MONASH University

Emergency and Prehospital Care for Older People Living in Residential Aged Care Homes

Rosamond Anne Delvas Dwyer

MBBS BMedSci FACEM

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Prehospital, Emergency and Trauma Research Group
School of Public Health and Preventive Medicine
Faculty of Medicine, Nursing and Health Sciences

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Abstract

Background

Older people living in residential aged care homes (RAC) frequently use acute and emergency medical services with high rates of emergency department (ED) presentation and inpatient hospital admission. The majority of these ED presentations include transport to hospital via an emergency ambulance. These emergency transfers may be a considerable burden for this population and yet there is only limited evidence surrounding the appropriateness, determinants and outcomes of these episodes of acute care

Aims

The aim of this program of research was to examine the nature and outcomes of emergency transfer to hospital and prehospital care for older people living in RAC homes.

Methods

Two systematic reviews of peer reviewed evidence were undertaken to investigate the outcomes, firstly and secondly, the determinants of unplanned transfers to the emergency department. These reviews informed three subsequent studies involving retrospective analysis of clinical and administrative data from Ambulance Victoria, from 2008 to 2013, the Australian Bureau of Statistics and the Australian Institute of Health and Welfare. The first, a retrospective cohort study of rate of ambulance call-outs to older people living in Victoria. The second, a descriptive analysis of prehospital case-mix, intervention and disposition. And the third, a multivariable analysis of factors associated with increased odds of transfer to hospital following emergency ambulance call-out.

Results

Through the first systematic review, examining predictors of unplanned hospital transfers, both person, residential care home and health system factors were identified as being associated with rate of ED presentation. This included number and type of comorbidity, polypharmacy and poor RAC staffing profiles. In the second review, an examination of outcomes following hospital transfer, it was found people experiencing an unplanned hospital transfer may experience a number of unintended adverse outcomes such as invasive intervention, delirium, nosocomial infection and functional decline.

Results of the third study, a retrospective cohort study examining rates of emergency ambulance call-out from 2008 to 2013, included a high rate of ambulance call-out to people living in RAC. This rate was up to four times the rate for people living in the community. In the fourth study the case-mix, prehospital care and disposition of people attended by an emergency ambulance was examined. It was found older people living in RAC are frequently attended for low level falls, suspected infection and uncontrolled pain. In this study the incidence of prehospital intervention was low, however the rate of subsequent transfer to hospital was high with up to 90% of people attended by emergency ambulance, transferred to the ED.

The disposition of people attended by emergency ambulance was further examined in the fifth study, a multivariable analysis of factors associated with transfer to hospital following emergency ambulance call-out. Findings of this study indicated greater odds of transport to hospital for people living in rural areas, people with certain co-morbidities such as depression and cardiovascular disease, people prescribed psychoactive agents and people suspected of having a fracture or infection.

Conclusion

Through the research presented in this thesis, the nature of emergency, prehospital care for older people living in RAC homes has been comprehensively examined. Older people, living in RAC are frequent consumers of emergency medical care, yet under the current system of

care they risk experiencing considerable adverse consequences. Results of this program of research will be beneficial in informing improvements in training, protocol development and service delivery relating to the current system of prehospital and ED emergency care. Examination of the predictors of emergency hospital transfer has allowed for the identification of potential targets for primary care and preventative health programs. Findings from this program of research will inform design and implementation of future research into the acute care of older people living in RAC and design of appropriate patient-centred interventions.

Publications

Dwyer R, Gabbe B, Stoelwinder JU, Lowthian J. A systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities. *Age and Ageing*. 2014;43(6):759-66. doi: 10.1093/ageing/afu117

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Dwyer R, Gabbe B, Tran TD, Smith K, Lowthian JA. Patterns of emergency ambulance use, 2009-13: a comparison of older people living in Residential Aged Care Facilities and the Community. *Age and Ageing*. 2018;47:615-9. doi: 10.1093/ageing/afy056

Dwyer R, Gabbe BJ, Tran T, Smith, K, Lowthian JA. Residential Aged Care Homes – Why they call '000'. A study of the emergency prehospital care of older people living in residential aged care homes. *Emergency Medicine Australasia* (under review).

Dwyer R, Gabbe BJ, Tran T, Smith, K, Lowthian JA. Predictors of Transport to Hospital After Emergency Ambulance Call-Out for Older People Living in Residential Aged Care. *Australasian Journal on Ageing* (published online 18th June 2020). doi: 10.1111/ajag.12803

Conference Presentations

Dwyer R, Gabbe B, Stoelwinder J, Lowthian J. A review of outcomes following emergency transfer to hospital for residents of aged care facilities. *Australasian Association of Gerontology Conference*. November 2014. Poster presentation.

Dwyer R, Gabbe B, Stoelwinder J, Lowthian J. Emergency transfer to hospital for residents of aged care facilities. *Australasian College for Emergency Medicine Annual Scientific Meeting*. December 2014. Poster Presentation.

Dwyer R, Lowthian J. Emergency care of Older Patients. *Paramedicine Research Symposium, Monash University Department of Community Health and Paramedic Practice and Australian and New Zealand College of Paramedicine*. Invited Speaker. 6th July 2018

Dwyer R. Determinants and Outcomes of Pre-hospital and Emergency Care for Older People Living in Residential Aged Care Facilities. *Annual Conference, Australian and New Zealand College of Paramedicine*. Invited Speaker. 24th August 2018

Dwyer R. A Systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities. *International Conference on Emergency Medicine*. Speaker. 14th June 2019.

Dwyer R, McManamny T, Lowthian J. Prehospital care of older people: a clinical continuum. *International Conference on Emergency Medicine.* Speaker. 15th – 18th June 2020. (postponed by International Federation of Emergency Medicine in accordance with COVID-19 restrictions).

Declaration

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes *three* original papers published in peer reviewed journals, *one* paper accepted for publication and *one* submitted publication. The core theme of the thesis is the emergency and prehospital care of older people living in residential aged care homes. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the student, working within the Prehospital, Emergency and Trauma Research Group within the School of Public Health and Preventive Medicine under the supervision of Professor Belinda Gabbe and Adjunct Professor Judy Lowthian.

The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research

In the case of Chapters Two, Four, Five and Six my contribution to the work involved the following:

Thesis Chapter	**Publication Title**	**Status**	**Nature and percent of student contribution**	**Co-authors, nature and percent of contribution**	**Co-authors Monash student (Yes / No)**
Two	A systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities	Published	70% study design, search strategy, review of included papers, manuscript preparation and revision	Professor Gabbe - 12.5% study design, review of included papers, manuscript review Adjunct Professor Lowthian - 12.5% study design, review of included papers, manuscript review	No

				Professor Stoelwinder – 5% study design, manuscript review	
Two	Unplanned transfer to emergency departments for frail elderly residents of aged care facilities: A review of patient and organizational factors	Published	70% study design, search strategy, review of included papers, manuscript preparation and revision	Professor Gabbe - 12.5% study design, review of included papers, manuscript review Adjunct Professor Lowthian - 12.5% study design, review of included papers, manuscript review Professor Stoelwinder 5% - study design, manuscript review	No
Four	Patterns of emergency ambulance use, 2009-13: a comparison of older people living in residential aged care facilities and the community	Published	70% Study design, data cleaning, management and analysis, manuscript preparation and revision	Professor Gabbe - 10% study design, data analysis and cleaning, manuscript review Adjunct Professor Lowthian - 10% study design, data interpretation, manuscript review Dr Thach Tran -5% data analysis Associate Professor Karen Smith – 5% manuscript review	No
Five	Residential aged care homes – Why they call '000'. A study of the emergency prehospital care of older people living	Submitted	70% Study design, data cleaning, management and analysis, manuscript preparation and revision	Professor Gabbe - 10% study design, data analysis and cleaning, manuscript review Adjunct Professor Lowthian - 10%	No

	in residential aged care homes			study design, data interpretation, manuscript review Dr Thach Tran -5% data analysis Associate Professor Karen Smith – 5% manuscript review	
Six	Predictors of transport to hospital after emergency ambulance call-out for older people living in residential aged care	Accepted	65% Study design, data cleaning, management and analysis, manuscript preparation and revision	Professor Gabbe - 10% study design, data analysis and cleaning, manuscript review Adjunct Professor Lowthian - 10% study design, data interpretation, manuscript review Dr Thach Tran -10% data analysis Associate Professor Karen Smith – 5% manuscript review	No

I have renumbered sections of submitted or published papers in order to generate a consistent presentation within the thesis.

Student name: Dr Rosamond Dwyer

Student signature:  **Date:** 21st May 2020

I hereby certify that the above declaration correctly reflects the nature and extent of the student's and co-authors' contributions to this work. In instances where I am not the responsible author I have consulted with the responsible author to agree on the respective contributions of the authors.

Main Supervisor name: Professor Belinda Gabbe

Main Supervisor signature:  **Date:** 21st May 2020

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I have received generous financial support from the Monash University Faculty of Medicine, Nursing and Health Sciences through the award of a Faculty Postgraduate Research Scholarship. I interleaved my research with my advanced training in emergency medicine, requiring periods of intermission from candidature. Nevertheless, during these periods my employers Melbourne Health and more recently Peninsula Health offered flexible working arrangements so that I could maintain research activities. I would like to acknowledge Ambulance Victoria for providing the data for several research components and the staff at the Monash University and Alfred Health library services for their guidance with systematic searches of the literature. I am very grateful for the opportunity to complete this degree, I would like to thank Monash University for enabling my higher degree research training. This

has been a period of growth and development, education and insight and a time through which my professional knowledge and aspirations have matured. I look forward to becoming an academic clinician in emergency medicine and health service research.

I would like to thank my co-students and in particular Dr Susie Cartledge, Dr Kylie Dyson, Dr Kate Cantwell and Ms Tegwyn McManamny. Their collegial support, advice and motivation has been both welcome and uplifting. I would also like to acknowledge my clinical colleagues and senior supervisors in emergency medicine, in particular Dr Bridget Honan and Dr Nick Hooper who encouraged my completion of a PhD alongside advanced training, and whose supportive participation in our study group enabled me to concurrently complete my training and exams for Fellowship with the Australasian College for Emergency Medicine.

Personally, I would like to truly thank my parents Professor Jane Fisher and Dr Nicholas Dwyer. The love and safety they provided has enabled me to seek out these and many other opportunities. They have both demonstrated and instilled the values of resilience, compassion and learning which have inspired me to embrace and achieve these endeavours. Their wisdom and sustenance have carried me through challenging times.

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Chapter One: An Ageing Population, the Australian Aged Care and Emergency Care Systems

1.1 Background and Rationale

1.1.1 Ageing Population

Australia's population, as with many other high -income countries, is ageing [1, 2]. Globally, this change in the population is expected to be one of the most substantial influences on social and economic development over the coming century [1]. At the Second World Assembly on Ageing in 2002, the Madrid Plan of Action on Ageing was adopted and identified 'advancing health and well-being into old age' as a priority for political, policy and scientific action. Within this report was a recognised need for specialist services for older people stating, 'health services designed to meet the *special needs* of the older population *must* be available', and that 'there is a need to encourage and advance comprehensive, diversified and specialised research on ageing' [3].

Within Australia, the proportion of the population aged 65 years and over is projected to increase from 15% of the total population to 23% in the next 50 years [2]. People aged 85 years and over currently comprise 2.0% of the population and it is estimated this will double to 4.4% over the same period [2]. This oldest age group is expected to experience the highest growth rate of all ages over the next 50 years [2]. Largely due to differences in life expectancy, there is a greater proportion of women in the older age groups, currently representing approximately 62% of all people aged 85 years and over [2]. This sex-difference is predicted to decrease over coming years [2].

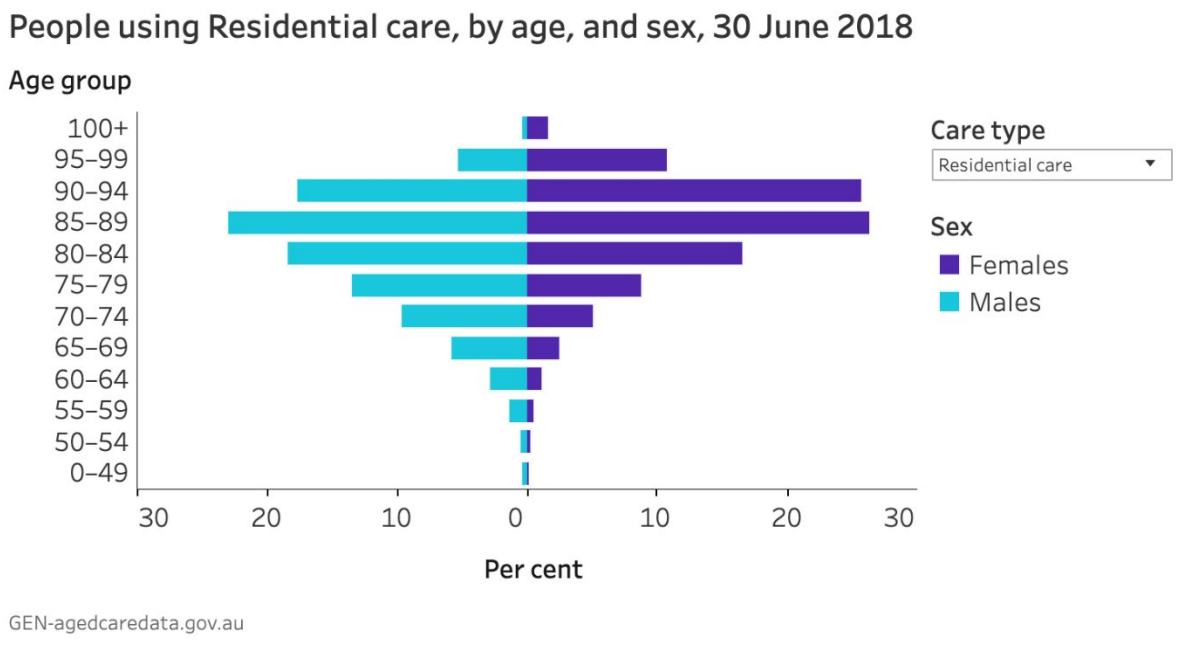
In Victoria, consistent with the national Australian estimates, people aged 65 years and over comprise 15% of the population, equating to over 960,000 people [4]. In general, older people represent a greater proportion of rural communities compared with metropolitan settings [4].

1.1.2 Residential Aged Care Homes

In Australia, residential aged care (RAC) is provided by a mixture of private, not-for-profit and government organisations. These services are partly financed by a mixture of federal and state government funding with some clients also contributing privately to the costs of care [5]. In 2019, there were an estimated 282,000 people living in RAC, equating to 58.4 per 1000 older people [5, 6]. The number of people living in RAC has increased by 15% over the last 10 years [6]. It is anticipated this population will continue to grow in line with the projected increases in the older population [7].

