Reducing emergency presentations from long-term care: A before-and-after study of a multidisciplinary team intervention

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ABSTRACT

Introduction: The complexity of care required by many older people living in long-term care (LTC) facilities poses challenges that can lead to potentially avoidable referrals to a hospital emergency department (ED). The Aged Residential Care Intervention Project (ARCHIP) ran an implementation study to evaluate a multidisciplinary team (MDT) intervention supporting LTC facility staff to decrease potentially avoidable ED presentations by residents.

Methods: ARCHIP (conducted in 21 facilities [1,296 beds] with previously noted high ED referral rates) comprised clinical coaching for LTC facility staff by a gerontology nurse specialist (GNS) and an MDT (facility senior nurse, resident’s general practitioner, GNS, geriatrician, pharmacist) review of selected high-risk residents’ care-plans. A before-after repeated measures analysis was conducted for 9 months before and 9 months after intervention commencement (a 29-month period because of staggered facility enrolment). Modelling was adjusted for time trend, seasonality, facility size, and cluster effect.

Results: ED admission rate ratio post- versus pre-intervention was 0.75 (95% C.I. 0.63, 0.89, p-value = 0.0008), a 25% reduction in ED presentations post-intervention. A sensitivity model used a shorter, staggered time period centred on intervention start (9 months pre-intervention and 9 months post-intervention) for each facility, and a four-level categorical intervention variable testing intervention effect over time. The sensitivity test showed a 24% reduction in ED presentations in months 1–3 post-intervention (p-value = 0.07), a 34% reduction in months 4–6 (p-value = 0.01), and a 32% reduction in ED presentations in months 7–9 (p-value = 0.03). However, when the higher ED referral rates for 3 months immediately pre-intervention were modelled, the impact of the intervention on ED presentation rates reverted almost to previous levels.

Key Conclusions: A GNS-led MDT outreach intervention, targeted at selected conditions, decreases avoidable ED admissions of high-risk residents from selected facilities.

1. Introduction

Older people’s health is an increasingly important issue. The proportion of New Zealanders over age 85 will double between 2021 and 2040. [1] Similar demographics exist OECD-wide, raising sustainability issues for healthcare models [2].

Older residents of long-term residential care (LTC) are at high risk of hospitalisation due to increased frailty and disability. In follow-up of our 2008 Auckland LTC cohort [3,4] 6% were hospitalised (mostly acute admissions) within four weeks post-survey. In common with other jurisdictions, New Zealand has witnessed increasing age and co-morbidity and polypharmacy in its LTC residents. Our previous work has described in some detail these changes [3,4]. Thus, new ways to support LTC are needed to improve outcomes [5].

Although it is not justifiable to claim a direct association between LTC care quality and hospitalisations, useful indicators of LTC quality, which have large between-facility variation, [6] may include hospitalisations [7] many of which relate to complications or exacerbations of chronic medical conditions and some of which are potentially avoidable [8]. It is well known that older people often decondition during a
hospitalisation, and are at high risk for skin tears, pressure ulcers, falls, under-nutrition, confusion, infections and new disability \[5,9\]. Rates of avoidable hospitalisations vary with patient and practice factors and with method of classification \[8\].

The Aged Residential Care Healthcare Utilisation Study (ARCHUS: funded by the Health Research Council of New Zealand) was a cluster-randomised controlled trial of an interdisciplinary outreach intervention aiming to decrease potentially avoidable hospitalisations from LTC. We have previously reported \[10\] ARCHUS had no overall effect on avoidable admissions, all acute admissions or mortality, but that in a post-hoc analysis we did demonstrate reduction in hospitalisations for five important medical conditions which we termed ‘the big five’: congestive heart failure, chronic obstructive pulmonary disease, ischaemic heart disease, stroke and pneumonia \[11\]. The present paper reports an uncontrolled district-wide implementation of a modified initiative, the aim of which was to assess its generalisability across a wide range of LTC facilities with high rates of acute hospitalisation.

