Potentially Preventable Hospitalizations: MonashWatch telehealth self-reported journeys before and after acute admission

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May 5, 2020

Abstract

Rationale aims and objectives Potentially preventable hospitalizations (PPH) are a challenge. What happens before hospital admission? Are there crucial tipping points before admissions in at-risk cohorts' trajectories? HealthLinksChronicCare (HLCC) hospital risk-prediction algorithms using admission, diagnosis, and lifestyle data identifies at-patients. MW monitors HLCC patients with outbound phone calls using telehealth – the Patient Journey Record System with alerts representing a real-time anticipated risk of PPH. Health Coaches triage and intervene to optimize GP, hospital and community service utilization to reduce the risk of PPH. Aims To describe a time series of telehealth phone calls related to an acute admission (? 10 days) to investigate tipping points in self-reported biopsychosocial environmental concerns (total alerts) and or condition symptoms of concern (red alerts). Methods MW participants had an acute (non-surgical) admission and >44 calls between 23/12/16 - 11/10/17. The Patient Journey Record System (PaJR) and Victorian Admitted Episode Data/ Emergency Minimum Dataset provided longitudinal data. Descriptive time series analysis employed Pettitt's homogeneity test to detect 'tipping points' using XLSTAT package. Findings One hundred three patients aged 74 ± 15.4 years, with 59% male and 61% female, provided 764 call records around admission(s) and 22,715 records over 10 months. Total alerts and red alerts were higher in the 10 days before and after admission. Total alerts significantly increased (tipped) at day 3 before hospitalisation persisting until 10 days. Red alerts increased (tipped) 1 day before admission and remained high following discharge. Discussion and Conclusion Self-report in phone calls describe a pre-hospital phase of 'post-hospital syndrome' (PHS), which began at least 10 days before admission and persisted after discharge. Wide-ranging health, psychosocial, and environmental concerns preceded a tipping point into acute symptoms. Telehealth monitoring of biopsychosocial, as well as disease, concerns require further investigation.

Introduction

Potentially preventable hospitalizations (PPH) are the subject of considerable concern for stakeholders – patients and families, hospital and community services and funders. They are of particular interest when they are 'band-aid' solutions to managing community crises in older adults with uncertain health improvements.

Post-hospital syndrome (PHS is *'a transient period of generalized susceptibility to disease as well as an elevated risk for adverse events, including hospital readmission and death'* [1]. There have been a range of theories – from biomedical to hospitalization-induced allostatic overload [2.] Much PPH effort has focused on post-hospital transitions of care. An international literature review indicates that transitional care interventions can successfully support older patients with complex conditions [3]. Nevertheless, an irreversible loss of systemic resilience in the longer term and fast(er) decline follows most hospital admissions in this category

[4]. The importance of intervention before hospital admission would seem a logical approach; however, few articles report findings on this topic. Resilience theories provide a comprehensive conceptual framework [5] with practical application to reflect biological, psychosocial, and environmental influences on admissions, which open up diverse opportunities for early intervention in collective and individual journeys [6]. The Patient Journey Record (PaJR)system is a telehealth system that addresses the risk of PPH [7]. The PaJR system was initially developed and validated with an Irish primary care cohort.

Background

The Victorian Department Health and Human Services' (DHHS) state-based public hospitals' database HealthLinks Chronic Care (HLCC) employs data analytics to predict a cohort at risk of 3 repeat hospitalisations in the subsequent 12 months [8]. The HLCC algorithm identifies an eligible cohort of patients with parameters including acute non-surgical admissions in previous 6 months; emergency department visits in previous 3 months; age; residence status, smoking; and chronic conditions including gastrointestinal disorders, renal disease, asthma, chronic obstructive pulmonary disease (COPD), rheumatoid arthritis, diabetes, pancreatic conditions, cirrhosis/alcoholic hepatitis, with the exclusion of conditions such as serious mental illness. The DHHS provides a 'HLCC eligible cohort' list to hospital groups with periodic updates.

Monash Health, the largest hospital group in Victoria, Australia, implemented an HLCC program called MonashWatch (MW), incorporating the PaJR telehealth system 23/12/2016 [9]. The MW service started in lower socio-economic, and an ethnically diverse area of Melbourne proximate to Dandenong Hospital. This paper reports on an internal formative evaluation in the first 10 months of the active group of the pragmatic MW clinical trial.

