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Characteristics and Hospital Activity of Elderly Patients Receiving Admission Avoidance Home Visits: A Population-Level Record Linkage Study

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Abstract

As pressures on healthcare systems increase, due to an ageing population, hospital admission avoidance interventions have been emphasised. These interventions can be difficult to objectively evaluate due to non-randomised roll-out, requiring observational methods with carefully selected control groups. This study aims to identify the defining characteristics of elderly patients receiving admission avoidance home visits. We conducted a record linkage study using routinely collected data to compare characteristics and outcomes of the general elderly population and a subset of high-risk patients. Intervention patients were found to have significantly different demographics and admission rates compared to the general population, having four times higher admission rates at baseline. However, they share similarities with high-risk patients, particularly in that after a period of increased admissions, both groups experienced a reduction in the following year. Identifying defining characteristics of the target intervention population can guide the careful selection of a control group for evaluation.

Keywords:

Home Care Services; Evaluation Research; Informatics

Introduction

Within the last decade, there has been an increased emphasis on reducing unscheduled admissions to the hospital, reflecting the need to better manage the increased pressures faced by health systems due to the changing demographic profile of European populations [1]. This has led to the development of alternative care models, focusing on proactive rather than reactive care. Alternative care models include proactive chronic condition management, intermediate care, community-based care interventions and using telemedicine, telehealth and digital health solutions. Young states that intermediate care "is conceived as a range of service models aimed at 'care closer to home' by expansion and development of community health and social services," including hospital-at-home services [2]. There are currently two main hospital-at-home models: *early discharge models* where hospital-level care is provided at home following early discharge from hospital, and *admission avoidance models*, in which multidisciplinary rapid response teams provide treatment, assessment and support for a short period of time [1,2].

The latter models are concerned with unscheduled care, differentiating them from models such as health promotion visits or preventive home visits, which involve assessments primarily aimed at preventing new problems for patients living independently in the community [3].

Hospital-at-home models are complex interventions with several interconnecting parts. Their evaluation can prove challenging, often because the interventions have not been fully defined or developed at roll-out [4]. Furthermore, they are also prone to evolve over time, particularly within a community setting [5]. Randomisation may be unfeasible or inappropriate, with the decision to evaluate often being made in hindsight [5].

Observational studies can provide an alternative evaluation approach where randomisation is unfeasible; however, these evaluation studies require a robust design and methodology. Often evaluations may use the general non-intervention population as a control group and use standardisation of likely confounders, such as age and sex. However, the inclusion criteria of hospital avoidance interventions will usually be linked to the outcomes being measured for evaluation [5].

Hence, trends in hospital activity for the intervention population and the characteristics that define them will differ greatly from that of a general elderly population. This is particularly the case in people over 65 years of age with a history of emergency admissions (also known as high-risk patients), whose levels of hospital use have been shown to naturally reduce over time compared to the general elderly population, due to both mortality and regression to the mean [6]. In their study, Roland et al warranted further research for defining high-risk patient groups for interventions to reduce admissions [6]. To evaluate the effect of a healthcare intervention on hospital admissions, a carefully selected control group is essential and, in the case of interventions for high-risk patients over 65 years of age, must match the intervention group according to their defining characteristics [6].

The aim of this paper is to identify the defining characteristics of patients receiving admission avoidance home visits, for which the decision to evaluate was made in retrospect and referral criteria has been loosely defined (as is common in complex community interventions).

This was done by comparing patients receiving the intervention to two groups: the general population over 65 years of age and a subset of high-risk patients in the area of interest. We first compared patient characteristics in these three groups, obtained through healthcare record linkage of several datasets, some of which have never previously been used in research.

We then made a temporal comparison of hospital admission rates for the three groups. Identifying characteristics that define the intervention patients will enable the appropriate selection of a comparison group for evaluation, which is essential for a robust evaluation in this setting, and may prove useful to others evaluating similar services and interventions.

Background

'Closer to Home' programme

In 2011, the Scottish Government rolled out the Reshaping Care for Older People (RCOP) strategy with the vision that older people should live full and positive lives at home or in a homely setting [7]. The allocated RCOP strategy Change Fund resulted in a number of local initiatives across Scotland aiming towards promoting home and community care. The Forth Valley (FV) health-board includes a central area of Scotland with an estimated population of 57,317 residents aged 65 and over in 2017 [8]. 'Closer to Home' is a coordinated programme, set up in December 2015, to achieve the RCOP aims within the NHS Forth Valley health board. We have developed an evaluation framework for the 'Closer to Home' programme which has been previously described elsewhere [9].