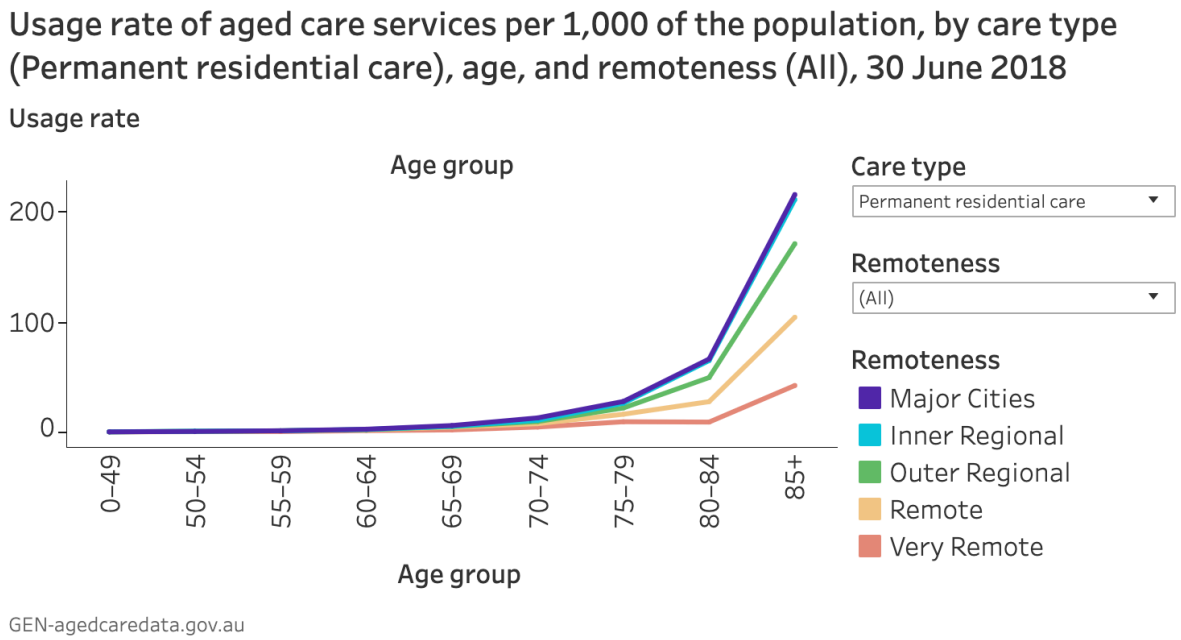
1.1.2.1 Population Characteristics

Most people living in RAC are aged 80 years and over (Figure 1) [6]. Approximately two thirds are female, with women older on average than men [6]. People living in RAC are more often situated in urban regions with fewer in rural areas (Figure 2), likely reflecting availability of services in these regions [6].



SOURCE: "People Using Aged Care". 2018. Australian Institute of Health and Welfare.[6]

Figure 1: Rate of residential aged care use by age



SOURCE: "People Using Aged Care". 2018. Australian Institute of Health and Welfare.[6]

Figure 2: Rate of residential aged care use by area of remoteness

Individual aged care funding is currently guided by the Aged Care Funding Instrument which assesses a person across three domains: activities of daily living (ADLs), behaviour and cognition, and complex healthcare needs [8]. Using the Aged Care Funding Instrument, it has been estimated that over 80% of people in RAC have high care needs and 30% of have high level needs for all three of the tool's domains, indicating a substantial level of disability [9, 10].

People living in RAC are frequently medically complex with high rates of co-morbidity. Over half of people living in RAC have a recorded diagnosis of dementia [9, 10]. However, this may be an under-estimate of the true prevalence of significant cognitive impairment in the RAC population [11, 12]. Psychological distress is also common in RAC dwelling individuals, with up to 86% of people found to have a psychological or behavioural complaint and 52% of people identified as having symptoms of depression [9, 10, 13]. Other common co-morbidities include hypertension (45%), osteoarthritis (14.9%- 37%), osteoporosis (20%), cardiac disease (7.5% - 13%), cerebrovascular disease (8.0%-37%), diabetes (6.9%) and chronic renal impairment (15%) [9, 12]. In addition to these medical diagnoses, the RAC population may also frequently

display more diffuse, multi-system conditions such as frailty, malnutrition, poor mobility and falls which are each associated with additional substantial morbidity and mortality [9, 12].

Polypharmacy is prevalent among older people living in RAC, with an average of eight different prescribed medications per person [12, 14]. There is high frequency, yet under-reported and under-recognised instances of potentially inappropriate prescribing [14]. Use of psychotropics and sedatives is common [14] with antidepressants prescribed in 32% and antipsychotics in 12% - 20% of people [11, 12, 14]. Medication related errors are also frequent and include prescribing error, dose or strength error, omission, failure to monitor adequately and dispensing errors[15]. These errors are reported to be associated with poor communication between General Practitioners (GPs), RAC staff and pharmacists, inadequate staff knowledge of indications and correct administration of certain medications, and lack of adequate medication management protocols [15].

1.1.2.2 Residential Aged Care Home Characteristics

In Australia, RAC homes are frequently large, with an average of 60 beds per home [16]. Eighty percent of homes are part of multi-facility organisations [16, 17]. Overall, approximately 55% of RAC is provided by not-for-profit organisations, 40% by private or “for profit” enterprises and the remainder, by the government [16]. Ownership may fluctuate according to geographic location, with for-profit enterprises more common in metropolitan regions, and the proportion of not-for-profit and government facilities increasing in rural and remote areas [16]. Facility ownership type has been associated with staffing composition, which may have important implications for clinical care outcomes. For example, not-for-profit status has been associated with higher staffing numbers and improved staffing quality [18].

1.1.2.3 Residential Aged Care Staffing and Clinical Support

Within RAC homes, most paid staff (70%) are personal care attendants (PCAs) and there is a growing reliance on these professions for the majority of the work [17]. Registered nurses (RNs) comprise 15% of the workforce, enrolled nurses (ENs) 10%, and followed by nurse practitioners (0.2%) and allied health professionals (1.4%) [17]. Of the RNs working in RAC, less

than 30% have additional specialist qualifications in aged care, gerontology or palliative care [17]. Models of staffing care vary widely between settings [19]. Quality of care and resident-centred outcomes including functional ability, prevalence of pressure ulcers and nutritional status may be associated with both overall staffing numbers, as well as staffing ratios and staff composition, or balance between RNs, ENs and PCAs [19].

Primary health care to people living in RAC is predominantly provided by GPs [20-23]. A range of different models of care exist including an individual maintaining contact with their long-term GP (from prior to entry into RAC), provision of care by a RAC GP, or provision of care by a group of GPs affiliated with a particular care home [22]. It has been estimated that, there is a mean of 3.8 to 4.2 different GPs per home providing care [12, 15]. In 2017 the Australian Medical Association found just over 60% of all GPs regularly visit RAC to provide medical care [23]. However, of these practitioners, 35% intended to either reduce their visits or stop attending RAC entirely within the next two years [23]. Both within Australia and internationally, a number of barriers to delivery of high-quality primary care within RAC have been identified. These include insufficient physical resources within RAC, inadequate billing procedures and insufficient time within current practice schedules, and remuneration schemes [20, 22, 24].

Given the complex health needs of many people living in RAC, it has been recommended that GPs practicing in RAC undertake additional training in geriatric medicine [20], however this is not common. In the UK it has been estimated that less than 40% of GPs have specialist training in the care of older people [21]. In Australia, it is not known how many GPs who regularly provide care to people in RAC have undertaken advanced gerontology or palliative care training.

Specialist geriatricians also have a role in providing medical care to older people living in RAC. A search of the peer reviewed and grey literature was unable to find a current estimate of the quantity or frequency of geriatrician visits to RAC in Australia. Currently geriatricians may be more likely to be involved with admissions to RAC from hospital than from home, and with providing geriatric medical assessments in the community and inpatient hospital settings [21]. In community-dwelling older people, specialist geriatrician assessment and care teams may

be associated with lower risk of hospital re-admission, reduced functional and cognitive deterioration and fewer acute visits to hospital [25, 26].

Ongoing geriatrician-led care to people living in RAC is believed to be beneficial, but evidence is limited [27] and geriatrician care may be currently limited by workforce and resourcing concerns [21]. In one study from the UK, only 15% of geriatric medicine departments allocated time for RAC patients, and only 30% participated in initiatives to support ongoing care to RAC [21]. Within this cohort a high proportion of clinician geriatricians believed that more input would be valuable to residents, but this ability is limited by resources [21].

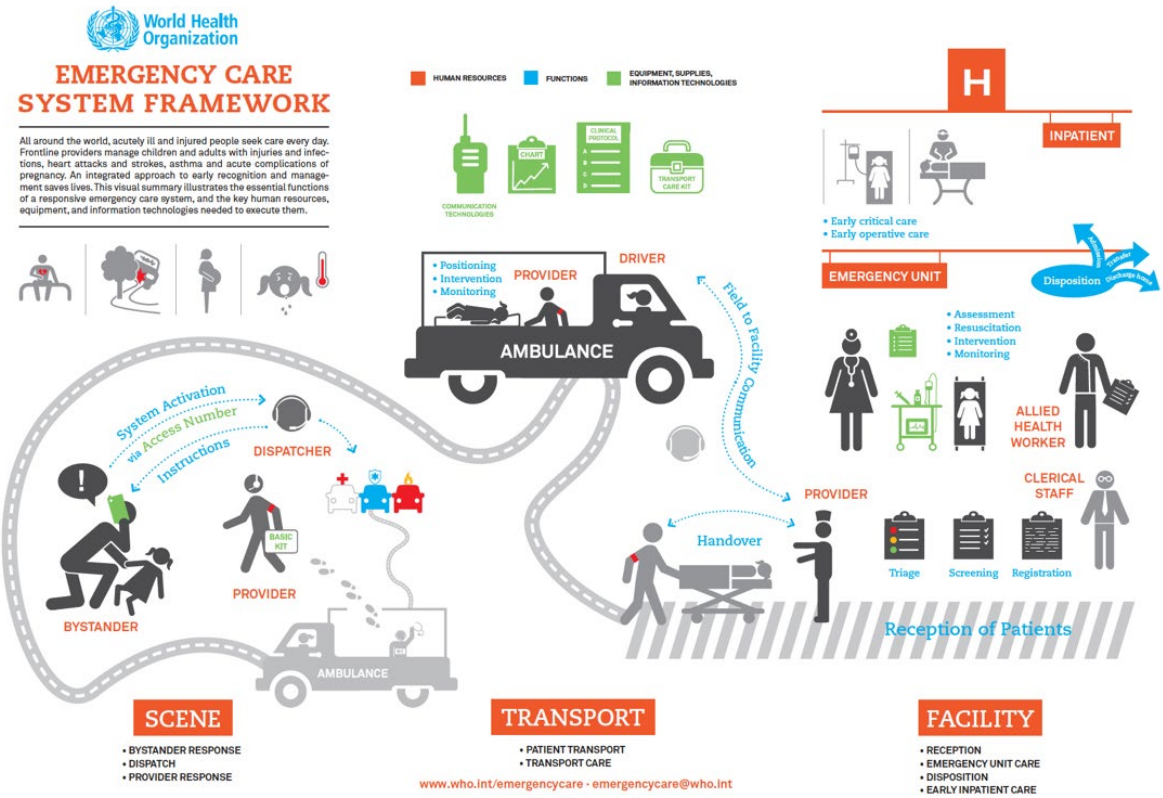
To date, there has been limited evidence about the efficacy of preventive care and outreach health programs that aim to reduce acute events and avoidable ED presentation and hospital admission from RAC [27]. Many hospitals have developed programs to deliver acute care outside of a hospital environment such as 'Hospital in the Home' or 'Hospital in the Nursing-Home', 'Residential In-Reach' and HARP [28]. However, these programs have been under-evaluated in the peer-reviewed literature for people living in RAC. There is no clear evidence that these programs lead to a sustained reduction in unplanned emergency presentations to hospital from RAC [27, 29]. These programs are also frequently limited by staffing and geographical considerations, and may only be accessible during certain hours or days of the week [28].

1.1.3 Emergency Medical Care System

Emergency medicine has been defined as *'a field of practice based on the knowledge and skills required for the prevention, diagnosis and management of acute and urgent aspects of illness and injury affecting patients of all age groups with a full spectrum of undifferentiated physical and behavioural disorders. It further encompasses an understanding of the development of pre-hospital and in-hospital emergency medical systems and the skills necessary for this development'*[30].

There has been a continual evolution of the emergency medical system and the specialty of emergency medicine over the last 60 years [31]. The specifics of emergency medical care may

vary according to setting, yet, broadly, across most high-income countries, emergency care systems include prehospital/community, transport and intra-hospital clinical teams (Figure 3).



SOURCE: "Emergency Care". 2018. World Health Organisation[32]

Figure 3: World Health Organisation Emergency Care System Framework

Prehospital emergency care has evolved from being purely a transport service, to trained health professionals providing a range of health assessments and interventions in the out-of-hospital setting [31, 33-36]. Prehospital care is an emerging area of healthcare that is beginning to benefit from robust research and evidence development [37, 38].

Globally, demand for emergency medical care and use of emergency ambulances continues to grow [39-41]. Key contributors to this escalating demand include demographic change, improved awareness of service availability, reduced threshold to call an ambulance and importantly, an ageing population [39-44]. Ambulance transport rates for people aged 85 years

and over are up to eight times higher than for younger people and account for over 13% of total ambulance transportations, despite representing 1.6% of the population[40, 45]. This may reflect increased prevalence of co-morbidity, poorer physical and cognitive function, diminishing social support and reduced access to primary health care for this population [44-47].

A subgroup of this population is older people living in RAC. People living in RAC frequently use acute and emergency medical services with high rates of emergency department (ED) presentation and inpatient hospital admission, greater than the rate for older people living in the community [48-50]. The majority of these ED presentations include transport to hospital via an emergency ambulance [51, 52].

1.2 Summary and Rationale

People living in RAC are a unique and growing subgroup of the older Australian population [53]. Due to frequent co-morbidity, cognitive impairment, frailty and disability, people living in RAC are physically, psychologically and socially vulnerable [54, 55].

An acute transfer to hospital, takes a person away from their usual home setting into a challenging and unfamiliar emergency care environment. Transfer in an ambulance, and then care in the hospital ED, is frequently characterised by noise, bright lights, uncomfortable stretchers and trolley beds and absence of orientating features [54-57]. Staff are often focused on diagnostic and medical intervention tasks, and may be limited by time and resource constraints to provide holistic care [54, 55, 57, 58]. Older people living in RAC, frequently experience these acute, unplanned transfers; and yet there is only limited evidence surrounding the appropriateness, determinants and outcomes of these episodes of acute care.

1.3 Thesis Aim and Objectives

The overall aim of this doctoral research program was to examine the nature of emergency, prehospital care for older people living in RAC homes. Specific objectives, focused on older people living in RAC, were to:

1. Explore the outcomes of an emergency transport to hospital
2. Examine the predictors of emergency transport to hospital
3. Describe local Australian rates of emergency ambulance use
4. Describe the case-mix and acuity of older people living in RAC attended by an emergency ambulance
5. Investigate the outcomes of emergency ambulance attendance including medical intervention and decision to transport to hospital

1.4 Thesis Overview

Seven chapters comprise this thesis (Figure 4). For this program of research, methods encompass two systematic reviews with thematic analysis; and quantitative analysis of clinical data from Ambulance Victoria, the Australian Bureau of Statistics and the Australian Institute of Health and Welfare. In Chapter One, an overview of the structure of RAC and the current system of emergency and prehospital medical care is provided. This chapter describes the background to and rationale for this research, including the frequent interaction between people living in RAC and the emergency medical services.