The Service

The MW service monitored the participating HLCC cohort through outbound phone calls using (PaJR) (See Figure 1). The PaJR system provides analytics of semi-structured call data. Self-reported observations of daily health and living data are processed to generate alerts to assist in proactively managing HLCC patients. Alerts (total alerts and red alerts) are indicators of stressors, resilience, and health perceptions with more alerts per call, indicating vulnerability to worse health and or hospital admission [10].

- *Total alerts* reflect generic issues including perceptions of self-rated health (SRH), illness and coping, and concerns about health care, medications, social and environmental issues.
- *Red alerts* are those that require prompt clinical assessment including typical symptoms that are likely to lead to hospitalisation including chest pain, severe pain of any nature, breathlessness, fever and infections, falls, crises in mental health crisis and or recent attendance at the ED.

MW Clinician assessments and proactive interventions, triggered by alerts, aim to address root causes of worsening health and potential readmissions [11].

Aims

This paper aims to describe patterns of total alerts (self-reported biopsychosocial concerns) and red alerts (disease symptoms of concern) and self-rated health patient trajectories 10 days before and after admission in the intervention cohort of MonashWatch.

Methods

A descriptive time series analysis aims to identify significant shifts (potential tipping points) in patient journeys derived from phone call records from PaJR database and admission data from the Victorian Admitted Episode Data/Victorian Emergency Minimum Dataset.

Descriptive homogeneity tests on a time series aimed to determine if a series is homogeneous over time, or if there is a time at which a change occurs (potential tipping point). For all tests, XLSTAT provides p-values using Monte Carlo resampling. Pettitt's test was selected as a descriptive tool for detecting changes and suitable for all continuous distributions. All tests are two-sided, and alpha was set at 0.05[12].

Monash Health Research Ethics Committee (HREC) provided ethics approval for the MW pilot service and its internal evaluation by the MonashWatch team.

Findings

The study characterized 103 patients' emergency non-surgical admissions with 768 calls before and after an acute non-surgical admission in the 23/12/16 - 11/10/17 period in the context of their total 22,715 calls in that period with an average of 5.52 calls per participant per month. The age range was 65 years with a mean 71 ± 15.4 and median 74 years. Gender distribution was male 59% female 61%. Each individual admission time series had a median of 7.63 total calls before and after admission. Calls were distributed evenly in relation to admission day = 0 (See Figure 2). Calls were not intentionally made during admissions, although a few did occur.

Admissions demonstrated a wide range of length of stay (LOS) from >1 to 37.3 bed days with median 4.1 and mean 5.8 ± 5.8 days. Admission rankings of the top 6 conditions were in descending order (with complexity): chest pain (minor); COPD (minor); chest pain (major); abdominal pain and mesenteric adenitis (minor); other digestive system disorders (major); and respiratory infections and inflammations (major). See Figure 3 for most common DRG admission code for the group.

Alerts in the 10 days before and after an acute admission were compared to general rates of alerts for these patients in the same 23/12/16 - 11/10/17 period. Total alerts 10 days before and after an admission were 3.1 per call vs 1.6 average total alert rates. Red alerts in the admission $\pm$ 10 days period were 0.8 per call vs 0.6 average. Chi-square test indicated a significant difference in both red alerts and total alerts in general versus 10 days before and after an admission. alpha = 0.05.

The time series of alerts and other measures within the 10 days before and after an acute admission were analysed using Pettitt's test of homogeneity. This demonstrated that there was a significant shift towards higher levels of total and red alerts before admission. See Figure 4

Figure 4 Tipping Points in alerts identified by homogeneity metrics in 103 admission trajectories.

Features of alerts

Total alerts time series demonstrated a statistically significant shift before the day of admission, day -3. Red alerts time series demonstrated a statistically significant shift 1 day before admission (day -1) based on 768 calls and 103 admissions. Self-rated health today (SRH) was reported fair to good on average from day -10 before admission and demonstrated a statistically significant improvement after discharge on day +4. Pain was reported throughout all the 20 days at a rate of 20% of calls. Feeling depressed some or most of the time was reported in 20% of calls with improvement on day +5. Medication change and more GP visits were reported on average in 75% of calls in the 10 days before and after the admission, with a peak or tip of 82% calls at 2 days before an admission using Pettitt's measure of homogeneity.

Total alerts patterns were associated with increased sleep disturbances, not eating and drinking or going to the toilet as usual and not going out as usual; and environmental concerns related to housing, transport, weather and finances. Calls reported that participants had more concerns about people who cared for them or were close to them in the 10 days before admission. Rating 'anticipated health over the next few days,' 100 of the 736 (14%) calls indicated possible poorer future health, which was significantly higher than at other times.