'Enhanced Community Teams'

The 'Closer to Home' programme includes Enhanced Community Teams (ECTs) which are multidisciplinary rapid response teams of nurses, physiotherapists, occupational therapists, social care staff and, more recently, specialty-trained general practitioners (GPs) (from January 2017). In this paper, ECT is the intervention of interest.

The ECTs provide both early discharge and admission avoidance home visits, with a focus on the latter. Care is provided 24 hours a day, 7 days a week. Referrals are made mainly through the patient's GP, however, referrals can also be made by discharge coordinators, emergency department clinicians, the ambulance service, and other community services. The criteria for referral are loosely defined but state that the patient must require immediate hospital-level support that can be provided at home and must be registered with a FV GP. Treated patients are predominantly elderly, frail patients over 65 with long-term conditions. Acutely ill elderly patients who did not receive the intervention received usual care which includes hospital admission along with community services such as district nursing which may support a patient's recovery but are not aimed at admission avoidance.

Implementation of the ECTs was staggered in the first year in a non-randomised fashion, area by area through contact with GP practices and other potential referral sources to promote the teams. ECTs use NHS FV's Multidisciplinary Information System (MiDIS) for the recording of community activity data, including assessments and contacts with patients such as home visits.

Methods

Constructing a study cohort

A cohort of patients was defined to include any patient within FV who was aged 65 years or older at any point between a year before the time the ECTs were started (December 2014) and the time at which the cohort was constructed (April 2018). To construct this cohort, two main datasets were combined: one consisting of a list of the patients registered with a GP in FV, and one consisting of records of deaths registered in FV by the National Records of Scotland. These datasets are used nationally and go through several quality checks. These were combined to create a cohort of 65,189 patients.

Record linkage methods and ethics

Linkage of patient datasets was conducted using deterministic record linkage in SQL Server (Management Studio 2008), which allows full control of the linkage process. Pre-merge data cleansing to resolve typographical differences was required to enable linking keys to be matched [10]. In Scotland, the Community Health Index (CHI) is used to uniquely identify patients, often used in linking patient datasets [11]. Using the CHI and postcode as linking keys, demographic, hospital activity and prescribing records were linked to the compiled cohort described previously.

Research ethics approval was not required for this study as it is for the purpose of a service evaluation based on retrospective analysis of routinely collected data. Caldicott approval within FV and the Information Services Division (ISD) for Scotland was obtained for the request for prescribing data. All analysis was conducted on pseudonymised data.

Identification of intervention patients

Intervention patients were identified from datasets collected from MiDIS. These datasets are not used for national reporting and prior to this study, have never been used in research, hence they required multiple linkages and data cleansing in consultation with the ECTs to understand each variable held. The main linked MiDIS datasets were a master patient dataset and datasets of episodes of care, individual contacts, and episode registrations. This linkage combined with consultation with ECT members enabled the compilation of a validated dataset containing episode details, including number of contacts, type of patient and discharge reason, from which intervention patients were identifed (1,294 records).

Main linked datasets

The linked datasets which are locally held include emergency department attendance data, community health visit data and a master patient dataset for any patient having received inpatient, day case or outpatient care in FV. The linked datasets which are nationally held include outpatient attendance data (Scottish Morbidity Record for outpatients (SMR00)) and hospital inpatient stay data (Scottish Morbidity Record for general acute inpatients and day cases (SMR01)) [11]. Data for prescribed items dispensed in the community were obtained for each patient in the cohort through a request for data through ISD.

Demographic data linkage

The linked demographic variables include age, gender, GP practice, locality, deprivation, ethnicity, marital status, smoking status, living alone, and a care home stay indicator. These primary variables were compiled in an analytical dataset and additional secondary variables were created from these. Due to missing values for the primary variable living alone, marital status was incorporated to create a secondary variable indicating if the patient has been recorded as living alone or not at any point, with not married being classified as living alone and married/cohabiting as not living alone. This reduced the missing values by 34.0%. An additional variable was created combining nursing home residency and having had a stay in a nursing home, to characterise patients who have had a nursing home stay (used as a proxy for functional status with high dependency needs).

Hospital inpatient stay records were linked to obtain a Charlson comorbidity score for each patient, which identifies and gives weights to each of 17 comorbidities according to the relative risk of one-year mortality [12].