Within Chapter Two, the results of two systematic reviews are described. The first review explores individual patient and system level health resource outcomes associated with unplanned emergency hospital transfers. The second review examines the patient, facility and health systems factors that impact on the rate of unplanned, emergency transfers to hospital for older people living in RAC. In Chapter Three, a description of the data sources and data management is provided; including an outline of how the data were prepared for each study, as well as the quality and limitations of the data.

In Chapters Four to Six, the results of three studies are presented, providing an analysis of the prehospital emergency care of older people living in RAC in Victoria, Australia. In Chapter Four the differences in rates of ambulance call-outs between older people living in the community and people living in RAC are examined; including detail of fluctuations in these rates associated with age, gender and season. Chapter Five comprises exploration of the clinical acuity and case mix of older people living in RAC, attended by an emergency ambulance, and description of the incidence and nature of prehospital medical intervention. In Chapter Six, the findings of an investigation of the prehospital decision point of transferring a patient to hospital. Further, individual person and system factors that are associated with an outcome of acute hospital transfer are presented.

In the final chapter, Chapter Seven, an analytical overview of this research program is provided. This includes consideration of implications of the findings, as well as recommendations for future directions for research and health system developments.

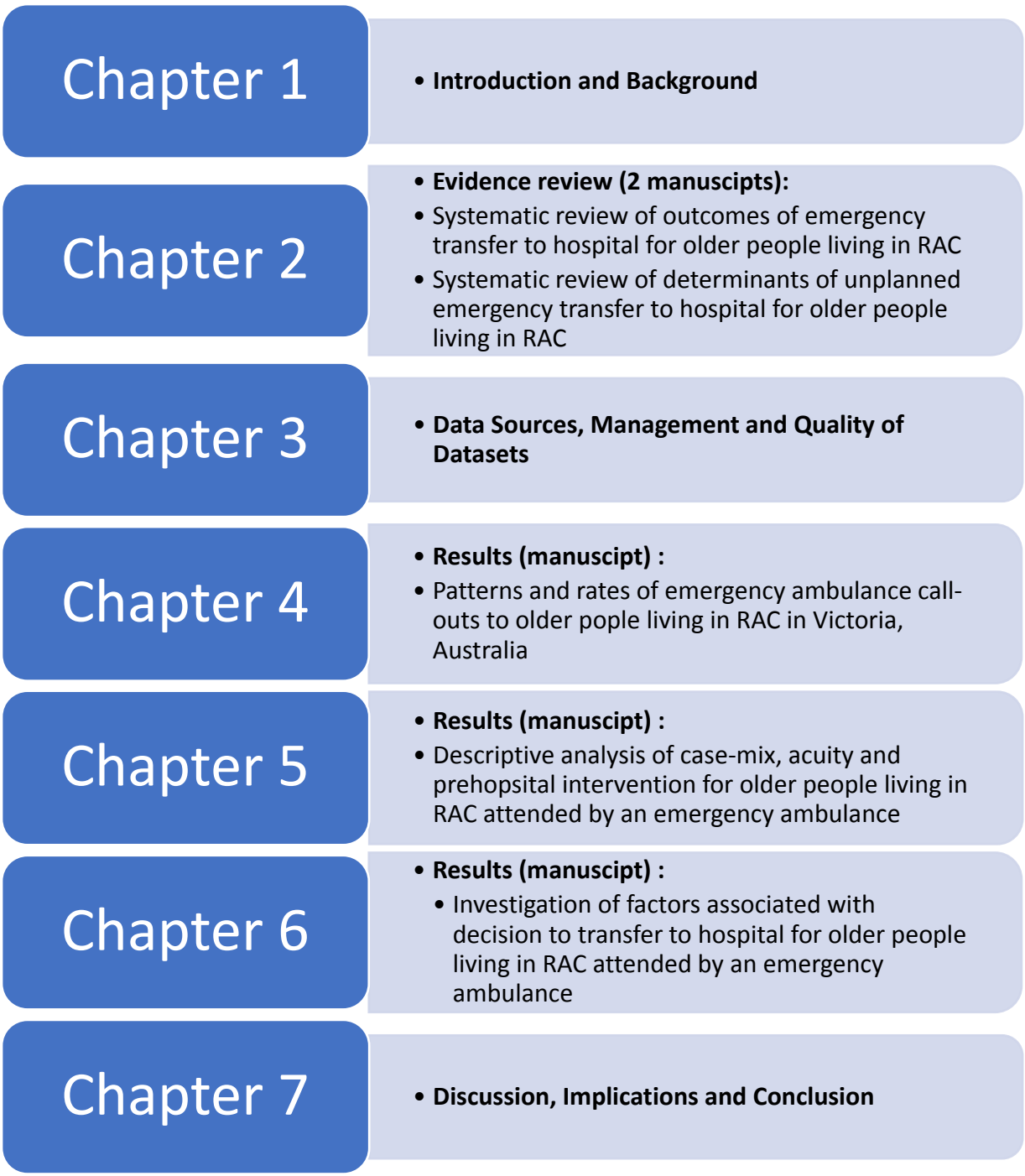


Figure 4: Thesis structure

Chapter Two: Evidence Review

2.1 Introduction

As described in Chapter One, there is persistent growth in the older population, which is reflected across most high-income countries [1]. A growing proportion of these older people experience physical, cognitive or psychological disabilities requiring enhanced personal care, leading them to move into a residential aged care (RAC) Home [6] [7]. There is considerable variation in the models of care and medical support across different RAC homes, different organisations, health systems and geographical locations [18] [59, 60]. However, an overarching concern is the deficit of specialist medical and allied health support to residents [61, 62]. In relation to this, older people living in RAC frequently interact with the emergency medical system [48, 49] [50, 51]. However, despite frequent care episodes, both the outcomes of an emergency care episode and the patient and organisational predictors of an acute health episode requiring emergency care have not been systematically described.

The first two objectives of this thesis were to address these evidence gaps. This was achieved in the form of two reviews, the first describing patient and health system outcomes of emergency care for people living in RAC - *A systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities.* The second review examined patient and facility factors associated with experiencing an acute care event - *Unplanned Transfer to Emergency Departments for Frail Elderly Residents of Aged Care Facilities: A Review of Patient and Organisational Factors*.

2.2 Methods

The two systematic reviews were conducted in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [63].

A comprehensive search of the peer reviewed literature was undertaken using electronic data bases Medline, Embase, CINAHL and Informit as well as interrogation of reference lists of

selected articles. The search was restricted to English language but not by date of publication. Details of the search strategy are provided in Appendix 1. Both reviews were conducted using the same search strategy but with different inclusion and exclusion criteria. The inclusion and exclusion criteria, the methods of assessment of validity and synthesis of findings are described in the published manuscripts.

2.3 Outcomes of Emergency Transfer to Hospital

2.3.1 Manuscript One

This study is presented in the form of a manuscript, *A systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities*. Dwyer R, Gabbe B, Stoelwinder J, Lowthian J. Age and Ageing. 2014 43: 759-766[64]

Full Table of included references for 'A systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities' is presented in Appendix 2.

Supplementary list of references is provided in Appendix 3.

Age and Ageing 2014; **43:** 759–766
doi: 10.1093/ageing/afu117
Published electronically 15 October 2014

A systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities

Rosamond Dwyer[1], Belinda Gabbe[1], Johannes U. Stoelwinder[1,2], Judy Lowthian[1]

[1]Monash University, Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, The Alfred Centre, Alfred Hospital 99 Commercial Road Melbourne, VIC, Melbourne, Victoria 3004, Australia
[2]Epidemiology and Preventive Medicine, Monash University, Melbourne, Victoria, Australia

Address correspondence to: R. Dwyer. Tel: (+61) 399030555; Fax: (+61) 399030556. Email: rosamond.dwyer@monash.edu

Abstract

Background: residential aged care facility (RACF) resident numbers are increasing. Residents are frequently frail with substantial co-morbidity, functional and cognitive impairment with high susceptibility to acute illness. Despite living in facilities staffed by health professionals, a considerable proportion of residents are transferred to hospital for management of acute deteriorations in health. This model of emergency care may have unintended consequences for patients and the healthcare system. This review describes available evidence about the consequences of transfers from RACF to hospital.
Methods: a comprehensive search of the peer-reviewed literature using four electronic databases. Inclusion criteria were participants lived in nursing homes, care homes or long-term care, aged at least 65 years, and studies reported outcomes of acute ED transfer or hospital admission. Findings were synthesized and key factors identified.
Results: residents of RACF frequently presented severely unwell with multi-system disease. In-hospital complications included pressure ulcers and delirium, in 19 and 38% of residents, respectively; and up to 80% experienced potentially invasive interventions. Despite specialist emergency care, mortality was high with up to 34% dying in hospital. Furthermore, there was extensive use of healthcare resources with large proportions of residents undergoing emergency ambulance transport (up to 95%), and inpatient admission (up to 81%).
Conclusions: acute emergency department (ED) transfer is a considerable burden for residents of RACF. From available evidence, it is not clear if benefits of in-hospital emergency care outweigh potential adverse complications of transfer. Future research is needed to better understand patient-centred outcomes of transfer and to explore alternative models of emergency healthcare.

Keywords: *emergency, nursing homes, older people*

Introduction

As people age they become more likely to require assistance with activities of daily living. Some require care in nursing homes or residential aged care facilities (RACF). The proportion of people living in RACF increases significantly with age from 2% of people aged 65–75 years to 26% of people 85 years and over [1].

People living in RACF frequently have advanced cognitive and functional impairment and medical co-morbidities. Many are transferred to hospital emergency departments (ED) for management of acute changes in health, with up to 75% experiencing an emergency transfer each year [2–**14**]. Residents of RACF have a higher rate of ED presentation and hospital admission than their community-dwelling peers [**3**, **10**, 15–17].

Despite the substantial burden of acute hospital transfer, the implications are not well quantified. This systematic review summarises current evidence relating to patterns of presentation, clinical consequences and health system utilisation surrounding emergency hospital transfer of RACF residents.

Methods

Search strategy

A comprehensive search of the peer-reviewed literature was conducted using the electronic databases Medline, Embase, CINAHL and Informit in December 2013. Box 1 shows the Medline(OVID) search strategy. Strategies for other databases were adjusted for database-specific indexed terms. Reference lists of selected articles were hand-searched for additional papers. The search was not restricted by year of publication.

Box 1. Search strategy for Medline (OVID)

1. exp Nursing homes/OR nursing hom*.mp. OR exp Residential Facilities/OR residential facilit*.mp. OR exp Long-Term Care/OR long term care .mp. OR exp Skilled Nursing Facilities/OR skilled nursing facilit*.mp.
2. exp Geriatrics/OR geriatri*.mp. OR exp Aged/OR aged .mp. OR elderly .mp. OR exp Frail Elderly OR frail elderly .mp. OR exp 'Aged, 80 and over'/OR 'Aged, 80 and over' .mp. OR gerontolo .mp.
3. 1 AND 2
4. exp Housing for the Elderly/OR housing for the elderly .mp. OR exp Homes for the Aged/OR homes for the ages .mp. OR residential aged care .mp. OR exp Geriatric Nursing/OR geriatric nurs*.mp.
5. 3 OR 4
6. exp Emergency Medical Services/OR emergency medical servic* .mp. OR exp Emergencies/OR emergenc*.mp. OR exp Emergency Treatment/OR emergency treatmen*.mp. OR exp Emergency Service, Hospital/OR emergency servic* .mp. OR exp Trauma Centers/OR trauma servic* .mp. OR trauma cent* .mp. OR exp Emergency Nursing/OR emergency nurs*.mp. OR exp Emergency Medicine/OR emergency medicine.mp. OR 'accident and emergency'.mp. OR emergency department.mp. OR exp Ambulances/OR ambulanc*.mp. OR paramedi*.mp. OR prehospital.mp. OR prehospital care.mp. OR prehospital.mp.
7. 5 AND 6

Inclusion criteria

Broad inclusion criteria were used to ensure a comprehensive overview. These included participants living in RACF, aged at least 65 years, outcomes reported of acute transfer to ED or hospital admission, and published in English. A RACF was defined as nursing home, care-home, or long-term care, skilled nursing or residential care facility. Studies referring to acute or chronic illness, palliative care or end-of life care, without reference to ED or hospital transitions were excluded.

Synthesis

Slavin's [18] method was followed to produce a best-evidence synthesis of the peer-reviewed literature. This includes selection of studies based on appropriate and consistent inclusion criteria, examination and evaluation of study characteristics and synthesis of the included literature with systematic description and analysis of key concepts [18, 19].

Findings

Overview of included studies

Eighty-three papers, from 15 high-income nations met the inclusion criteria (Figure 1). No studies from low- or middle-income countries were found. Most studies were conducted in the USA (30/83, 36%), Australia (17/83, 20%), the UK (11/83, 13%) and Canada (8/83, 10%). Study settings varied by healthcare systems, funding models and access to care.

Most studies analysed hospital-based data; 42% (35/83) from a single hospital, and 27% (22/83) multiple hospitals within a specified jurisdiction. Others analysed RACF data (20%,17/83) or national data sets (11%,9/83). Most (63%,52/83) involved a 12-month study period.

Methodologies were diverse. Medical record review, combined with hospital administrative data was the most common (63%,52/83), while 24% (20/83) used patient interviews and 13% (11/83) included data from national health agencies such as Medicare and Medicaid. Sample size varied from <100 admissions to >500,000 episodes.