### 2. Methods

The study was carried out with Waitemata District Health Board (WDHB), which comprises a large geographical region to the north of Auckland, New Zealand. It is New Zealand’s most populous District Health Board with an estimated population of 600,000 and includes both urban and rural catchments. At the commencement of the study WDHB had 63 LTC facilities certified to provide care for older people. Using routinely-collected ED presentation records (hospital data), the research nurse selected and recruited 21 facilities with above-average rates of hospital presentations during the three-month period excluding the calendar month prior to intervention start. All facility residents during the study period were included. Bed-types included lower-level ‘rest home’ care (24-hour-care but not 24-hour registered nurse coverage), higher-dependency ‘private hospital’ care (24-hour registered nurse coverage) low level dementia care and high-level psychogeriatrics care.

ARCHUS study methodology has been previously described in detail \[12,13\]. It was a cluster-randomised controlled trial (RCT) of an intervention in 36 greater Auckland RAC facilities (18 intervention,18 control matched by facility type & size; stratified by District Health Board (DHB)). All residents in these facilities during the study were included, contributing nationally collected data on hospital admission, death and person-time information. The ARCHUS intervention combined several approaches to care: (a) Baseline facility assessment to identify areas of need and facility care plan developed by the interdisciplinary team; (b) monitoring and benchmarking of resident indicators linked to quality of care provided (falls, nutrition, restraint use, weight loss, UTIs, residents on >9 medications); (c) three 1-hour multidisciplinary team (MDT) meetings - monthly for the first three months at each facility, including medication review by study gerontology nurse specialist (GNS), geriatrician, general practitioner (GP), pharmacist & nurse manager. Typically, six residents were considered per meeting with priority given to new admissions, the recently hospitalised, those with recent ‘incidents’ (e.g. fall) and those on >9 medications; (d) gerontology education and clinical coaching for RAC nurses & care-givers. For specific residents the intervention also included consultation with community physiotherapy, speech-language therapy, palliative care/ hospice. GNS’s time commitment was 20% across all intervention facilities. Residents in control facilities received usual DHB support, which did not include any of the elements (a–d) above. Potentially avoidable admissions (the primary endpoint) were classified from a pre-specified list of diagnoses recorded as ICD codes in routinely-collected public hospital admission records held by the Ministry of Health using the NHI (unique national health identifier for all NZ health service users). Facilities supplied NHIs and minimal other resident information monthly during the study.

The currently reported ARCHIP intervention combined several approaches from the ARCHUS intervention following the CReDECI guidelines for reporting development and evaluation of complex interventions \[14\]: (a) baseline facility assessment identifying needs, and facility care plan developed by study GNS and facility senior nurse; (b) clinical coaching for LTC nurses & care-givers, with (compared to ARCHUS) increased clinical coaching time at each facility (paper in preparation); (c) three 1-hour MDT meetings, including medication review, by study geriatrician, GNS, pharmacist & facility general practitioner and senior LTC nurse(s). It was anticipated that clinical coaching would enhance ability of the LTC staff understand and implement the recommendations of the MDT. The ARCHIP intervention differed from ARCHUS in that it did not include benchmarking of resident indicators linked to care quality or an enhanced education package for LTC nurses & care-givers. However, based on the findings of the ‘big five’ analysis \[11\], the MDTs and clinical coaching pre-ferentially (though not exclusively) targeted residents with a history of at least one of the ‘big five’ diagnoses recorded in their clinical notes (including hospital records). For the purposes of the intervention the 21 facilities were classified into four geographical clusters. Each cluster received the three-month intervention on a staggered basis starting in May 2014.

The study was approved by NZ’s Health and Disability Ethics Committee as a facility-level intervention (NZ/1/SC2405). Facility managers provided written, informed consent before randomisation. ARCHIP was registered with the Australian New Zealand Clinical Trials Registry (ACTRN12614000499684). Care was taken to blind investigators to facility identification where possible \[13\].

Endpoints were obtained from national databases of all publicly-funded hospital visits maintained by the Ministry of Health. The primary endpoint was the number of presentations (for any cause) to hospital emergency department (‘ED presentations’). Internal WDHB data indicates that approximately 85% of older people presenting to ED from LTC are admitted to hospital.

The SAS® 9.4 software was used for statistical analyses (SAS Institute, Cary, NC). Generalised linear mixed models were used to investigate the impact of intervention on ED presentations. In the model, the response variable was the number of ED presentations per facility per month which was assumed to have a Poisson distribution. The key predictors (covariates in the model) were intervention, month and seasonality. Facility size (number of beds) was used as an offset variable. The clustering effect was also adjusted. The main model included 21 intervention facilities only and 29-month period for each facility which was at least nine months before and nine months after intervention start. Three sensitivity models were conducted with different numbers of facilities (21 intervention facilities only or all 63 facilities) and time periods. All analyses were “intention to treat” and significance tests two-tailed.

