

Research Article

Effectiveness of AI- Powered Passive Remote Patient Monitoring (RPM) on Senior Living Outcomes: A Pilot Study

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Abstract

Background: This study aimed to evaluate if and how Remote Patient Monitoring (RPM) wearable technologies can improve patient and caregiver outcomes for staff and older adults living in a senior care living facility.

Methods: We conducted a study with 99 patients from Holy Family Senior Living across long-term care and sub-acute care. Hard metrics were measured at numerous time periods. These periods occurred before and after the introduction of RPM wearable technologies. Average changes for hard metrics during these periods were calculated. Soft metrics were also collected from facility staff through surveys to analyze the impact of RPM wearable use on staff.

Results: The implementation of Somatix's RPM wearable technologies revealed that for all hard metrics being measured, there were improvements in health outcomes for patients. ADL Declines and Falls with Injury experienced the largest reductions after implementing Somatix's technology. For soft metrics, staff responses revealed a directional effect of increased perceived empathy for patients. Somatix's technology did not exert a statistically significant effect on perceptions of increased productivity or perceptions that the technology reduces time to handle other aspects of their respective jobs.

Conclusion: We found that improvements overall increase over time, indicating that there is likely a learning curve for patients and staff in the early stages of technology adoption. We also found that our results aligned with similar studies which indicate high potential for RPM technologies.

Keywords: Remote patient monitoring technology; Wearable; Staff insights; Passive monitoring

Introduction

Skilled Nursing Facilities (SNFs) provide high-quality care services at a much lower cost compared to hospitals. In 2018, the U.S. SNF market size was estimated at \$168.5B [1]. Furthermore, the long-term care market is expected to expand with a CAGR of 7.1% from 2021 to 2028 [2]. An increasing incidence of chronic diseases along with an aging population have fuelled market growth of SNFs. Older adults will make up 21% of US population by 2030 and 51.8% of adults have at least one diagnosed chronic condition [3,4]. There is opportunity to develop products and services to address needs in these markets.

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COVID-19 effect

Growths in the SNF and long-term care market have led to nursing home staff shortages. Low wages and brutal working conditions during the pandemic have exacerbated this issue; in September 2021, 99% of nursing homes reported facing a staffing shortage [5]. Another study reports nearly 264,000 jobs left vacant in the residential nursing industry since February 2020 [6]. Furthermore, growing anger and resentment in the workplace has resulted in millions of workers quitting their jobs.

RPM technology integration

There is growing interest in evaluating how the integration of technology can increase efficiency, reduce costs, and improve health outcomes. The market for cloud-based, passive Remote Patient Monitoring (RPM) technology is predicted to reach \$1.7B by 2027 and serve 30M patients by 2024 [7]. In this study, we assess the effects of Somatix's RPM technology instituted in a senior living facility (Holy Family Senior Living) by analyzing the delta pre and post instantiation of SafeBeing technology on several important hard and soft performance indices (i.e., KPIs).

Somatix RPM technology

Somatix's SafeBeing AI-powered RPM platform leverages machine learning and big data analytics to translate sensor data from

any wearable hardware device (i.e., off-the-shelf smartwatch or smart-band with standard existing sensors). The technology uses completely passive monitoring of older adults' ADLs (Activities of Daily Living), such as sleeping, drinking, walking and medication intake, as well as real time alerting of falling and wandering. The method can accurately detect gestures, and instantly alert caregivers of dangers posed to older adults under their care, enabling immediate response. By basing its RPM on gestures rather than hardware installation, the technology's passive monitoring grants elderly people full independence and the freedom to go about their daily activities uninterrupted.

Methods

The study required no changes in users' routines and did not necessitate sensors or cameras to be installed. Somatix's technology delivered actionable insights and predictive analytics for diagnostic treatment. The technology was deployed across two levels of care (long-term care and sub-acute care) with a total of 99 participants completing the full duration of the study. The average monthly percentages of numerous quality metrics were recorded for residents who hit a triggered quality metric reported to CMS (Centers for Medicare and Medicaid Services).