Patterns of presentation

Common reasons for transfer of RACF residents to ED are summarised in Table 1. They had high rates of falls and fall-related injuries [20–22] and more frequently presented with fractures (particularly hip fractures) than community-dwelling peers aged >65 years [**16**, 23–**27**]. Watson *et al.* found RACF residents accounted for 30% of medically

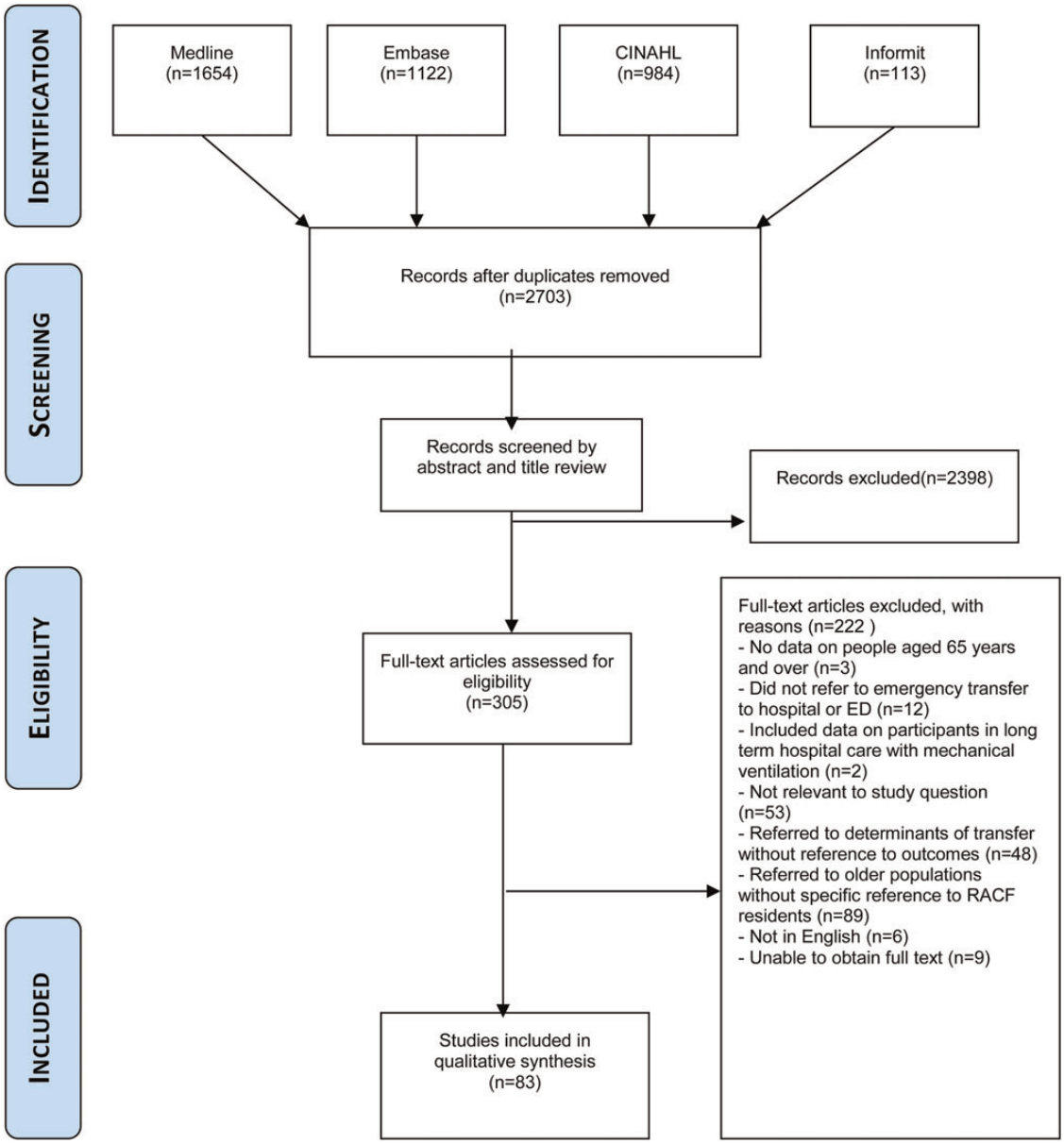


Figure 1. Search results (PRISMA) [89].

Table 1. Reasons for transfer of RACF residents to ED

	Proportion of total presentations
Respiratory tract disease	12–37% [5, 6, 8, 10, 16, 26, 29, 32, 37, 45, 47, 50, 71]
Fall-related presentations	12–23% [8, 10, 14, 35, 46, 47, 50]
Fractures and orthopaedic injuries	6.7–24% [8, 16, 26, 29, 35, 37, 82]
Cardiovascular illness	11–28% [5, 6, 10, 16, 26, 29, 32, 35, 37, 47, 71]
Infection	5.3–24% [6, 14, 29, 82]
Altered mental state	7.2–12% [5, 35, 46, 50]
Device (usually PEG tube or IDC)-related complication	2.3–10% [37, 46, 47, 50]

treated falls despite comprising only 5.6% of the study population [28]. Overall, RACF residents accounted for up to 26% of all hospital admissions with femoral fractures [27].

Residents of RACF were more commonly diagnosed with infection, particularly of the respiratory and urinary systems, and presented more frequently with severe sepsis than community peers [3, 16, 27, 29, 30]. However, they had lower admission rates for cardiac and gastrointestinal conditions, and neoplasms [16, 26, 31, 32]. Reflecting substantial comorbidity, cognitive and functional decline, RACF residents were commonly transferred to ED with aspiration pneumonia or drug-related complications [33, 34].

Compared with the general ED population, RACF residents were more commonly acutely unwell on arrival according to ED triage categories. Street *et al.* found 59% of RACF residents were triaged in emergent and urgent categories compared with 45% of all ED presentations [35]. More broadly, 14–36% were assigned to category 1–2 (resuscitation, emergent), 49–80% to category 3 (urgent) and 15–35% to category 4–5 (semi-urgent, non-urgent) [5, 6, 8, 16, 26, 36, 37]. Variability in these proportions reported may reflect difficulties in rapidly assessing these patients. Residents of RACF more frequently presented with hypotension, tachycardia, impaired consciousness, delirium, dehydration, respiratory failure and septic shock, compared with community-dwelling older people [20, 29, 32, 33, 38–40]. This may reflect the relatively advanced age of RACF residents, as proportions are comparable with those for all ED patients aged over 65 years [26, 37], or may indicate their susceptibility to severe, acute illness.

Further, RACF residents typically presented with multisystem disease, with an average of 3.4–4.5 diagnoses [10, 35, 41], and 69% having four to seven secondary diagnoses applied in hospital [10]. Polypharmacy (93%), nutritional deficiency, pressure ulcers, cognitive and functional impairment (up to 81%), incontinence (up to 76%), immobility (up to 89%) and vision/hearing loss (up to 57%) were prevalent [39, 42–45]. Although comparator rates for community-dwelling populations were largely absent, Han *et al.* described cognitive impairment in 38% and vision/hearing impairment in 22% of older people living in the community who were seen in ED [39].

Clinical consequences

Intervention and investigation

In ED, RACF residents experienced high rates of investigation and intervention [8, 37, 41]. These included potentially invasive procedures, with 43–80% having blood tests [6, 45, 47, 49, 50], 25% having arterial blood gas sampling [50], 40–66% undergoing insertion of an intravenous cannula [6, 41, 45, 47, 50] and 12–23% placement of an indwelling urinary catheter [6, 45, 50]. Smaller numbers underwent more invasive procedures such as ventilatory support and cardiopulmonary resuscitation with questionable benefit given the extremely poor survival to discharge rates in this population [45, 50, 51]. Up to 85% of residents experienced radiological examinations [6, 29, 45, 47, 49, 50]. Although largely non-invasive, radiological investigations commonly involve intra-hospital transfers, movement between beds and pharmacological or physical restraints to restrict movement. Up to 70% received medication or blood products in the ED with associated potential for drug interactions or adverse drug reactions [6, 29, 45, 50]. Patients from RACF had higher rates of intervention and investigation than community-dwelling older people [29, 41]. Wang *et al.*, reported 72% of RACF residents underwent imaging, 92% diagnostic testing and 72% experienced a procedure in ED compared with 44, 72 and 49%, respectively, of patients presenting from the community [29].

In-hospital complications

A greater proportion of RACF residents had pressure ulcers upon admission and developed new pressure ulcers in hospital (19%) compared with community-dwelling older people (4.3%) [52]. Compared with residents with no transfers, residents transferred to hospital had higher rates of new pressure ulcers and longer healing times [53, 54].

Thirty-eight percent of RACF residents seen in ED had developed delirium [39]. Delirium was associated with dementia, greater functional impairment, hearing loss and the presence of systemic inflammatory response syndrome [39, 55]. Of RACF residents seen in the ED, 6-month mortality was higher for those with delirium than those without (46 versus 27%) [55]. Despite the prevalence and adverse outcome associated with delirium, proportion of patients assessed or managed for this condition in ED is unclear.

An ED visit was associated with a three-fold increased risk of new, likely hospital acquired, gastrointestinal or respiratory tract infection for RACF residents [56]. Further, people living in RACF had increased rates of antibiotic resistant bacteria, which can result from frequent, or inappropriate antibiotic prescription, shared amenities and reduced awareness of optimal infection control practices within RACFs [57–62]. Moreover, among RACF residents, recent or recurrent hospitalisation or ED transfer was associated with increased acquisition of resistant organisms [57, 59, 60, 63, 64]. RACF residents appear particularly susceptible to iatrogenic illness and hospital-acquired infection, potentially adversely influencing the complexity, cost and success of treatment.

Acute hospital admission was associated with further functional decline in this population [65]. Post-hospitalisation functional decline, measured using the minimum data set activity of daily living score (MDS-ADL), was greater for people with significant pre-existing cognitive impairment. Average increases in scores among those admitted with fractured hip (7.65), stroke (6.53) and septicaemia (2.97) indicated deteriorations in functional ability [65]. Studies have suggested that functional outcomes following infection and pneumonia are better for residents treated in their facility compared with those who were hospitalised [53, 66, 67]. However, it was uncertain whether these effects resulted from acute transfer or greater severity of initial illness.

Mortality

Mortality from acute illness and transfer to hospital was high; 1–5% of RACF residents transferred to hospital died in the ED [8, 35, 37, 45, 50, 68, 69]. Once admitted a further 5–34% of residents died in hospital [2, 10, 26, 32, 35, 37, 41, 45, 68–71]. Most deaths occurred within 1 week of admission, and up to half within the first 3 days [14, 29, 41, 70, 71]. Mortality rates were higher compared with older people admitted from the community, and RACF residents had a shorter time to death as an inpatient [3, 16, 31, 32, 70, 72, 73]. Among all patients admitted with pneumonia or sepsis,

transfer from RACF was independently associated with mortality [30, 72, 74].

Up to 52% of RACF residents died within 3 months of acute hospital transfer [14, 70, 75] and 12–29% died within 1 month of leaving hospital [8, 10, 33, 76]. Higher 30-day mortality rates were reported for people admitted with respiratory (43%) and circulatory disease (34%) [10]. Risk of transfer to ED and admission to hospital increased considerably over the last few months of life [77, 78].

Higher C-reactive protein, lower estimated glomerular filtration rate, higher Modified Early Warning Score and polypharmacy on admission were associated with higher odds of death within 1 week of admission [71]. Multiple comorbidities and advanced age were also associated with an increased risk of in-hospital mortality [37, 70].

Health system utilisation

Appropriateness of ED presentation

There have been attempts to quantify avoidable or inappropriate transfers from RACF to ED. Methods of classifying presentations varied between studies, often relying on subjective, retrospective assessment by healthcare professionals, resulting in estimates of inappropriate transfers ranging from 5–60% [7, 8, 14, 46–48, 68, 79]. Improved advance care planning and use of existing resources, for patients transferred with non-urgent symptoms, or without prior assessment by their GP could reduce avoidable transfers [7, 14, 47, 50, 68, 75, 79]. However, other 'inappropriate' transfers although not needing emergency care would require additional services, which may not yet be available in care facilities, for example, care of indwelling devices, radiology services or provision of parenteral medications [7, 47, 50, 79].

Ambulance use

A greater proportion of RACF patients than community-dwelling elderly people used ambulance transport [29, 41] with almost all (80–95%) transferred to ED by emergency ambulance [7, 8, 29, 37, 41, 43, 48, 69].

Hours of arrival

Approximately half of RACF transfers arrived in the ED during normal business hours, with the remaining arriving in late evening or overnight [6, 8, 16, 20, 26, 29, 37, 43, 48, 50, 69, 80]. These proportions are comparable with those for community-dwelling older people [26, 29]. This suggests some RACF residents could potentially have accessed other 'in-hours' services such as general practitioners, pathology and radiology services. Although most EDs operate 24 h-a-day, outside of standard business hours there may be fewer senior staff, and reduced access to radiology and specialist consultation [81].

Emergency department length of stay

Residents of RACF transferred to ED had an average length of stay (LOS) of 3.1–7.9 h [7, 26, 29, 35, 37, 50]. Emergency department LOS was longer for patients more unwell at presentation, and those admitted to inpatient units compared with those discharged [35, 37, 47]. In comparison with community-dwelling older people, RACF residents experienced longer average ED LOS and more frequently remained in the ED for over 4-h, with up to 37% of residents still in the ED 8-h after presentation [26, 29, 35, 37, 41]. A longer ED LOS was associated with out-of-hours presentations [26, 37], possibly due to medical complexity of RACF residents and lack of access to specialist services.

Admission and inpatient LOS

People transferred from RACF had a high rate of hospital admission with 41–81% of residents seen in ED admitted to inpatient beds [5–8, 16, 26, 35, 37, 41, 45–47, 50, 68, 69] and short stay units [37, 45]. RACF residents had a greater rate of inpatient admission than community-dwelling older people [16, 26, 29, 41, 47], and longer average inpatient LOS [26, 31]. The average inpatient LOS for patients transferred from RACF ranged from 3 to 19 days [2, 5–7, 10, 26, 32, 35, 37, 45–47, 75, 76, 82].

Re-presentation to ED

Up to 37% of residents represented within 2 weeks of the initial ED visit and up to 66% re-presented within 12 months [8, 26, 35, 45, 46, 71, 75, 80]. Re-presentation rates were higher for older people from RACF compared with those living in the community [26, 83]. Associated characteristics included greater number of medical diagnoses, greater functional or cognitive impairment and depressed mood [84].

Economic estimates

Costs of care were higher for residents admitted to hospital compared with those discharged from ED [50]. In North America, costs per resident for each ED presentation have been estimated at USD 748 (GBP452); with an additional USD 486 (GBP94) for each ambulance transfer and total costs per hospitalisation up to USD 6,796 (GBP4109) per person [50, 79]. Estimated cost of managing residents with pneumonia was higher for those hospitalised compared with those managed within the RACF [85, 86]. Bookvar *et al.* reported average costs of USD 5,202 (GBP3145) per hospitalised resident with pneumonia compared with USD 996 (GBP602) for those treated in the RACF [86]. It has been suggested that average hospital costs were higher for people admitted from RACF compared with those admitted from the community [5, 31]. Other studies estimated average inpatient costs per RACF resident of AUD 5,715 (GBP3165) in Australia and EUR 5177 in Norway [14, 35].

Discussion

This review provides a comprehensive overview of international evidence surrounding clinical and health system-related outcomes of emergency transfer to hospital of people living in RACF. The findings show RACF residents experience high rates of transfer to the ED, comprise a distinct group of ED patients, and when compared with community-dwelling older people, present with higher acuity of disease and a different case-mix. Outcomes of emergency hospital transfers include a number of adverse clinical consequences and mortality remains high despite often intensive use of acute healthcare resources.

A previous systematic review by Arendts *et al.*, described transfer rates of up to 1.5 ED visits per RACF resident bed/per year associated with a diverse range of clinical presentations [88]. Lower rates of presentation with cardiac disease and neoplasm, and higher rates of infection and fall-related injury is a consistent finding. This may reflect greater susceptibility of RACF residents to these conditions or may indicate a more restricted referral pattern from RACF staff. Infection and injury may potentially be more treatable or reversible than other conditions, or may lead to more rapid clinical deterioration, lowering the threshold for acute transfer. It was not clear from the reviewed studies whether referral for particular presentations was guided by policy or individual clinical judgment and it is likely this varies between facilities.

Frequent, pre-existing disease, polypharmacy, cognitive and functional impairment may complicate acute illness and higher rates of delirium and confusion on presentation can contribute to difficulty in patient assessment and treatment. Thus management of acutely unwell RACF residents may be highly complex and time critical. There may also be differences in the goals of care, in balancing palliative and curative therapy for this compared with other ED patient groups.