### 3. Results

All 21 selected LTC facilities completed the intervention. All planned MDT meetings and all per-protocol GNS visits occurred. Forty-two MDT meetings were completed, with 247 residents discussed, and invited participants (GNS, geriatrician; clinical pharmacist & facility GP and senior LTC nurses) attended each MDT 184 (74.5%) of residents discussed had a history of one or more of the big five diagnoses prior to MDT. There were no deviations from the study protocol.

Table 1 details the characteristics of the ‘intervention’ facilities. There were 21 intervention facilities and 42 non-intervention (used in sensitivity analyses) facilities in the study (1258 and 1934 beds respectively at study start). The 21 intervention facilities were grouped into four geographical clusters. In terms of facility size, there were four small facilities (less than 30 beds), nine mid-sized facilities (30–59 beds) and eight large facilities (more than 60 beds). 12 facilities were part of chain, and nine facilities were stand-alone. Six facilities were part of retirement villages and 15 were not.
In the whole 36-month study period (Jan 2013 to Dec 2015), 1227 residents from the intervention facilities presented to ED on 2345 occasions. Of these 484 (20.6%) were diagnosed as ‘big five’ conditions from the 21 intervention facilities. 3086 ED presentations were recorded for the 42 control facilities of which 659 (21.4%) were diagnosed as ‘big five’ conditions, in the 21 intervention facilities (Fig. 1). 657 hospitalised patients died in the 36-month period, at a rate of 1.69 [95% CI = 1.54, 1.85] deaths per 100 beds per month pre-intervention, and 1.02 [95% CI = 0.89, 1.18] deaths per 100 beds per month post-intervention.

Table 2 details the results of models testing the effects of the intervention. The main model (21 intervention facilities only, 29-month period for each facility which is at least nine months before and nine months after intervention start) showed there was a 27% reduction (rate ratio 0.73) [95% C.I. = 0.62, 0.86; p-value < 0.001] in ED presentations over the whole period of follow-up post-intervention compared to pre-intervention period. The model also showed ED presentations were significantly higher in the winter seasonal peak months in New Zealand.

Three sensitivity models were conducted. The first sensitivity model differed from the main model only by including the 42 non-intervention facilities in order to improve adjustment of time trends and seasonality. This model showed there was a 13% reduction (rate ratio 0.87 with 95% C.I. [0.79, 0.97], p-value 0.01) in ED presentations over the whole period of follow-up post-intervention.

The second sensitivity model differed from the main model by 1) using a shorter staggered 18-month period centred on the month of intervention start (that varied by cluster), (9 months pre-intervention and 9 months post-intervention) for each facility, and 2) using a four-level categorical intervention variable (1:pre-intervention: 2: months 1–3 post-intervention; 3: months 4–6 post-intervention; and 4: months 7–9 post-intervention) to test whether the intervention effect was constant over time. The model showed a 29% reduction in ED presentations in months 1–3 post-intervention (p-value 0.003), a 39% reduction in ED presentations in months 4–6 post-intervention (p-value < 0.001), and a 39% reduction in ED presentations in months 7–9 post-intervention (p-value 0.004).

The third sensitivity model differed from the second sensitivity model by introducing a four-level categorical variable (1: months 1–3 pre-intervention; 2: months 4–6 pre-intervention; 3:months 7–9 pre-intervention; and 4: post-intervention) in order to test whether the maximum intervention effect observed remained once the period of higher admissions prior to intervention start is adjusted for. The three months immediately prior to the intervention start did not demonstrate a significantly higher rate of ED presentations compared to the first 3-month period in the 9-month period prior to the intervention start (p value 0.15). However, when the above-average rates of hospital presentations in the three-month pre-intervention period were taken into account, no significant post-intervention fall in ED presentations was visible in months 1–3 post-intervention (p value 0.07) or in months 7–9 post-intervention (p value 0.08). There remained however a 31% reduction in ED presentation in months 4–6 post-intervention (p value 0.03).