Patient selection

Patients were selected from two levels of care: long-term care and sub-acute care. Figure 1 demonstrates how this study ultimately narrowed down to include 99 participants, most of who were sub-acute care patients.

Hard metrics

Averages were tracked over several time periods (e.g., January-June) which occurred before and after the introduction of Somatix's RPM technology. Changes in these averages were examined over four segments of time (twelve months prior, six months prior, six months post, twelve months post) to obtain the percent change in averages. Additionally, the percentage was obtained by comparing the averages from the same set of months (January-June) before and after. The correlation between each metric value (Y) and time in months (X) was studied by comparing the line of best fit slopes over these time periods. To further examine KPI shifts and control for seasonal variables, percentage changes between specific months (i.e., April-December, September-December, and September-March) were studied.

Soft metrics

Past research has shown that when patient-to-health care provider's ratios are disproportionate, it leads to a cascade of excessive, burdensome effort which is costly to the institution. Emotional needs for competence are also undermined when resources are inadequate; this can lead to turnover driven by lower job satisfaction, job fatigue and unhappiness [8,9]. These effects have a significant impact on professional empowerment and positive job satisfaction, so any technological advancements which free up time and energy are highly desirable because they can positively affect these organizationally critical metrics [10,11]. A questionnaire with twenty-one questions was sent to staff members who provide sub-acute, long-term and personal care to collect self-reported perceptions of workers at the senior living health care facility. Some of these questions are as follows:

1. "Sometimes I feel like I do not have enough time to give patients/residents the individualized care and monitoring that I would like to."
2. "I feel like I have too many electronic technology systems that I have to be in charge of to give care for my patients/residents."
3. "It would be hard to measure a lot of things I do for my patients/residents."

Staff members answered by selecting one of seven options (Strongly agree, Agree, Somewhat agree, neither agree nor disagree, somewhat disagree, Disagree, Strongly disagree) depending on how much they aligned with the given statement. A follow-up survey was conducted after six months of RPM technology to examine changes.

Results

Hard metrics

Figure 2 summarizes the most significant findings from the hard metrics studied.

Falls with injury: Regarding patient outcomes, average falls with injury per month improved by 42% from six months before and the same time of year six months after the introduction of RPM technology.

Ulcers: Across the same period, the average occurrence of ulcers per month reduced by 12%.

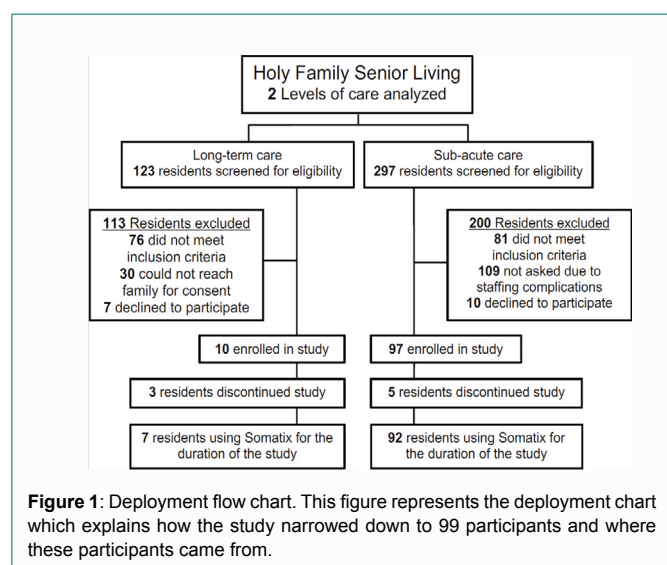


Figure 1: Deployment flow chart. This figure represents the deployment chart which explains how the study narrowed down to 99 participants and where these participants came from.