A number of adverse clinical consequences of acute transfer of RACF residents were identified. In-hospital complications for this patient group were high compared with people admitted from the community [33]. Adverse events reported with inpatient treatment of RACF residents included falls, medication errors, nosocomial infection, delirium, pressure ulcers and potentially unnecessary invasive interventions [**45**, 52, **56**]. Whether these are outweighed by the benefit of specialist hospital-based emergency care is unclear. Importantly, there is little evidence about patient-centred outcomes of care such as pain and symptom control, management of delirium or agitation and patient comfort and privacy.

High mortality rates were evident in the ED and with inpatient admission, possibly indicating some acute transfers are not associated with the intended outcomes of improved quality of life or increased life expectancy. Potentially, patients who are seriously unwell and die soon after transfer may benefit more from appropriate and earlier palliative care within the RACF. Alternatively, it may be that these adverse outcomes reflect late or delayed transfer of residents, or transfer of only the very ill and perhaps with improved recognition of deteriorating patients and earlier management, outcomes could be improved. This requires further exploration through prospective studies within RACF.

Overall, in the ED, residents of RACF experienced a high rate of intervention of varying levels of invasiveness. This may contribute to adverse clinical outcomes as well as increased costs of care and prolonged LOS in the ED. While these interventions may be necessary to ensure good patient care, their benefits have not been widely explored, and it could be argued that some could be undertaken in the RACF.

The current model of acute care for RACF residents may contribute to substantial healthcare costs through high rates of ambulance usage, investigation and inpatient admission. These would be of less concern if patient outcomes were clearly favourable. Despite frequent use of emergency ambulance services, no studies reported on the degree of pre-hospital intervention or treatment. Furthermore, there has been no evaluation of which residents could be treated by paramedics within the RACF, without ED transfer. It is therefore unclear if this type of emergency pre-hospital service is appropriate, if additional supports are required or if other community-based services may be more suitable to best care for these patients. In hospital, RACF residents experienced longer ED and inpatient LOS, and greater rates of re-presentation, compared with other patient groups, potentially exacerbating the problems of hospital and ED overcrowding and quality of care delivery.

The wide variation in study methodologies restricted synthesis and prevented meta-analysis. Studies were observational and from diverse healthcare systems, limiting conclusions of causality and generalisability of findings. It was not possible to specify results for subsets of RACF residents (e.g. low- versus high-level care). Nevertheless, we have systematically reviewed the current evidence and found a number of consistent findings across a range of international settings. These provide a broad description of clinical-, patient- and health system-related outcomes for RACF residents following emergency transfer to hospital.

Conclusion

The complex clinical presentations, high acuity and frequent adverse outcomes of RACF residents indicate the need for specialist emergency care for this population. However, exploration of risks and benefits of in-hospital acute and emergency care is currently limited by deficiencies in alternative models of acute care, significant variation in healthcare systems in different settings, and potential differences in capabilities between individual facilities and hospital outreach services. The current evidence is insufficient to appraise the quality of care provided, identify training requirements and develop evidence-based guidelines for emergency healthcare professionals caring for RACF residents. Ideally randomised trials are needed to systematically investigate outcomes of care from ED versus RACF-centric models of acute care. Future research should quantify patient-centred outcomes

from current care pathways better, examine determinants of adverse outcomes of emergency transitions and explore efficacy of alternate emergency healthcare models.

Key points

- High proportions of residents of aged care facilities are admitted to emergency departments each year.
- Transfer to the emergency department may have adverse consequences for this group of patients.
- Alternative models of care might be more effective and cost effective.

Conflicts of interest

None declared.

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The very long list of references supporting this review has meant that only the most important are listed here and are represented by bold type throughout the text. The full list of references is available on Supplementary material online, Appendix S1.

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2.3.2 Updated Literature Review

As these reviews were conducted in 2014 and 2015, the initial search strategy was re-run on 26th September 2019 to capture any new data since publication of these manuscripts. Nine new publications were identified as meeting the initial search strategy (Table 1).

Table 1: Characteristics and references for additional included outcome studies.

Study	Country	Setting	Sample Size	Duration	Methods
Bjorck et al, 2018 [65]	Sweden	Single hospital	366	2011-2012	Retrospective review of medical record
Burke et al, 2015 [66]	USA	Nationally representative dataset	4032	2005 - 2010	Retrospective analysis of National Hospital Ambulatory Care Survey data
Campbell et al, 2017 [67]	Australia	Single hospital	89	2013-2014	Retrospective review of electronic medical records
Carron et al, 2017 [68]	Switzerland	Single hospital	3590	2001 to 2010	Retrospective review of hospital administrative dataset
Gruneir et al, 2018 [69]	Canada	Single district	25,653	2010	Retrospective review of Continuing Care Reporting System (CCRS), the National Ambulatory Care Reporting System (NACRS), the Discharge Abstract Database(DAD), and the Registered Persons Database (RPDB) datasets
LaMantia et al, 2016 [70]	USA	Single public health organisation	4491	2000 - 2009	Retrospective review of Medicare and Medicaid and residential care minimum health datasets
Manckoundia et al, 2016[71]	France	Single district	1000	2013	Prospective, observational study of consecutive visits to ED by people living in RAC
Morphet et al, 2015 [72]	Australia	Two hospitals	408	2012	Retrospective review of medical records

Unroe et al, 2018 [73]	USA	Single district	1174	2014-2016	Prospective, observational data collection from medical records

All studies were from high-income countries, were observational and used either medical records or administrative datasets. Findings from these studies complemented the overall findings of the review, with no notable differences identified.

Patterns of presentation

Common presenting conditions from RAC to hospital included falls with and without associated injury, suspected infection, uncontrolled pain, shortness of breath and acute respiratory complaint and abdominal pain and acute gastrointestinal complaint [65-68, 71, 72]. There was frequent investigation within the emergency department (ED) including radiology in 24% to 70%, pathology in up to 89% and intravenous medication in 31% of people transferred to ED from RAC [66, 72].

Admission and inpatient length of stay

Overall 36% to 66% of residents were admitted to an inpatient bed with a mean inpatient length of stay of 7 to 9 days [66, 68-70, 72, 73]. LaMantia et al (2016) examined disposition with regard to severity of cognitive impairment and found no difference in rates of admission according to severity of dementia [70]. Burke et al (2015), found 70% of people has represented to ED within a 12 month period [66].

Ambulance use

Over 96% of people were transferred to hospital via emergency ambulance [72]. In terms of appropriateness of transfers to ED, from 17% to 44% of presentations were deemed potentially avoidable or preventable admissions[69, 71-73]. Similar to findings from the review, the definition of 'appropriateness' varied between studies which limits comparison between settings. These studies also used retrospective, hospital based data which may not capture,

time, setting and resource constraints which impact on the ability to care for a person in the community and the decision to proceed with transfer to hospital.

Re-presentation to the Emergency Department

Gruneir et al (2018) investigated repeat transfers residents to ED [69]. The authors found almost half of residents made a repeat ED presentation within 12 months and up to 11% experienced three visits within this time. These findings are consistent with those from the systematic review. The authors estimated up to 60% of repeat presentations by individuals were for similar presenting complaints to the index presentation [69]. Similar to the review these authors found co-morbidity to be a significant contributor. In this population, repeat presentations were associated with being male, certain co-morbidities including congestive heart failure, chronic pulmonary disease and chronic liver disease, and older age. Notably, results were inconclusive for impact of cognitive impairment or severity of functional impairment on rate of repeat presentation [69].

2.4 Patient and Organisational Determinants of Emergency Transfer to Hospital

2.4.1 Manuscript Two

This study is presented in the form of a manuscript *Unplanned Transfer to Emergency Departments for Frail Elderly Residents of Aged Care Facilities: A Review of Patient and Organizational Factors.* Dwyer R, Stoelwinder J, Gabbe B, Lowthian J. Journal of the American Medical Directors Association (JAMDA) 2015. 16(7) 551-562[74]

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Review Article

Unplanned Transfer to Emergency Departments for Frail Elderly Residents of Aged Care Facilities: A Review of Patient and Organizational Factors

Rosamond Dwyer MBBS [a,*], Just Stoelwinder MD [a], Belinda Gabbe PhD [a,b], Judy Lowthian PhD [a]

[a] School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia
[b] Farr Institute, Center for Improvement in Population Health through E-Records Research (CIPHER), College of Medicine, Swansea University, Swansea, Wales, United Kingdom

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A B S T R A C T

Background: With an aging population, a growing number of older adults experience physical or cognitive decline that necessitates admission to residential aged care facilities (RACF). Each year a considerable proportion of these residents has at least 1 emergency transfer to hospital, which may result in a number of adverse outcomes. Rates of transfer from RACF to hospital can vary considerably between different RACFs suggesting the presence of potentially modifiable risk factors for emergency department (ED) transfer.

Methods: A systematic and comprehensive search of the peer-reviewed literature using 4 electronic databases was conducted. Included papers were those reporting on determinants of unplanned transfer to hospital for elderly people (aged 65 years and above) living in RACFs. Studies were assessed for quality and key concepts and themes extracted.

Results: There are both individual patient factors and health system factors, which influence rates of transfer to hospital for elderly RACF residents. For individuals, increased risk of ED transfer has been associated with presence of particular comorbidities such as chronic airways disease, congestive cardiac failure, and diabetes; presence of indwelling devices; absence of an advance care plan; and reduced functional ability. For organizations, "for profit" facilities and those with poorer staff to patient ratios also have higher rates of transfer to hospital, compared with those owned by not-for-profit organizations and those with improved registered nurse and medical practitioner staffing.

Conclusions: This review has identified a number of potentially modifiable patient and organizational factors that should reduce the need for burdensome transfer to the ED and improve the quality of both acute care and end-of-life care for this population of frail, elderly individuals. A number of these determinants, including facility staffing, the role of specialist geriatricians, and advance directives, should be further examined, ideally through interventional trials to evaluate their impact on the pre-hospital and emergency management of these patients.

Increasing numbers of frail, elderly people require care in residential aged care facilities (RACFs). These residents frequently have cognitive or functional impairment in addition to considerable medical comorbidity and are, therefore, vulnerable to episodes of acute deterioration in health.

Each year, up to 75% of residents experience an unplanned transfer to hospital emergency departments (ED) for care.[1–4] The outcomes of these transfers include a number of adverse sequelae.[5] In hospital, elderly residents have a high rate of potentially invasive interventions and may experience delirium, pressure ulcers, and hospital-acquired infections.[6–8] Many experience further functional decline post admission[9]; and short-term mortality rates post-transfer are high, even after specialist inpatient treatment.[4,10–12] For a proportion of residents these transfers may disrupt and inhibit appropriate palliative and end-of-life care. Gozalo et al[13] identified that 19% of RACF residents with advanced cognitive impairment were transferred within the last 90 days of life, 12% had a transition within the last 3

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* Address correspondence to Rosamond Dwyer, School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia.
E-mail address: rosamond.dwyer@monash.edu (R. Dwyer).

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days of life, and 8.1% had multiple hospitalizations in the last 90 days of life. In this study, the rate of these burdensome transfers at the end of life increased from 17% to 20% of RACF residents between 2000 and 2007.

Unplanned transfers to hospital may occur for a variety of reasons such as deterioration in physical health, falls, complications relating to indwelling devices or medications, and difficulty in managing complex behaviors. They frequently include transfers for ambulatory care sensitive (ACS) conditions and end-of-life care.[5] These transfers usually result in a patient being assessed or managed in the ED with a high likelihood of admission to hospital. They do not include planned admissions for elective procedures or operations. Given the considerable potential for negative outcomes, it is important to understand the individual patient and health system factors that place a resident at increased risk of emergency hospital transfer. This would enable those modifiable risk factors to be addressed and inform development of appropriately targeted interventions to reduce the frequency of burdensome transfers. Therefore, the aim of this review was to synthesize current evidence regarding clinical and organizational determinants of unplanned emergency transfer to hospital for acute illness or injury among frail, elderly people living in RACFs.

Methods

Search Strategy

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[14] Four electronic databases Medline, Embase, CINAHL, and Informit were searched systematically in August 2014. The search strategy for Medline (OVID) is outlined in Figure 1. Strategies for other databases were adjusted for database-specific indexed terms. Reference lists of selected articles were hand-searched for additional peer-reviewed papers, however, gray literature was not included. The search was not restricted by year of publication. The search results are outlined in Figure 2.

Inclusion Criteria

Studies of participants aged at least 65 years, living in RACF, that reported determinants of unplanned transfer to ED and hospital admission, and published in English were included. All included studies were from peer-reviewed sources and included quantitative analysis of primary data. Studies had to include specific analysis of the population of RACF residents aged 65 years and older. Unplanned transfers included those for acute deteriorations in health, ACS conditions, and end-of-life care. Qualitative studies and systematic reviews were not included. Studies referring to elective hospital admissions, such as for preplanned procedures were not included. A RACF was defined as a nursing home, care-home, or long-term care, skilled nursing, or residential care facility. These criteria were broad to ensure a comprehensive review. Studies that did not refer to ED or hospital transitions were excluded. Reasons for exclusion of studies after review of full-test articles are presented in Figure 2.

