility and acceptability of the approach generally. Participants in LTC facilities broadly embraced the technology, which was found to be both usable and enjoyable. Its introduction did not turn out to be problematic or burdensome. Its use engaged the attention and enthusiasm of participants in ways that promoted the FMP's effectiveness. Participating residents in the facilities arguably benefited from the experience in important ways. Such findings provide the encouragement for follow-on research, development, and program elaboration.

To conclude, with a growing segment of the American population moving into old age, and projections of record numbers of elderly citizens in two decades, it is important to prepare adequately to meet the challenges they will pose. Not all seniors will move into LTC settings, but many will. Improving LTC operations to yield more coherent and effective service delivery, improved outcomes, higher satisfaction levels, and lowered costs is imperative. Properly developed and utilized technology appears to be well positioned to contribute in important ways to achieving those results.

Declarations

This content is solely the responsibility of the authors and does not necessarily represent the official views of ATIA. The authors disclosed financial relationships with Lingraphica and Hallmark Rehabilitation Services. No non-financial disclosures were reported by the authors of this paper.

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