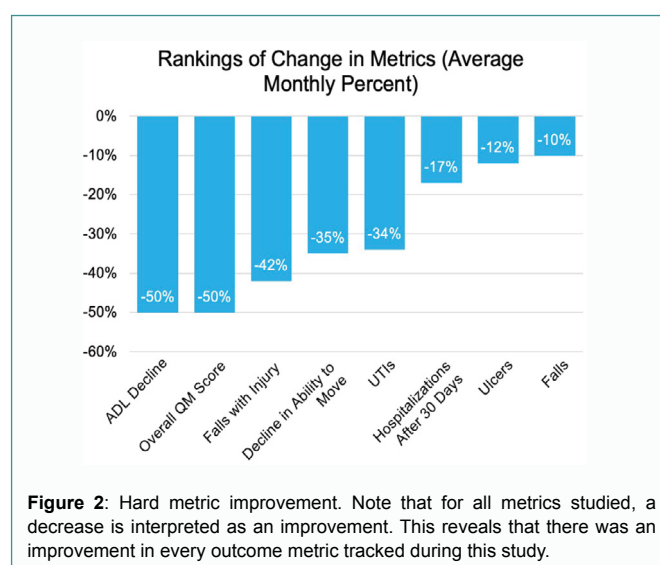


Figure 2: Hard metric improvement. Note that for all metrics studied, a decrease is interpreted as an improvement. This reveals that there was an improvement in every outcome metric tracked during this study.

UTIs: UTIs decreased by 16% in the first six months and 52% in the following six months, for an overall 34% decrease in UTIs relative to months prior.

Hospitalizations after 30 days: Regarding the average monthly percent of hospitalizations after 30 days, an 11% reduction was seen initially, which grew to 17% during the second 6-month period.

Falls: Comparing the pre-six months to post twelve months, the average monthly falls decreased 5%. When comparing the same six months, the average monthly falls decreased 10%.

Decline in ability to move: Decline in ability to move decreased 29% from the average for the pre-six months to the average of the twelve months with Somatix. It improved by 35% when comparing the same six months pre and post.

ADL decline: ADL (Activities of Daily Living) declined in each period, but results were strongest in the same six-month period, where ADL decline decreased 28%.

Overall quality metric score: The Overall QM score improved by almost 50% in the second six-month period with Somatix.

ADL declines and falls with injury experienced the largest changes with 50% and 42% reductions respectively. Other metrics like Ulcers and Falls experienced less change but still saw notable improvements of 12% and 10% respectively.

Soft metrics

Staffing adequacy and other soft metrics are markers of the extent to which the facility provides the necessary resources for health care practitioners to do their job.

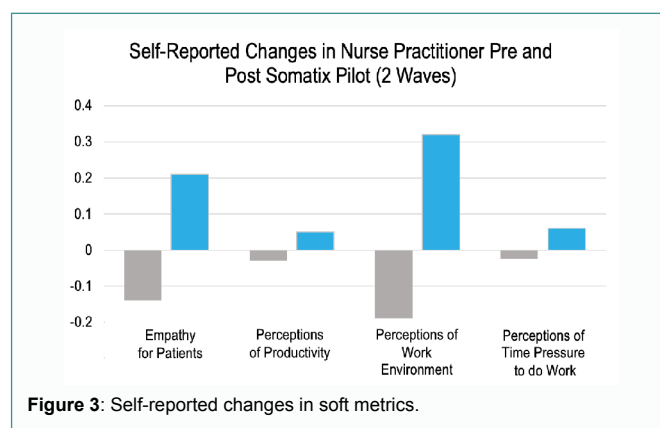
In this study, we deployed a survey at two time periods. The first time period was before the actual deployment of the RPM technology. This wave one measurement was a baseline of soft metrics across participating caregivers. The second wave was six months after the RPM had been instituted into the care facility. Hence, the dependent measure is a delta of the change on soft metrics prior to and six months into RPM deployment. Specifically, we measured four important soft metrics: caregiver self-reported and self-perceived Empathy, Productivity, Empowerment and Time Pressure.