Assessment of Validity and Synthesis of Findings

Study quality was assessed using the Newcastle-Ottawa Scale (NOS).[15] The NOS is a checklist scale developed for observational studies which assesses 3 domains of study methodology: selection and representativeness of participants, comparability of different participant groups, and assessment of outcome or exposure.[15] There are a set number of points awarded to each domain with the maximum achievable score being 9 points for cohort and case-control studies and 10 points for cross-sectional studies.[15] Previously, the total NOS score has been used to rate quality of studies as follows:

1. exp Nursing homes/ OR nursing hom*.mp. OR exp Residential Facilities/ OR residential facilit*.mp. OR exp Long-Term Care/ OR long-term care .mp. OR exp Skilled Nursing Facilities/ OR skilled nursing facilit*.mp.
2. exp Geriatrics/ OR geriatri*.mp. OR exp Aged/ OR aged .mp. OR elderly .mp. OR exp Frail Elderly OR frail elderly .mp. OR exp “Aged, 80 and over”/ OR “Aged, 80 and over” .mp. OR gerontolo .mp.
3. 1 AND 2
4. exp Housing for the Elderly/ OR housing for the elderly .mp. OR exp Homes for the Aged/ OR homes for the ages .mp. OR residential aged care .mp. OR exp Geriatric Nursing/ OR geriatric nurs*.mp.
5. 3 OR 4
6. exp Emergency Medical Services/ OR emergency medical servic* .mp. OR exp Emergencies/ OR emergenc*.mp. OR exp Emergency Treatment/ OR emergency treatmen*.mp. OR exp Emergency Service, Hospital/ OR emergency servic* .mp. OR exp Trauma Centers/ OR trauma servic* .mp. OR trauma cent* .mp. OR exp Emergency Nursing/ OR emergency nurs*.mp. OR exp Emergency Medicine/ OR emergency medicine.mp. OR “accident and emergency”.mp. OR emergency department.mp. OR exp Ambulances/ OR ambulanc*.mp. OR paramedi*.mp. OR prehospital.mp. OR prehospital care.mp. OR pre-hospital.mp.
7. 5 AND 6

Fig. 1. Search Strategy (Medline)

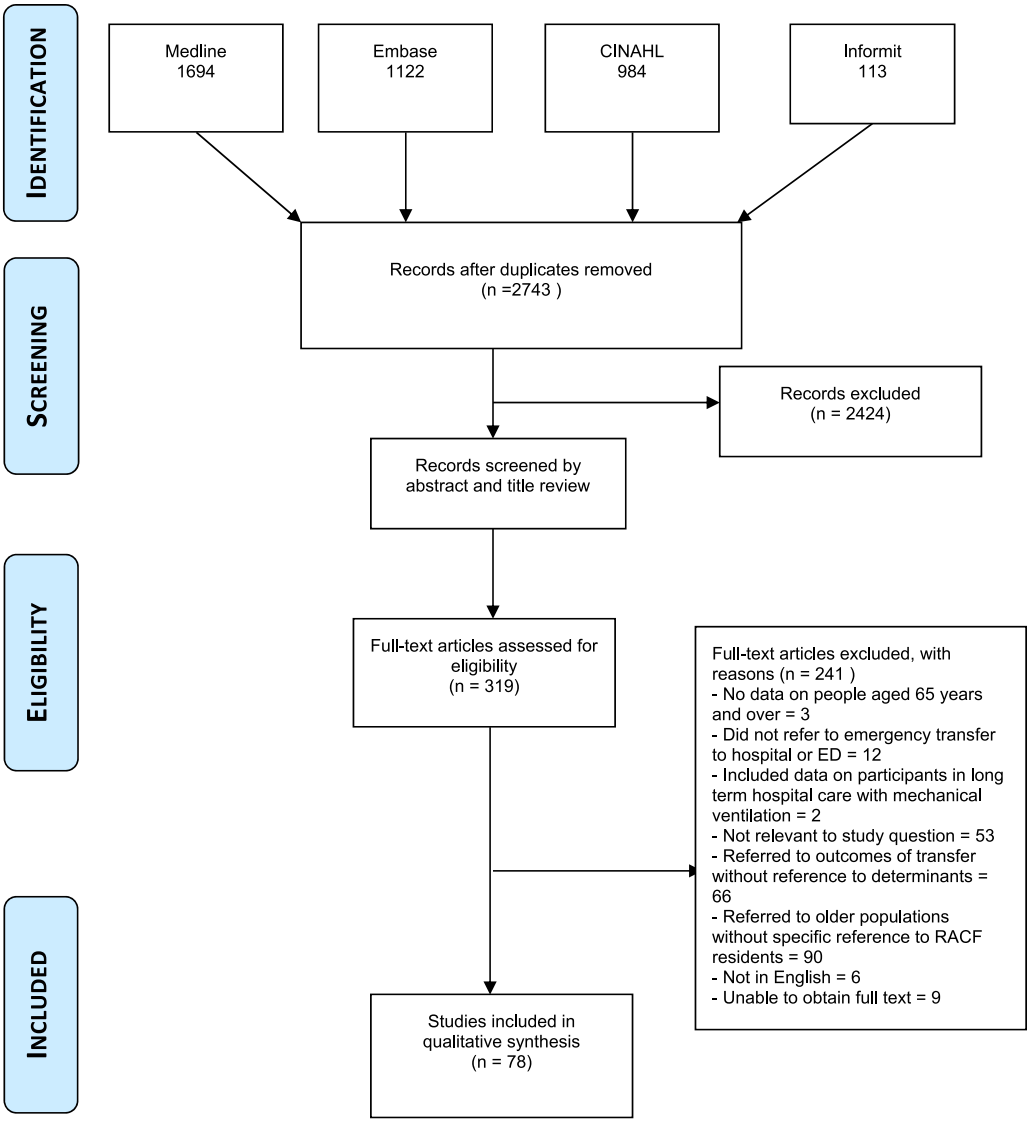

Fig. 2. Search Results (PRISMA).[14]

0 to 5 classified as low quality, 6 to 7 moderate quality, and ≥8 as high quality.[16,17] All studies were rated by R.D. with 25% of studies undergoing duplicate assessment by J.L. and J.S. Assessment of studies between authors demonstrated consistent scoring, suggesting adequate inter-rater reliability.

Data were extracted systematically from included papers. Key concepts were identified and grouped into 2 overarching categories, individual patient characteristics, and RACF characteristics, and are summarized in Table 1. Variables were then further categorized into relevant subgroups for each category enabling thematic analysis and production of a best evidence synthesis of the literature.[18–20]

Results

Summary of Included Studies

A total of 78 papers met the inclusion criteria for this review. The features of included studies along with the NOS quality rating score have been summarized in Table 2. All were observational studies with considerable variability in methodology. All studies included in analysis achieved NOS scores of 6 or more. In general, study quality was very good with the average score for cohort and case control studies being 8 out of 9, and cross-sectional studies being 7.5 out of 10, respectively. In total, 54 papers (69% of all papers) achieved a NOS score of 8 or more.

A large proportion of studies reported retrospectively collected data from hospital or RACF chart reviews (29/78, 37%) or health administrative datasets (37/78, 47%). Overall, 28 of 78 (36%) studies included some prospective data collection through assessment interviews with patients, RACF facility staff, or hospital clinicians. Among studies with similar methods, such as chart review or use of administrative data, there were considerable differences in data extraction techniques, tools and databases used. Study sample sizes varied substantially from 46 participants to national datasets reporting more than 900,000 clinical encounters.

Most studies were conducted in the USA (42/78, 54%), with others from 13 different countries including Australia (9/78, 12%), Canada (8/78, 10%), Taiwan (4/78, 5%), and England (2/78, 3%). There were no studies identified from low-income countries. Given the heterogeneity of studies, meta-analysis of data was not possible.

Table 1
Factors Associated With Higher Numbers of Unplanned Transfers From Residential Aged Care Facilities to Hospital

Patient Factors
Cognitive impairment
Presence of a permanent indwelling device (eg, PEG tube)
Chronic respiratory or cardiac disease
Depression or anxiety
Low body weight
Pressure ulcers
Lower functional ability
High number of medications or recent commencement of new medication
Recent change in environment (eg, new admission to the facility)
Absence of an advance directive
Facility Factors
Privately owned or part of corporate chain
Those not aligned with an acute hospital
Absence of dementia special care unit
Lower quality of the physical environment
Lower RN to LPNs and RN to CNA staffing ratio
Higher rates of staff turnover
Lower number of physician hours per resident
Absence of specialized geriatrician consultation
Lower facility prevalence of advance directives

CNA, certified nurse assistant; LPN, licensed practitioner nurse; PEG, percutaneous endoscopic gastrostomy.

Patient Factors

Demographics

Aged care residents transferred to hospital were elderly, on average aged over 80 years.[3,4,11,12,21–40] This is consistent with population surveys that have identified up to 75% of all elderly people living in RACF are aged 80 years and over.[41] However, 2 studies, both involving retrospective analysis of routinely collected healthcare data for over 2000 residents, found that in contrast to community-dwelling patients, RACF residents were less likely to be transferred to hospital as age increased further to the very extremes of old age.[34,42]

Overall, there is a greater number of women living in care facilities with up to 70% of residents being female, likely reflecting their increased life expectancy compared with men.[41] Thus, females comprised a greater proportion of RACF residents seen in ED and admitted to hospital, with women accounting for 56% to 76% of transferred residents.[4,11,12,21–26,28–34,36,38–40] Many studies demonstrated that men had a higher rate of transfer to hospital and admission, higher ED usage, and higher readmission rates compared with female residents.[1,13,34,42–49] However, these associations were not investigated in detail and, therefore, the reason for these proportional differences is not clear.

It is possible that in some countries, there are ethnic influences on the decision to transfer residents to hospital for treatment. In US populations, both Ackerman et al[1] and Wang et al[33] noted a higher number of RACF residents presenting to ED were Caucasian. In contrast, subsequent studies have reported that being non-Caucasian was associated with increased risk of transfer to hospital in case of acute medical illness,[48] increased rate of admission for ACS conditions,[50] which are admissions that may be considered potentially avoidable, increased likelihood of a burdensome transition in the last 90 days of life,[13] and increased risk of dying in hospital compared with in the RACF.[51] In a primary study of the impact of race on rehospitalization rates of RACF residents, Li et al[47] found a 40% increased odds of 30-day re-hospitalization for black compared with Caucasian residents. Black RACF residents were more likely to reside in for-profit and lower resourced facilities, factors which were associated with increased rates of transfer to hospital, however, this only partially accounted for the differences in transfer rates in this study.[47]

Comorbidity

A number of disease-related factors were found to influence risk of acute medical illness, severity of deterioration, and rate of hospital transfer. One Taiwanese and several US studies found residents with cognitive impairment had higher risk of ED transfer or hospital admission for acute illness than those without cognitive impairment.[1,47,49,50,52,53] However, this may vary among healthcare settings as other studies reported that residents with a diagnosis of dementia, in particular those with more advanced cognitive deficit, were less frequently referred to ED.[54,55]

It has been reported that having permanent indwelling devices such as a percutaneous endoscopic gastrostomy tube or indwelling catheter may lead to increased rates of ED presentation.[46,48,49,56] Rehospitalization for tube complications has been reported in 20% to 35% of RACF residents within a short period after insertion.[56,57]

Many chronic comorbidities may lead to emergency transfer to hospital through acute exacerbation of symptoms or worsening of underlying disease states. Diagnoses of chronic obstructive pulmonary disease, asthma, congestive cardiac failure, diabetes, and chronic pain have been associated with higher risk of ED transfer and hospital admission.[42,43,48,58–62] Spector et al[49] found admissions for ACS conditions, were higher for those residents with urinary tract infection, congestive cardiac failure, asthma, chronic obstructive pulmonary disease, and diabetes. As well as physical disease, poor mental health may require increased health service usage. In particular, a diagnosis of major depression, anxiety, or less commonly psychosis has been associated with increased rate of medical consultation, ED visit and hospitalization.[50,52,63]

Physical status

Further markers of poor physical health such as low body mass index, recent illness, pressure ulcers, swallowing difficulties, and increased functional dependence have been shown to be associated with higher risk of acute hospital transfer.[42,44,46,47,49,52,62,64–68]

Medication

Large numbers of prescribed medications,[69] use of specific medications such as anxiolytics and hypnotics and recent initiation of new medication have all been associated with an increased risk of emergency hospital transfer.[42,46,49] This may reflect increased burden of disease or hazards of adverse drug reaction.

Recent RACF transfer

A recent change in environment may leave a resident more vulnerable to acute illness or injury. Both new admission to RACF or recent discharge from ED or hospital has been associated with increased risk of falls resulting in ED transfer and inpatient admission.[49,67,70] Transfer rates have been reported to be highest within the first 90 days of admission to the facility.[43,54]

Facility and Health System Characteristics

ED and hospital transfer rates varied considerably between different RACFs, with reports ranging from 15% to over 75% per year, suggesting that individual facility characteristics may significantly influence an individual's risk of ED transfer for acute illness.[1,2,13,37,65,71,72]

Ownership

Facility ownership could impact on policies and availability of resources needed to manage acute illness within the RACF. In the US, facilities that are privately owned (compared with those run by not-for-profit or government agencies), part of a corporate chain, those not linked with hospitals, and those with higher proportions of Medicaid patients compared with privately funded residents

Table 2
Characteristics of and NOS Score for Included References

Study	Country	Setting	Sample Size	Study Duration/Year	Methods	NOS Rating			
						Selection (4)	Comparability (2)	Outcome (3)	Total (9)
Cohort Studies									
Arendts et al, 2012[11]	Australia	District	4680	1 year (2006–2007)	Review of health administrative datasets for 6 hospital EDs	3	2	3	**8**
Avidan et al, 2005[67]	USA	District (single)	34163	1 year (2001)	Review of health administrative data (RAI/MDS) for RACF residents in one state	4	1	3	**8**
Barker et al, 1994[43]	USA	>2 RACF	2120	2 years (1982)	Review of health and administrative data for RACF residents from Monroe County Long-Term Care Program case management agency and hospital records and billing data	3	1	3	**7**
Becker et al, 2010[50]	USA	District	72,251	3 years (2003–2006)	Review of health administrative data for residents using Medicaid claims and enrollment and for RACFs using OSCAR for 1 district	4	2	3	**9**
Boockvar et al, 2005[74]	USA	>2 RACF	2153	2 years (1992–1995)	Prospective enrollment and follow-up of a cohort of RACF residents review of medical record, MDS data and interview with facility staff	4	2	3	**9**
Brookvar et al, 2008[66]	USA	>2 RACF	3618	3 years (1992–1995)	Prospective enrollment and follow-up of RACF residents review of medical record and Medicaid and Medicare data	4	2	3	**9**
Burton et al, 2001[54]	USA	>2 RACF	2153	3 years (1992–1995)	Prospective enrollment and follow-up of RACF residents, baseline interviews and examination, review of medical record	4	2	3	**9**
Carroll et al, 2001[93]	USA	>2 RACF	551	6/12 (1999)	Review of facility medical record, pharmacy record healthcare and administrative data	3	1	3	**7**
Chiang et al, 2012[52]	Taiwan	Single RACF	609	1 year (2006)	Prospective enrollment and follow-up of residents, baseline interview and assessment, review of facility and hospital medical record	3	1	3	**7**
Chou et al, 2009[3]	Taiwan	Single RACF	635	1 year (2006)	Review of hospital medical record and administrative data	3	1	3	**7**
Crilly et al, 2008[26]	Australia	Single hospital	9744	1 year	Review of hospital healthcare and administrative data and medical record	4	2	3	**9**
D'Arcy et al, 2013[84]	USA	Nationally representative data	66,551	1 year (2003–2004)	Use of nationally representative healthcare and administrative datasets (Medicare)	4	2	3	**9**
Girio-Fragkoulakis et al, 2011[40]	England	Single hospital	11760	6/12 (2007)	Review of hospital administrative data and hospital medical records	4	1	3	**8**
Givens et al, 2012[48]	USA	>2 RACF	323	1.5 years	Prospective enrollment and follow-up of residents, interview and examination of participants, review of medical records and hospital discharge summaries	3	2	3	**8**
Goldfeld et al, 2013[78]	USA	>2 RACF	291	6 years (2003–2009)	Prospective enrollment and follow-up of residents, interview and review of medical records, review of linked healthcare datasets (Medicare)	4	2	3	**9**
Gozalo et al, 2011[13]	USA	National	90,228	7 years (2000–2007)	Review of healthcare and administrative data from residents using national datasets (MDS, Medicare claim files)	3	2	3	**8**
Graverholt et al, 2011[37]	Norway	District	2451	2 years (2007–2008)	Review of linked healthcare and administrative datasets (hospital and ambulance records)	3	1	3	**7**
Graverholt et al, 2013[34]	Norway	District	2451	2 years (2007–2008)	Review of health administrative data through hospital patient record and ambulance records	3	2	3	**8**
Grunier et al, 2010[83]	Canada	District (single)	64,589	1 year (2005)	Review of healthcare and administrative data for residents and facilities (LOC, NACRS, registered persons database, Ontario drug benefit claims, the Canadian Institute for Health Information Discharge Abstract Database, OHIP)	3	1	3	**7**

(*continued on next page*)

Table 2 (*continued*)