The comorbidities were identified from International Classification of Diseases codes (10^{th} revision) (ICD-10) recorded as hospital diagnoses [12] (923,465 records). An algorithm within R package "icd" was then used to generate the Charlson scores for each patient using ICD-10 codes recorded in the past 5 years [13].

Hospital activity and prescribing data linkage

Hospital activity data linked for each patient included the number of emergency and elective inpatient hospitalisations (from SMR01), two years before and after the implementation of ECT (2014-17) (100,071 records). Prescribing data linked for each patient included prescription items dispensed and reimbursed by the NHS in the community (94.6% were prescribed by a GP). This data included the number of items prescribed and the number of British National Formulary (BNF) classes (paragraphs) covered by the prescribed items (1,510,018 records). The average monthly number of BNF classes was selected for use as it reduces variation and reduces the effect of exaggerated polypharmacy for patients who have multiple medications in the same BNF paragraph (class), hence it was deemed a better proxy measure of multimorbidity [14].

Population selected for analysis

The activity data collection period was set as data registered between the 1st January 2016 to the 1st May 2018. From the 65,189 patients in the compiled cohort, exclusion criteria were applied before analysis. Patients receiving the intervention outside of the collection period were excluded (including only episodes occuring between 1st January 2016 to the 1st May 2017, to allow for outcomes to be collected for one year post-intervention). Patients were included if they were over 65 years of age at the start of the collection period, registered with a GP in FV, had not transferred to another health board and had not died at the start of the collection period. Intervention patients who were receiving palliative care or whose episodes of care were recorded as failed (due to inappropriate referrals or inability to contact the patient) were excluded. This left a total of 566 intervention patients and 60,901 patients from the general population.

Data analysis

A subset of high-risk patients, defined as those who had two or more emergency admissions in the same year that the intervention patients experienced a deterioration in health (2016), were grouped separately from the general population in order to compare their characteristics and identify their hospital activity patterns, following Roland et al's comparison [6]. To test for differences between demographic variables in the intervention group, the high-risk group and the remaining population, Welch two sample *t*-tests were used for continuous variables, chi-squared tests were used for categorical variables and Fisher's exact test was used for categorical variables with small observed values in contingency tables.

A temporal comparison was made in admission rates per person between the intervention patients, high-risk patients and the general population (all patients) using the denominator equal to the number alive in each year of the comparison, which Roland et al were unable to do because of a lack of data on deaths. They have previously shown, however, that including mortality has little impact on overall conclusions [6]. Data analysis was conducted in R Studio (R v3.4.1).

Results

Demographic differences

The ECT intervention group and the general population were shown to be very different in the analysis of demographic data. The differences between the general population and both the intervention and high-risk groups were all found to be significant at the 0.1% level for each of the variables shown in *Table 1*. Differences in ethnicity and the average number of prescriptions were not found to be significant between the intervention and high-risk group, while other variables showed significant differences (at the 5% level for care home stay and deprivation, and at the 0.1% level for all other variables).

The proportion of patients aged 75 and older was found to be higher in the intervention group than the other groups (83.5% of intervention patients, 62.4% of high-risk patients, and 38.9% of general population) (*Figure 1*). A greater proportion of intervention patients were female and had a care home stay compared to the other groups. Another major difference between the groups was that 38.5% of the general population were found to have no hospital inpatient stay records in the past 5 years compared to 4.6% in the intervention group, hence had no Charlson score. Greater proportions of high-risk' patients had moderate to severe Charlson comorbidity scores than intervention patients, and only 3.2% of the general population had severe scores. The intervention group had an average of 6.6 monthly prescriptions (BNF classes) with 21.7% of the group having more than ten prescriptions, while the general population had 4.2 on average with only 3.0% having more than ten prescriptions.

Other differences were observed in ethnicity, deprivation, smoking status, and having lived alone, however one of the greatest differences is in the missing values for these variables. There are much lower numbers of missing values for the intervention and high-risk groups, indicating that they have greater interaction with the healthcare systems where these data are recorded. Excluding patients with missing values, 41.5% of intervention patients were recorded as having lived alone, compared to 19.6% of high-risk patients and 12.5% of the general population. Among ethnicity, smoking status and deprivation, when excluding patients with missing values, such great differences were not observed between all three groups.