The most significant change was in the four average items that measured empowerment (example item: "Overall, my current work environment empowers me to accomplish my work in an effective manner"). This perception increased after deployment of the technology ($F(1,87)=5.55, p<0.021$). We also found a directional effect of an increase in perceived empathy for the patients ($F(1,87)=2.50, p=0.12$). We found no statistically significant effects for perceptions of increased productivity, nor perceptions that the technology reduces time for the care practitioners to be able to handle other aspects of their respective jobs ($p>0.75$). These results are summarized in (Figure 3).

Discussion

Somatix's RPM technology implemented in this study has produced improvements to all measured indicators between the first six months and second six months.

A learning curve triggered by the integration of new technology might explain why the first six months yielded weaker results. Growth in improvements can potentially be explained by growing staff comfort levels which is consistent with the findings regarding



increases in self-perceived empowerment of care practitioners.

Our findings in the skilled care setting are similar to those of recent studies conducted by the Mayo Clinic and BMJ Public Health Emergency Collection [12]. Both found that RPM technology led to positive outcomes including low hospitalization and readmission rates for hospital in-patient care in the context of COVID-19.

Limitations

Despite the outcome improvements outlined above, there are limitations that must be acknowledged. Not every resident wore the band; however, the outcome data examined came from all residents. Additionally, the timeframe examined may be too narrow to draw substantial conclusions. Moving forward, it may be interesting to measure and consider the monetary value of these benefits for in-patient care.

Conclusion

While this study reveals that the integration of RPM technology showed long-term improvements for both hard and soft metrics at Holy Family Senior Living's inpatient care facility, more studies are necessary to reinforce our conclusions. For example, this study, although it accounts for a pre-post comparison, is not a true experiment in the strictest causal sense. Future research could attempt to randomize participants (both patients and care providers) to treatment (wear the device) and control, whereby the treatment and control conditions are reversed such that all participants eventually receive the treatment. Furthermore, future research should also gather more participants, such that higher sample sizes are attainable. These analyses, although smaller data samples, still lead to statistically significant results. Nonetheless, larger scale studies will need to be done to buttress our conclusions. Finally, future research should document the pre and post cost savings as additional downstream consequences of the delta in ADLs that are documented here. These costs will be both objective and subjective in that at least in terms of these preliminary data, there appears to be no adverse impacts or disruptions to seamless workflow.

Impact Statement

With shortages in the long-term care facility workforce exacerbated by the Covid-19 pandemic, there is growing interest in how the integration of technology into health care can mitigate some of these shortages. This study sought to test whether the adoption of RPM wearable technologies in a senior living facility has substantial benefits for patients and staff. The results of this study indicate that there are clinical benefits for patients as well as staff. These findings

have implications for care teams in senior living facilities and demonstrate that monitoring wearable technologies can significantly impact the delivery of care in long term care facilities by encouraging providers to challenge traditional methods of care. We believe that this work is novel and contributes to the existing literature regarding the clinical benefit of Remote Patient Monitoring (RPM) technologies for older adults.

Key Points

- The integration of Somatix's RPM technology had long-term improvements for numerous KPIs.
- For staff members, this technology increased workplace empowerment and the perception of empathy towards patients.

Why Does This Matter?

- The adoption of RPM technologies in long-term care facilities can significantly improve both patient and health care provider experiences.

Conflict of Interest

The authors of this paper are affiliated or involved with Somatix Inc., which is an entity discussed in this study. There was no sponsor involved in this study.

Author Contributions

Indicate authors' respective roles: Ex: Study concept and design: AR, CH, DF. Data acquisition: CH, DF. Data analysis and interpretation: AR, CH, LS, DF. Manuscript preparation: AR, CH, AS, LS, DF.

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