4. Discussion

The previous ARCHUS study was a well-designed, well-conducted RCT of a complex intervention. As previously reported, it demonstrated no effect (beneficial or harmful) on its major end-points of avoidable admissions, total acute hospitalisations, bed-days or mortality [10]. However, in a post-hoc analysis prompted by a review of the literature showing early disease-specific interventions improve LTC care quality and reduce acute hospitalisations for ‘big five’ diagnoses in older people from LTC or the community [8,15–22], it became apparent that a complex, multicomponent intervention might reduce acute hospitalisations for these conditions [11]. Given the epidemiology of these conditions as a major cause of ED presentation (32% of acute hospitalisations for these conditions [11]. Given the epidemiology of these conditions as a major cause of ED presentation (32% of acute hospitalisations for these conditions) it is reassuring that the current ARCHUS study showed this effect observed remained once the period of higher admissions prior to intervention start is adjusted for.

![Fig. 1. Emergency Department presentation rates over study period, with linear trends.](image-url)
involving residents with one or more of the big five diagnoses, it is possible to reduce all cause urgent ED referrals for at least nine months in facilities with higher than average referral rates.

In ARCHIP we assessed ED presentations as the primary outcome measure. This was in contrast to ARCHUS and the big five analysis [10,11] in which hospital admissions were the primary outcome. In the current study we reasoned that LTC staff have the ability to directly influence ED referral rates, but not hospital admission rates. In WDHB approximately 85% of older people referred urgently to ED with a medical, surgical or orthopaedic problem are admitted (based on WDHB data). It is unclear which of the ARCHIP intervention components (s) impacted ED referrals, though capacity of facility staff in assessing residents’ (including residents not discussed at MDT meetings) medical instability, access to GNS clinical support [12] and to geriatrician and/ or pharmacy review (i.e. MDT input either directly or indirectly) may be relevant. It is also possible that the MDT meetings effectively gave facility staff and general practitioners ‘permission’ not to refer all very ill residents to hospital – whether explicitly or (more likely) otherwise.

The reduction in ED referrals seen in this study and in the big five analysis [11] as well as being statistically significant was clinically impressive both in terms of its absolute impact and its duration of at least nine months.

The current analysis has many strengths. It had excellent facility ‘buy-in’ and retention. Its intervention was pragmatic and structured yet flexible, and the close clinical relationship of the research study GNS to the LTC staff facilitated adherence. It was adequately powered, able to exclude a treatment effect greater than 0.62 though unable to detect a treatment effect smaller than 0.86. In order to adjust for seasonality, we included a 12-level categorical variable (one level for each calendar month) in the model. However, it studied specifically-selected LTC facilities with high hospitalisation rates, raising the possibility of regression to the mean as a factor in the results – and the reduction in ED presentations was indeed blunted, though perhaps not totally lost, when the period before the start of the intervention was included in modelling. The study was however based on an (albeit post-hoc) analyses from a randomised controlled trial [10,11] which also selected (and controlled for) LTC facilities with high hospitalisation rates. As in ARCHUS, in the current study only a small proportion of (admittedly high-risk) residents were discussed in MDT meetings (23% in ARCHUS, approximately 25% in the current study). We do not believe that there were any unexpected interactions between the different components of the intervention that could have affected the study outcomes.

ARCHUS itself had other weaknesses. These have been detailed elsewhere [10–12] but included reporting hospital admissions rather than presentations to emergency units, and some facilities declining participation (reducing the benefit of facility targeting); – problems in design which we corrected in the current study. It is possible that correction of these weaknesses enhanced the beneficial effect of the current intervention. In addition, in ARCHIP, the GNS did more ‘hands on’ clinical coaching and less didactic teaching than in ARCHUS. This may represent an important difference in the two models.

Despite previous non-RCT evidence that interventions in LTC may result in improved care and/or reduced hospitalisations across a wide range of conditions [8,12,18,21–30], the main ARCHUS RCT results were largely inconsistent with previous investigations, though a recently published quasi-experimental study has supported our ARCHUS findings [31]. As indicated above, the ARCHIP findings and the post hoc ‘big five’ analyses are consistent with some previous literature, and represent an advance in knowledge.