Study	Country	Setting	Sample Size	Study Duration/Year	Methods	NOS Rating			
						Selection (4)	Comparability (2)	Outcome (3)	Total (9)
Grunier et al, 2012[70]	Canada	District (single)	64589	1 year (2005)	Review of healthcare and administrative data for residents and facilities (LOC, NACRS, registered persons database, Ontario drug benefit claims, the Canadian Institute for Health Information Discharge Abstract Database, OHIP)	3	2	3	**8**
Grunier et al, 2014[92]	Canada	District (single)	>100,000 episodes	6 years (2002–2008)	Review of linked healthcare administrative data (LOC, NACRS, Registered persons database, Ontario drug benefit claims, the Canadian Institute for Health Information Discharge Abstract Database, OHIP) and influenza surveillance data	4	1	3	**8**
Hillen et al, 2011[32]	Australia	Single hospital	3310	6 years (1999–2005)	Review of hospital administrative data and medical records	3	2	2	**7**
Hutt et al, 2002[58]	USA	>2 RACF	2414	1 year (1994)	Review of resident medical records and healthcare administrative data (Medicare provider analysis and review file)	4	2	3	**9**
Ingarfield et al, 2009[30]	Australia	District	6165	3 years (2003–2006)	Review of hospital and ambulance healthcare and administrative data	3	2	3	**8**
Intrator et al, 1999[44]	USA	Districts (multiple)	2080	1 year (1993)	Review of healthcare administrative data for residents and RACFs (RAI-MDS, OSCAR)	4	2	3	**9**
Intrator et al, 2004[71]	USA	Districts (multiple)	54631	1 year (1997)	Review of healthcare and administrative data (MDS, OSCAR) across 4 states	4	2	3	**9**
Jayasinghe et al, 2007[25]	Australia	Single hospital	737	8.5/12 (2004)	Review of hospital and ED administrative records and patient medical records, smaller groups followed up within 48 hours with assessment interview	3	1	2	**7**
Jones et al, 1997[21]	USA	Two hospitals	709	1 year (1993)	Review of patient medical record and transfer documents, completion of questionnaire by ED treating physician while patient in hospital	3	1	2	**6**
Kaw et al, 1994[57]	USA	Single hospital	46	2 years (1988–1990)	Review of patient medical records from hospital, RACF, and family physician	3	1	3	**7**
Ku et al, 2013[68]	Taiwan	>2 RACF	940	1 year (2009–2010)	Interview and assessment of individual participants with follow-up over study period. Review of patient medical record	3	2	3	**8**
Kuo et al, 2009[56]	USA	National data		2 years (2000–2002)	Review of nationally representative healthcare and administrative data (MDS, Medicare claim files)	4	1	3	**8**
Lane et al, 2012[38]	Australia	Single hospital	228	6/12 (2009)	Review of hospital medical record for individual participants	3	2	3	**8**
Leung et al, 2013[69]	Hong Kong	>2 RACF	169	1 year	Prospective enrollment and assessment of residents. Use of routine healthcare data (RAI MDS 2.0)	3	1	3	**7**
Li et al, 2011[47]	USA	National	>500,000	<1 year (2008)	Review of nationally representative routine healthcare and administrative data (MDS, OSCAR, 2008 Area Resource File)	4	2	3	**9**
Mitchell et al, 2004[88]	USA	District (single)	2492	3 years (1994–1997)	Review of routinely collected healthcare and administrative data (MDS, National death index)	4	2	3	**9**
Mitchell et al, 2009[89]	USA	>2 RACF	323	1.5 years (2003–2007)	Prospective enrollment and follow-up of residents, interview and examination of participants, review of medical records	3	2	3	**8**
Nelson et al, 2013[39]	USA	Single hospital	100	4/12 (2011)	Review of hospital medical record and electronic ED record and survey of treating clinician	3	1	3	**7**
Ouslander et al, 2010[81]	USA	District (single)	377 RACF	1.5 years (2005–2006)	Review of routinely collected healthcare and administrative data (MDS, Medicare claims data)	3	2	3	**8**
Peng et al, 2009[60]	Taiwan	Single RACF	574	1 year	Prospective enrollment of participants with baseline interview and assessment, review of healthcare and administrative data (MDS)	4	2	3	**9**

Romero-Ortuno et al, 2012[35]	Ireland	Single hospital	1938	8 years (2002–2010)	Review of hospital healthcare and administrative data, review of patient medical records	3	2	3	**8**
Ronald et al, 2008[45]	Canada	District (single)	6826	3 years (1996–1999)	Review of health administrative data from BCLHD	3	1	3	**7**
Saliba et al, 2000[23]	USA	>2 RACF	100	8/12 (1994–1995)	Retrospective review of RACF and hospital records and transfer documentation	3	2	3	**8**
Simoni-Wastila et al, 2009[61]	USA	>2 RACF	3037	2 years (2003–2005)	Review of health administrative dataset (Market Scan Medicaid)	3	2	3	**8**
Smallbrugge et al, 2006[63]	Netherlands	>2 RACF	350	1.5 years (1999–2001)	Prospective recruitment of participants with individual interview and assessment	4	2	3	**9**
Spector et al, 2013[49]	USA	National	62745	2 years (2006–2008)	Review of nationally representative health administrative datasets (NH Stay file, MDS, OSCAR, Brown University State policy data)	3	2	3	**8**
Street et al, 2012[36]	Australia	Single hospital	4637	1 year (2009)	Review of hospital health and administrative data (VEMD, VAED)	3	2	3	**8**
Tang et al, 2010[46]	Hong Kong	District (single)	1820	<1 year (2001)	Review of health administrative data (MDS-RAI 2.0) and medical records and individual interview with patients	3	2	3	**8**
Temkin-Greener et al, 2013[51]	USA	National data	>2.5 million	5 years (2003–2007)	Review of national administrative healthcare datasets (CCW, MDS)	4	2	3	**9**
Teno et al, 2011[87]	USA	Nationally representative data	15784 RACF	6 years (1999–2007)	Use of nationally representative healthcare and administrative datasets (MDS, Medicare enrollment and inpatient hospitalization data, OSCAR)	3	1	3	**7**
Unroe et al, 2012[76]	USA	Nationally representative data	164,672	2 years (2006–2007)	Review of national health administrative datasets (Medicare provider and analysis review claims from CMS, MDS, Nursing Home Compare Website)	3	2	3	**8**
Vossius et al, 2013[4]	Norway	Single hospital	940	1 year (2011)	Review of health administrative data (AMIS, NIMES, Municipal medical file)	3	2	3	**8**
Walsh et al, 2012[75]	USA	National data	958,837	1 year (2005)	Review of national health administrative datasets (CCW, CMS, OSCAR)	4	2	3	**9**
Wang et al, 2011[33]	USA	National	>500,000	3 years (2005–2008)	Review of national health administrative datasets (NHAMCS)	3	2	3	**8**
Yeung et al, 2011[85]	Hong Kong	Single hospital	2942	1 year (2006–2007)	Review of hospital administrative data, review of medical record, weather information form the HK Government Observatory	3	2	3	**8**
Zimmerman et al, 2002[73]	USA	>2 RACF	2015	2 years (1992–1995)	Prospective enrollment and follow up of participants. Individual interview and assessment of residents, review of medical records	4	2	3	**9**
Zweig et al, 2004[42]	USA	>2 RACF	1031	3 years (1995–1998)	Prospective enrollment and follow-up of resident. Review of medical record and use of MDS data for participants	3	2	3	**8**

Study	Country	Setting	Sample Size	Study Duration/Year	Methods	NOS Rating			
						Selection (4)	Comparability (2)	Exposure (3)	Total (9)
Case-Control Studies									
Alrawi et al, 2013[12]	England	Single hospital	314	2 years (2005–2007)	Review of health administrative data and medical records for participants	3	1	3	**7**
Resnick et al, 2008[59]	USA	National	13,507	1 year (2004)	Review of nationally representative data (NNHS)	4	2	3	**9**

Study	Country	Setting	Sample Size	Study Duration/Year	Methods	NOS Rating			
						Selection (5)	Comparability (2)	Outcome (3)	Total (10)
Cross-Sectional Studies									
Ackerman et al, 1998[1]	USA	District (single)	1488	1 year (1995)	Review of hospital medical records, review of data from 1995 State of Georgia Annual Nursing Home Questionnaire	3	1	3	**7**
Aigner et al, 2004[79]	USA	>2 RACF	203	1 year (1997–1998)	Review of participant RACF medical records	2	2	3	**7**
Aminzadeh et al, 2004[2]	Canada	>2 RACF	178	1 year (2002–2003)	Interview with participants and review of medical records	5	2	3	**10**

(*continued on next page*)

Table 2 (*continued*)

Study	Country	Setting	Sample Size	Study Duration/Year	Methods	NOS Rating			
						Selection (5)	Comparability (2)	Outcome (3)	Total (10)
Carter et al, 2009[27]	Scotland	Single hospital	107	1/12 month	Questionnaire completed by treating physician whilst patient in ED and review of medical record	2	1	3	**6**
Cwinn et al, 2009[28]	Canada	Single hospital	457	6/12 (2004)	Review of hospital administrative data (NACRS), medical record, ambulance record and transfer documentation	2	1	3	**6**
de Souto Barreto et al, 2013[53]	France	>2 RACF	5684	1 year	Review of participants medical record, information on RACF organization and structure recorded	3	2	3	**8**
Finn et al, 2006[24]	Australia	Single hospital	541	6/12 (2002)	Review of hospital and ambulance records and documents	3	2	3	**8**
Finucane et al, 1999[22]	Australia	Single hospital	239	3/12 (1998)	Review of hospital record and transfer documents, phone interview with ED and NH staff to gather further information as needed	3	1	3	**7**
Jensen et al, 2009[29]	Canada	District (single)	606	1 year (2000)	Review of district wide healthcare and administrative datasets (HHS, paramedic records)	3	2	3	**8**
Konetzka et al, 2004[65]	USA	Nationally representative data	766	1 year (1996)	Use of nationally representative dataset (from Medical Expenditure Panel Survey) review of participants medical record	3	2	3	**8**
Langmore et al, 2002[64]	USA	Districts (multiple)	102842	1 year (1993–1994)	Use of MDS health administrative data from 3 states (through University of Michigan Assessment Archive Project)	4	2	3	**9**
Lee et al, 2003[82]	Singapore	Single hospital	201	3/12 (2001)	Completion of questionnaire by patient's treating ED physician	3	2	3	**8**
Lima et al, 2012[62]	USA	>2 RACF	18680	1 year (2006–2007)	Review of health administrative datasets (MDS, CMS, OSCAR) and survey of American Medical Directors Association members	3	2	3	**8**
Madden et al, 1998[86]	USA	Single hospital	420	1 year (1995–1996)	Collection of data from hospital transfer record and survey of treating clinicians	3	1	3	**7**
Mamhidir et al, 2012[55]	Sweden	>2 RACF	719	2 years (2000–2002)	Interview with and assessment of participants, review of medical record and MDS data	3	1	3	**7**
McGregor et al, 2010[90]	Canada	>2 RACF	369	6 years (2001–2007)	Review of individuals medical records	3	1	2	**6**
Mitchell et al, 2007[80]	USA	Nationally representative data	91521	1 year (2000)	Use of nationally representative healthcare and administrative datasets (RAI MDS, CMS, OSCAR)	4	2	3	**9**
Mitchell et al, 2010[31]	Scotland	Single hospital	615	1 year (2006)	Review of hospital administrative data and medical records	3	2	3	**8**
Parsons et al, 2007[72]	USA	District (single)	3985	1 year (2003)	Use of healthcare administrative data and review of EMS records	2	1	3	**6**
Platts-Mills et al, 2012[77]	USA	Single hospital	128	6/12 (2009)	Questionnaire completed by treating physician whilst patient in ED, review of medical record and Nursing Home Compare website	3	2	3	**8**

AMIS, Acute Medical Information System (Norway); BCLHD, British Columbia Linked Health Database (Canada); CCW, Chronic Conditions Data Warehouse (USA) supported by CMS; CMS, Centers for Medicare and Medicaid Services (USA); HHS, Hamilton Health Services administrative database (Canada); LOC, levels of care classification (Canada); NACRS, National Ambulatory Care Reporting System (Canada); NH Stay file, links subset of MDS with inpatient claims data (USA); NHAMCS, National Hospital Ambulatory Medical Care Survey (USA); NHS, National Nursing Home Survey (USA); NIMES, Nirvaco Medical Systems (Norway); OHIP, Ontario Health Insurance Plan Claims database (Canada); OSCAR, Online Certification and Reporting System for Nursing Homes (USA); RAI MDS, Resident Assessment Index Minimum Data Set (USA); RAI MDS 2.0, Resident Assessment Index Minimum Data Set 2.0 (HK); VAED, Victorian Admitted Episodes Dataset (Australia); VEMD, Victorian Emergency Minimum Dataset (Australia).
Healthcare and Administrative Datasets used in above studies.
Note: Bold values are statistically significant.

(indicating lower resourced organizations) frequently reported higher rates of hospitalization and readmission.[46,47,49,50,65,71,73–76] One study focused on residents living in facilities with additional resources such as dementia special care units, and reported reduced odds of admission to hospital.[44] Another study identified increased rates of hospitalization associated with factors related to low-resourcing such as a poorer physical environment, less resident privacy, and less visitation by family members.[73] In addition, 1 study reported that quality of information transfer from RACF to ED might be worse for those residents from facilities with higher proportion of Medicaid- funded residents, possibly because of facilities having fewer financial resources, operating closer to capacity, and having higher staff turnover rates.[77] As well as these facility factors, Goldfeld et al,[78] have demonstrated that different cost reimbursement policies may impact on transfer rates, with those residents who have their costs covered by fee-for-service plans experiencing more acute hospital transfers compared with those covered by a more comprehensive managed care plan under Medicare.