Most frequent symptom complexes reported in the red alerts before and after admission were: fever shivering or infection symptoms related to bladder, bowels, skin, etc. in 73 calls; significant pain 40 calls; 'weakness/unsteadiness/falls/collapse' 31 calls; Breathlessness 26 calls; significant 'coughing/wheezing/increase coloured phlegm' 17 calls; depression, mental or behavioural problems 14; 'swelling of ankles/legs; weight gain 1-2 kg in 1-2 days' 3 calls; and 'chest pain, sweating heart, angina type pain' in 2 calls.

Discussion

The high levels of alerts post-discharge support the counterintuitive notion of a post-hospital syndrome that started before admission and may persist to day 10 at least. This finding is in accord with the post-hospital syndrome and PPH literature.

A prodromal phase of an acute non-surgical admission – 'pre-hospital syndrome' is self-reported in this study with more alerts, health disturbances and medication changes before an admission compared to an average level over several months. The pre-hospital syndrome was associated with a general pattern that had more total alerts and red alerts than average for the cohort with these patterns persisting after discharge. Tipping points were identified in general alerts 3 days and red alerts 1 day before admission. However, while these tipping points were statistically significant, some individuals had no alerts and others had different variations before admission.

Poorer health, feeling depressed, worse experiences of daily living functions, increased GP visits and medication changes, all appeared to increase before the emergence of disease or condition symptoms. Also increased concerns about caregivers, and concerns about issues in the physical environment reportedly increased before admission. These patterns persisted in the 10 days post-discharge.

Do these findings represent disturbances in individuals across biological, health care, psychosocial and environmental domains; with an emergent instability potentially tipping to 'clinical disease'? It is difficult to disentangle the impact of the internal systemic stress triggered by an emerging acute illness from external stressors related to medical treatment, health system, psychosocial and environmental issues. In a vulnerable group, hospital care may not balance out these systemic and external stresses [2] and provide a band aid to complex individual and community-based dynamics. Moreover, such patients may be even more susceptible to adverse outcomes related to the stress of hospitalization. If this is a common pattern, addressing PHS would require reduction of modifiable stressors encountered by patients before hospitalisation.

There is a need to identify mechanisms to promote physical and psychosocial environmental resilience in order to address interconnected network processes *within an individual in their internal and external milieu* [13].

Recognising PPH as a *complex system and an adaptive systems response* to dynamic networks is called for. MonashWatch Integrative care delivery approaches such as broad-based monitoring of self-reported health and coaching, aim to more adequately address individual dynamics as well as disease management. Identifying the manifestation of an emerging deterioration with potential tipping point(s) is key to offering anticipatory and reactive care.

Tipping points – or the prediction of potential tipping points in resilience in different domains form is an important component of complex adaptive care [14]. However, the prediction is a very short-term phenomenon in such interconnected non-linear systems[15]. Ongoing wide-ranging self-reported narratives can provide opportunities for addressing PPH, particularly before an acute admission. Research indicates that each admission in these older complex patients is likely to result in less resilience, the ability to bounce back to a pre-prodromal state and ongoing decline[5]. On the other hand, many such hospitalizations may signify an unavoidable decline that hospital admission cannot avert, and post-hospital transitional care has a significant role in ameliorating the decline.

Telehealth approaches with a high-risk cohort can utilise a broad-based biopsychosocial approach to address the prehospital phase and post-admission phase of PPH. Whether biometric monitoring is needed for improved clinical care is an unanswered question. However, reported concerns and a tipping point in wide-ranging health, psychosocial and environmental areas can track interconnected multifaceted individual journeys. Research into potential tipping points and phases for increased intervention and support is needed.

Conclusion

This study of self-reported pre - post acute hospital admission trajectories in a cohort of high-risk individuals describes a pre-hospital phase (with intense medication/drug/alcohol changes) and high levels of poor health, symptoms and pain around acute admissions.

This prodromal phase pre-empted admissions and persisted on discharge with only some measures - self-rated health and feeling depressed improving 4 - 5 days after discharge.

Self-reported concerns and a tipping point in wide ranging health, psychosocial and environmental issues preceded a tipping point in acute disease symptoms signifying an interconnected multifaceted prodrome and possible phase for intervention and support. It would seem that telehealth approaches interconnected with GP and social care involvement would might be a way forward and entails further investigation and research into trajectories before as well as after hospitalisation.

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Acknowledgement

Conflict of Interest

Carmel Martin is a co-developer of the PaJR software and health services research adviser to PHC Research Pty Ltd which owns the PaJR software.

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