ED referrals (and hospitalisations) represent only a proxy and imperfect measure of care quality, and admission avoidance should never be at the expense of denying LTC residents access to appropriate hospital interventions and treatment. Nonetheless, on the basis of the results of the current study, taken in concert with our ARCHUS and ‘big five’ work, and our original Residential Aged Care Integration Programme [10–12] we recommend wider application of our intervention, at least within New Zealand settings; that is a gerontology nurse (preferably nurse practitioner) led, multidisciplinary, complex intervention targeted at LTC facilities with high hospitalisation rates and at LTC residents with at least one of the ‘big five’ diagnoses. A business case for district-wide implementation of the model is currently being developed. Our findings merit replication (preferably by randomised controlled trials) in other jurisdictions. Other questions, particularly how the intervention affects other measures of LTC care quality, require additional work.

### Table 2
Results of models testing effects of intervention.

<table>
<thead>
<tr>
<th></th>
<th>Main model (21 facilities, 29 months)</th>
<th>Sensitivity #1 (63 facilities, 29 months)</th>
<th>Sensitivity #2 (21 facilities, 18 months)</th>
<th>Sensitivity #3 (21 facilities, 18 months)</th>
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<tbody>
<tr>
<td><strong>Intervention effect</strong></td>
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<tr>
<td>Over whole post-intervention</td>
<td>0.73 (0.62, 0.86)</td>
<td>0.87 (0.79, 0.97)</td>
<td>0.71 (0.57, 0.88)</td>
<td>0.78 (0.60, 0.97)</td>
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<tr>
<td>Over 9-month post-intervention</td>
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<td>Months 1–3 post-intervention</td>
<td></td>
<td></td>
<td>0.61 (0.47, 0.81)</td>
<td>0.69 (0.50, 0.86)</td>
</tr>
<tr>
<td>Months 4–6 post-intervention</td>
<td></td>
<td></td>
<td>0.61 (0.44, 0.85)</td>
<td>0.70 (0.47, 0.94)</td>
</tr>
<tr>
<td>Months 7–9 post-intervention</td>
<td></td>
<td></td>
<td>0.61 (0.44, 0.85)</td>
<td>0.70 (0.47, 0.94)</td>
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<tr>
<td><strong>Seasonality</strong> (three winter months vs. January, other months not shown)</td>
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<tr>
<td>July</td>
<td>1.40 (1.12, 1.75)</td>
<td>1.26 (1.09, 1.46)</td>
<td>1.30 (0.99, 1.70)</td>
<td>1.33 (1.01, 1.74)</td>
</tr>
<tr>
<td>August</td>
<td>1.33 (1.06, 1.66)</td>
<td>1.30 (1.12, 1.51)</td>
<td>1.33 (1.03, 1.73)</td>
<td>1.37 (1.06, 1.79)</td>
</tr>
<tr>
<td>September</td>
<td>1.29 (1.03, 1.61)</td>
<td>1.29 (1.11, 1.50)</td>
<td>1.09 (0.82, 1.45)</td>
<td>1.15 (0.83, 1.47)</td>
</tr>
<tr>
<td><strong>Pre-intervention ED presentations</strong></td>
<td>1.14 (0.94, 1.37)</td>
<td>1.14 (0.94, 1.37)</td>
<td>0.85 (0.62, 1.14)</td>
<td>0.69 (0.50, 0.96)</td>
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<tr>
<td>3-month period prior to intervention start</td>
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Note: Adjusted also for other months of year, for trend over time, within-facility clustering (per random intercept), and for facility size (by offset).
Contributors

MJ Connolly conceived and designed the clinical intervention and experimental methods, and performed the experiments. JB Broad conceived and designed the experimental methods, and analysed and interpreted the data. T. Bish conceived and designed the clinical intervention, and performed the experiments. X Zhang analysed and interpreted the data. K Bloomfield performed the experiments. M Boyd conceived and designed the clinical intervention, and performed the experiments. All authors contributed to writing the paper. All authors had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and accuracy of the data analysis.

Conflict of interest

MJ Connolly, M Boyd, JB Broad, and K Bloomfield have support from the Health Research Council of New Zealand. They received no directly applicable funding. MJ Connolly is supported from the Health Research Council of New Zealand for the submitted work. T. Bish has support from the Health Research Council of New Zealand. X Zhang, K Bloom, and D Bramley have no financial interests that may be relevant to the submitted work. MJ Connolly, M Boyd, JB Broad, and K Bloom have no relationships with other organisations that might have an interest in the work. Their contributions to the study design, data collection, analysis or interpretation, and no influence on manuscript preparation.

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References