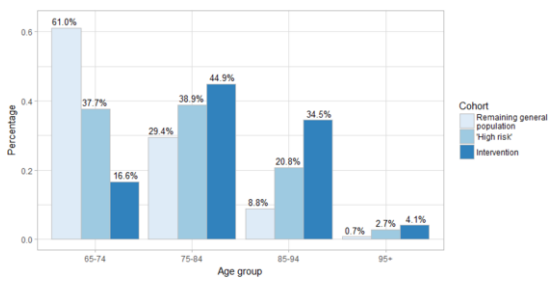

Figure 1– Age distribution of population aged 65 and over

Hospital activity differences between groups

All reported admission rates account for deaths as previously described. In the year prior to ECT implementation, the general population (all patients) had an admission rate of 0.17 emergency admissions, while the other groups had much higher admissions (0.68 in the intervention group and 0.81 in the high-risk group).

This means that prior to implementation of ECT the admission rate in the intervention group was 4.0 times higher than that of the general population but 0.8 times lower than that of the high-risk sub-group.

In the year following the implementation of the intervention, the rate of admission in the full general population increased by 27.5%, while both the high-risk and intervention groups had multiple times higher rates (see *Table 2* and *Figure 2*), reflecting a deterioration in health for intervention patients at the time of being admitted to the ECTs.

Two years on from the implementation of ECT (2017), the admission rate for intervention and high-risk patients decreased drastically from the previous year (by 32.0% and 60.8%

respectively), while in the general population a small increase was observed (5.0%).

Table 1 – Characteristics of the intervention group, high-risk and remaining population over 65 years in Forth Valley

Variable	ECT group (n=566) n (%)	High-risk group (n=2,467) n (%)	Remaining population (n=58,434) n (%)
Age, mean (SD)	82 (7.5)	78 (8.4)	73 (7.5)
Female sex	351 (62.0)	1,267(51.4)	26,458 (45.3)
Ethnicity			
White	546 (96.5)	2,407 (97.6)	47,859 (81.9)
Other	3 (0.5)	14 (0.6)	270 (0.5)
Unspecified	17 (3.0)	46 (1.9)	9,053 (15.5)
Null	0 (0.0)	0 (0.0)	1,252 (2.1)
Deprivation quintile[a]			
1	91 (16.1)	415 (16.8)	7,616 (13.0)
2	153 (27.0)	687 (27.8)	13,551 (23.2)
3	98 (17.3)	527 (21.4)	11,787 (20.2)
4	114 (20.1)	493 (20.0)	12,974 (22.2)
5	108 (19.1)	345 (14.0)	12,505 (21.4)
Null	2 (0.4)	0 (0.0)	1 (0.0)
Has lived alone			
Yes	235 (41.5)	483 (19.6)	5,849 (10.0)
No	331 (58.5)	1,978 (80.2)	42,485 (72.7)
Null	0 (0.0)	6 (0.2)	10,100 (17.3)
Care home stay			
Yes	132 (23.3)	481 (19.5)	2,956 (5.1)
No	434 (76.7)	1,986 (80.5)	55,478 (94.9)
Smoking status			
Yes	54 (9.5)	131 (5.3)	760 (1.3)
Ex-smoker	95 (16.8)	323 (13.1)	1,381 (2.4)
No	222 (39.2)	439 (17.8)	2,900 (5.0)
Null	195 (34.5)	1,574 (63.8)	53,393 (91.4)
Charlson comorbidity score group[b]			
No ICD-10 codes[b]	22 (3.9)	0 (0.0)	22,477 (38.5)
0	87 (15.4)	251 (10.2)	18994 (32.5)
1-2	196 (34.6)	840 (34.0)	11704 (20.0)
3-4	129 (22.8)	720 (29.2)	3386 (5.8)
≥5	132 (23.3)	656 (26.6)	1873 (3.2)
Average prescriptions[c], mean (SD)	6.6 (3.3)	6.4 (3.4)	4.1 (2.8)
<5	161 (28.4)	762 (30.9)	36,210 (63.7)
5-10	333 (58.8)	1405 (57.0)	20,677 (36.3)
>10	72 (12.7)	300 (12.2)	1,547 (2.7)

[a]*Scottish Index of Multiple Deprivation (SIMD) quintile (1=within most deprived fifth of population, 5=within least deprived fifth)*

[b]*Charlson comorbidity score groups: 0 (No comorbidities identified) 1-2 (Mild), 3-4 (Moderate), ≥5 (Severe), from ICD-10 codes in past 5 years*

[c]*Average monthly number of prescription classes (BNF paragraphs) in the year prior to ECT implementation (2015)*

Table 2 – Emergency inpatient admission rate by population sub-group by with number alive each year as denominator

Population sub-group	2014	2015	2016	2017
Intervention patients[a] (n=566)	0.408	0.678	1.977	1.345
High-risk patients[b] (n=2,467)	0.557	0.808	3.561	1.396
Remaining population (n=58,434)	0.123	0.139	0.095	0.191
All patients (n=60,901)	0.143	0.171	0.218	0.229

[a]*Receiving ECT intervention between Jan 2016-May 2017*

[b]*With ≥ 2 emergency admissions in 2016*

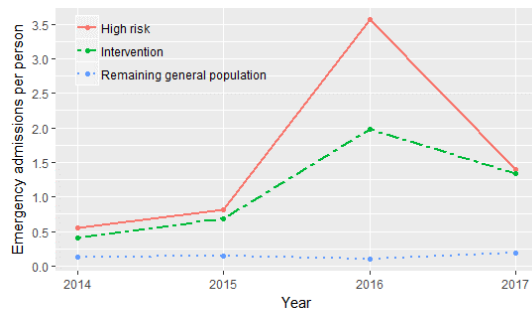

Figure 2– Trend in number of emergency admissions for population aged 65 and over in Forth Valley by sub-group

Discussion

The results of the study confirm that the characteristics of intervention patients differ significantly from those of the general elderly population in NHS Forth Valley. In comparison, the intervention group are older, a greater proportion were female, have higher comorbidity scores, higher prescriptions, four times higher hospital admission rates in the year prior to the intervention and a much higher proportion of intervention patients have lived alone or had a care home stay (proxy for high functional dependency). These characteristics, among others, have previously been identified as being associated with the need for home care [15]. A previous systematic review has also identified older age and Charlson score as risk factors for hospitalisations in community-dwelling elderly patients [16].

Compared to the high-risk patients, intervention patients were older, a greater proportion were female, a higher proportion had lived alone or had a care home stay but had a lower proportion of moderate to severe comorbidity scores. The difference that was most evident in variables with missing values was that the intervention and high-risk groups have much lower frequencies of missing values, indicating greater interaction with the healthcare system.

Overall, ntervention patients had lower admission rates than the high-risk group, however, their patterns of hospital activity were similar. In the year after ECT implementation (2016), both intervention and high-risk patients experienced multiple times higher emergency admission rates, followed by a dramatic reduction (rates including mortality) in the subsequent year; in the general population, a small decrease was observed. These results have been observed in a similar comparison of high-risk patients as previously noted [6]. Similarly, Roland et al. found a drastic reduction in emergency admissions per person in the high-risk patient group (a 75.0% decrease compared to 69.5% decrease in our study when including mortality) [6].

Hence, as Roland et al also found, admissions after the intervention should be compared with a control group satisfying the same criteria that define the intervention group (which can be approximated by their characteristics) [6].

Limitations

Due to the retrospective nature of this study, it is subject to a number of limitations. Retrospective analysis is always limited by the fact that the data may not have been collected for research purposes. For example, input options in MiDIS for discharge reasons can differ according to the user profile, hence this required standardisation through the consultation process with ECT. This study is also limited by data availability. The intervention patients are often described as frail and elderly. Frailty has been difficult to define but has been characterised by physical function, gait speed and cognition [17], which are not routinely collected for the full FV population. Hence, these variables may define the intervention patients, but we have been unable to investigate them. The Charlson comorbidity measure used in this study also has its limitations due to its reliance on ICD-10 codes which in FV are held in hospital records. Hence comorbidity information was not available for patients with no hospital records. In addition, the deterministic data linkage by personal identifiers used in this study is limited in that identifiers are subject to recording errors, hence links can be missed [11]. For prescribing data, ISD was able to confirm that in NHS FV personal identifiers were captured correctly for 96.3% of prescribed items between 2015-17.

Conclusions

In conclusion, this analysis has enabled the identification of defining characteristics of the intervention patients compared to both high-risk patients and the general elderly population, and has highlighted the differences in hospital activity between them. The intervention group are significantly different to the general elderly population, but share some similarities with high-risk patients. The identified characteristics will aid the selection of an appropriate control group, in the evaluatation of the effectiveness of the intervention, which currently ongoing.

The results also highlighted that high-risk patients experience reduced hospital admissions after a period of increased admissions, which has also been shown in other studies. Overall, the analysis indicates that a carefully selected control group is required for the evaluation of the intervention.

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