Size of facility

It has been suggested that, independent of ownership, larger facilities may have lower rates of transport to ED possibly because of greater staffing and treatment capacity.[37,43] However, findings are mixed with some studies reporting higher rates of transfer from RACF with greater number of beds.[47,50]

Staffing

One of the most important aspects of care within RACF is staffing. RACFs can be staffed by a range of clinicians including specialist nurse practitioners (NP), registered nurses (RNs), licensed practitioner nurses (or enrolled nurses), personal care workers or certified nurse assistants, physicians, and allied health professionals. A number of the included observational studies have found that both quantity and type of staffing to be associated with differences in rates of hospitalization and capacity of facilities to provide acute care to residents.[2,65,71,79,80]

Staffing mix and staff-to-resident ratios vary markedly between facilities; and greater staff-to-resident ratios and increased proportions of senior staff have been associated with reduced hospital admission rates.[2,65,80] Furthermore, more RNs or higher RN: licensed practitioner nurse ratios within facilities has been associated with reduced emergency transfer,[65,71] whereas higher personal care worker to nursing ratios were associated with increased emergency transfer rate.[71] In addition, specialist NPs work independently or in a team with physicians. In a study of 2 pre-existing models of care, Aigner et al[79] in their retrospective, observational study, found a NP and physician team compared with a physician only was associated with an increased number of acute visits by clinicians to RACFs but with no significant difference in the proportion of residents transferred to ED or admitted to hospital.[79] Others have found employment of a NP or a physician assistant was associated with reduced hospital transfer rates and lower rates of admissions with ACS conditions.[44,71,81]

In addition to staff profile, staff satisfaction and engagement have also been highlighted as important factors, with poorer physical environment, less importance placed on staff satisfaction and higher RN turnover all associated with increased rates of hospitalization of residents.[73]

Primary healthcare

It has been estimated that the decision to transfer a resident to hospital involves the primary care physician or general practitioner 41% to 71% of the time; and in only 11% to 44% of cases has the doctor reviewed the patient prior to transfer.[22,24,25,82,83] Greater involvement of medical staff through full-time staff appointments to larger facilities, greater availability of facility medical director and primary care physician, increased physician hours per resident, and a more formal, structured appointment that links the physician to the facility has been associated with lower rates of hospital admission and readmissions.[43,44,62,81] In addition, given the frequently complex medical treatment needed by many residents, involvement of a specialist geriatrician may lead to improved care; with D'Arcy et al[84] noting that residents receiving at least 1 geriatrician consultation during a 12-month period had a 12% reduction in monthly ED use compared with those who did not.[84]

Season/temperature

There is some suggestion that residents may be vulnerable to changes in season with some studies finding increased rates of falls and of hospital presentations by RACF residents increasing during the colder, winter months,[25,26,29,85] although the reasons for this variation have not been explored. Others have failed to find significant variability in rates of presentation across the year.[1,82]

Advance Directives

Advance directives (AD) are individualized, written documents that guide the end-of-life care and resuscitation treatment of a patient. They encompass a range of plans including do not resuscitate (DNR) and do not hospitalize (DNH) orders, advance care plans, and living wills and play an important role in directing medical and palliative care. Ideally, these documents should be completed in consultation with a patient, their next of kin, and current treating physician and should include discussion of prognosis, expected complications, and possible treatment options. Among residents seen in ED, the prevalence of advanced directives was variable with reported rates of 3% to 37% for documentation of resuscitation status, and up to 7.9% for DNH orders.[4,27,38,86] Within the broader population of RACF, prevalence of DNR and DNH orders vary significantly between different facilities with estimates ranging from 54% to 73% and 2.1% to 49%, respectively.[13,42,48,80,87] Prevalence of ADs may also vary according to health characteristics of residents with 1 study finding that individuals with advanced dementia were less likely to have an AD than those with other terminal conditions such as cancer, possibly due to under-recognition of dementia as an end-of-life disease.[88]

For residents, presence of these documents influences the risk of hospitalizations. Individually, presence of an AD, DNR, or DNH order may reduce the probability of transfer to hospital for acute treatment, reduce the risk of a burdensome transition in the last 90 days of life, and reduce the risk of dying in hospital compared with the home facility.[13,42,44,48,51,58] Mitchell et al[89] found residents whose healthcare proxy had an adequate understanding of the clinical course and possible complications of advanced dementia were less likely to undergo burdensome interventions such as ED transfer and hospitalization in the last 3 months of life.[89] However, in this study cohort, only 18% of healthcare proxies reported they had received prognostic information from a physician, and only 33% stated a physician had counseled them about the clinical complications expected in advanced dementia.[89]

At a facility level, higher prevalence of ADs has been associated with reduced rates of hospital admissions.[71,81] It has been proposed that prevalence of ADs could provide an indicator of quality of care for acute illness and at end of life within facilities. Teno et al[87] found over an 8-year period, that an increase in the proportion of completed AD within a facility was associated with decreased rate of terminal hospitalizations of residents. Broadly, factors associated with a higher proportion of residents having a completed AD, and fewer

hospitalizations at the end of life included not-for-profit facilities, urban area location, fewer Medicaid beds and those not part of a corporate chain, employment of a NP or physician assistant, facilities with greater staffing per resident, greater continuity of care by family physician and increased physician visits, and those facilities with dementia special care units.[42,80,87,90]

Many of these studies reported on rates of hospitalization or admission, and it is, therefore, not clear if they also reflect changes in rates of ED visits, where patients may be transferred, assessed, and treated in ED without being admitted to hospital.

Discussion

This review has identified a number of determinants, including patient and facility characteristics that influence risk of unplanned emergency hospital transfer for frail, elderly people living in RACF. Individual patient factors are all readily observable and are frequently recorded in residents' administrative and medical records. They may, therefore, serve to risk stratify residents and enable implementation of focused strategies to reduce risk of acute deterioration such as increased frequency of physician visits.

Rates of transfer vary according to age and gender with those at the very extremes of old age being less likely experience a transfer. This possibly reflects instigation of end-of-life care within the RACF and decisions not to hospitalize those residents surviving to very old ages. A number of studies describe transfer rates being greater in male compared with female residents. The reason for this has not been clearly elucidated but may be due to differences in life expectancy and disease burden between the sexes or may include some gender bias in the care of these residents. A few studies also identified difference in frequency of transfer according to ethnicity. It is postulated this may relate to differences in socioeconomic characteristics of these patients and the facilities in which they reside. However, this variation may also reflect cultural differences between groups, which may influence the level and intensity of care provided to these frail populations, particularly toward the end of life. Additional research is needed to explore how gender, age, and cultural background may influence medical management and decision-making by patients, families, and healthcare professionals for this population of vulnerable adults.

Among the population of elderly patients in supported residential care a high proportion of individuals have advanced functional and cognitive impairments. Degree of functional impairment is an indicator of both increased risk of transfer and of poorer outcomes following an emergency visit to hospital.[7,9,44]

Further, it is known that elderly people living in RACFs frequently present to hospital with infection, in particular respiratory and urinary, and with fall-related injuries.[33,91] Among residents, increased risk of falling was associated with increasing age, poor balance, recent ED visit, increasing functional impairment, dementia and cognitive impairment, insomnia, depression, stroke, arthritis, previous falls and visual impairment.[46,67,68]

With regards to infection, provision of immunizations may influence rate of development of acute infectious illness. Rates of hospitalization for influenza and pneumonia are higher among elderly people living in RACF compared with community dwelling individuals.[92] Carroll et al,[93] found significant deficits in the management of influenza risk in RACF in Virginia, USA. In this cohort of over 500 residents, 50% received an influenza vaccination, 13% were not vaccinated, and documentation about vaccination status was missing in the remaining patient records.[93] In addition, only 4.5% had documented evidence of pneumococcal vaccination. In this study, there was a significantly higher proportion of residents who developed an influenza like illness among those who did not receive the influenza vaccine, compared with those who did, frequently resulting in hospitalization.[93]

Overall, some individual health variables, such as medication use and vaccination, are modifiable and can be regularly evaluated through routine, structured primary healthcare. Presence of co-morbidities and functional disability may be less modifiable. However, their presence may signal the probability of future deterioration or falls, which can be anticipated and planned for to avoid need for acute, disruptive transfer out of the facility. There is considerable potential for improved planning for these more predictable deteriorations with earlier intervention within facilities. This may include triggers to increase frequency of review by a patient's usual treating physician, structured guidelines, protocols, and training programs for facility staff in the management of common acute medical conditions, improved infection prevention strategies including vaccination, infection control practices, and antibiotic stewardship, and earlier engagement of appropriate outpatient and palliative care services, which may mitigate the need for transfer to hospital. This review found that specialist consultation, in particular with geriatricians may reduce the need for frequent transfer to the ED. However, currently, only a small proportion of residents of RACF may receive regular specialist geriatric medical care.[22,84]

In line with this, advance care planning is gaining recognition as an important component of care in people with chronic or life-threatening illness, particularly amongst RACF populations. These documents are particularly important in the ED during an acute deterioration when treatment decisions must frequently be made quickly and often by clinicians who have only limited knowledge of the patient, their treatment preferences, and their current functional and cognitive abilities and quality of life. Frail, elderly people residing in RACF are highly vulnerable to acute deterioration in health and functional ability and, therefore, advance care planning and provision of a written document should be viewed as an essential component of their care. In hospital, presence of an advance care plan has been associated with improved knowledge of a person's end-of-life wishes and greater perceived quality of end-of-life care by family members.[94] Findings from this review suggest that presence of AD may reduce hospital admissions and rate of burdensome hospital transitions at the end of life, however, evidence as to the efficacy of ADs is limited by considerable variability in the prevalence and quality of these documents.

As well as these variations between individual patients groups, rates of residents experiencing unplanned hospital transfer differed between facilities and between geographical areas. This suggests that local training and administrative systems influence clinical care and propensity to transfer residents to hospital for acute care. It has been suggested that hospital transfer rates should be regarded as a key performance indicator and that facility managers and administrators should monitor how their facilities perform.[95] It could be that these rates provide a proxy measure of quality of care within individual organizations, and it would, therefore, be important to identify facilities with consistently high proportions of residents being transferred. In addition, it is evident that facilities with fewer resources and poorer staffing ratios or skill mix have greater need to transfer residents to the ED. As well as the potential for disruptive, adverse outcome for patients, these transfers may have downstream impacts on the broader healthcare system through over-utilization of emergency and acute care services[4,40] and should, therefore, be monitored and addressed at a system as well as individual facility level.

There were some limitations to this review. The broad study types and disparity and inconsistency of study methodologies inhibited quantitative synthesis of results and meta-analysis and made comparison of quality using the NOS difficult. Most lower scoring studies,

falling into the moderate category of quality, provided evidence supportive of findings from higher quality studies, and NOS scores have been reported in Table 1 to allow comparison and review of results. Studies were observational and incorporated participants from a range of differing facility types and healthcare systems, which limit the generalizability of findings and precludes confirmation of cause and effect. However, this systematic synthesis of current peer-reviewed literature provides a comprehensive overview of the key determinants for risk of ED and acute hospital transfer as well as identifying important directions for further investigation.

Conclusions

Unplanned transfer to hospital for elderly residents of aged care facilities is a frequent occurrence, yet considerable gaps remain in the evaluation of this current model of emergency care. Most studies exploring these determinants of acute transfer to hospital are based on participants from USA with a smaller number of reports from Australia and Europe. Both population and health system characteristics can vary markedly between countries, so it is important to undertake further investigation within local settings. There are a number of potentially modifiable patient and facility factors that could be addressed by clinicians and facility administrators, which should reduce the need for burdensome transfer to the ED and improve the quality of acute care for this population. In addition to this, there is the potential to develop models to identify individuals at highest risk of experiencing an unplanned hospital transfer, to improve planning for and management of predictable deteriorations in health without the need for an unplanned emergency transfer. A number of key determinants including facility staffing, role of specialist geriatricians, and advance directives require further examination ideally through interventional trials to evaluate their impact on the prehospital and emergency care of patients.

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2.4.2 Updated Literature Review

The initial search strategy was re-run on 26th September 2019 to identify newly published studies. A further seventeen recently published studies met the inclusion criteria for the original review (Table 2).

Table 2: Characteristics and references for additional included determinants studies.

Study	Country	Setting	Sample Size	Duration	Methods
Bjorck et al, 2018 [65]	Sweden	Single hospital	366	2011-2012	Retrospective review of medical records
Cai et al, 2016 [75]	USA	Nationally representative dataset	394,948	2007-2010	Retrospective review of Medicare and Minimum Data Set administrative databases
Carron et al, 2017 [68]	Switzerland	Single hospital	3590	2001 to 2010	Retrospective review of the hospital administrative dataset
Dyer et al, 2018 [76]	Australia	Multiple RACs	541	2015-2016	Cross-sectional survey and review of health and administrative datasets
Gruneir et al, 2018 [69]	Canada	Single district		2010	Retrospective review of Continuing Care Reporting System (CCRS), the National Ambulatory Care Reporting System (NACRS), the Discharge Abstract Database (DAD), and the Registered Persons Database (RPDB) datasets
Haber et al, 2017 [77]	USA	Nationally representative dataset	1.3 million	2007 to 2009	Retrospective review of health and administrative datasets, Chronic Condition Warehouse, Medicare, Medicaid, Online Survey, Certification, and Reporting data
Macri et al, 2017 [78]	Canada	Single district	32,074	2008 - 2014	Matched retrospective cohort using clinical and administrative databases, the Registered Persons Database, Canadian Institutes of Health Information (CIHI) National Ambulatory Care Reporting

					System, Ontario Mental Health and Complex Care Reporting System
Manckoundia et al, 2016 [71]	France	Single district	1000	2013	Prospective, observational study of consecutive visits to ED by people living in RAC
Manu et al, 2017 [79]	USA	Single district	78	2005 - 2010	Retrospective review of medical records
Miller et al, 2017 [80]	USA	Two districts	508	2005 to 2010	Retrospective review of medical records and health and administrative dataset, Palliative Care Providers, Minimum Data Set, Medicare, Online Survey, Certification, and Reporting data . Comparison of cases with match controls.
Min et al, 2019 [81]	USA	Nationally representative dataset		2016	Cross-sectional review of health and administrative data set, the Nursing Home Compare
Morphet et al, 2015 [72]	Australia	Two hospitals	408	2012	Retrospective review of medical records
Nakashima et al, 2017 [82]	USA	Single district	43,024	2010	Retrospective review of Minimum Data Set 2.0
O'Sullivan et al, 2016 [83]	Ireland	Three RAC	290	2010-2015	Pre and post implementation evaluation of an advance care planning program
Street et al, 2015 [84]	Australia	Three hospitals	300	2011	Retrospective review of medical record
Unroe et al, 2018 [73]	USA	Single district	1174	2014-2016	Prospective, observational data collection from medical records
Wheaton et al, 2015 [85]	USA	Nationally representative dataset	8089	2010	Retrospective review of data from the National Survey of Residential Care Facilities

Most studies were from North America, Canada, Australia and the United Kingdom. All studies were observational, with most using retrospective review of electronic medical records or administrative datasets.

Consistent with the findings from the published review [74], people transferred from RAC to hospital were, on average, aged in their 80s, with 60% to 70% of people transferred being

women [65, 68, 69, 71-73]. The 2015 review found that race may be associated with rate of transfer to ED, and again these findings were supported by a more recent study by Cai et al (2016), in North America who found people who were black less frequently had 'do not hospitalise' (DNH) and 'do not resuscitate' (DNR) orders, and experienced more hospitalisations at the end of life, compared with people who were white [75]. Authors postulated that this may reflect cultural differences in approach to medical intervention as well as certain disparities in education, socioeconomic status and health literacy [75].

Likewise, the 2015 review described people transferred from RAC to ED as experiencing frequent co-morbidity and polypharmacy. These findings were supported by more recent studies that identified cognitive impairment in up to 54% of people, with other frequent co-morbidities including depression, diabetes, chronic pulmonary disease and stroke. [69, 85]. Macri et al (2017) found ED presentations for falls and fall related injury to be more frequent in people prescribed anti-depressant medication [78].

Residential care facility ownership and staffing structures varied between studies. Consistent with previous findings, 'for profit' facilities and those with lower registered nurse (RN) staffing rates were associated with higher hospitalisation rates compared with government owned homes and those with higher RN hours [81]. One observational Australian study compared a 'clustered domestic' model of care characterised by smaller living units, greater resident autonomy in particular with respect to meal preparation and allocation of staff to specific units to standard RAC configuration [76]. The authors found the clustered domestic model to be associated with fewer ED presentations, fewer hospitalisations and higher ratings on a quality of life scale, compared with the standard model [76].

Access to both primary care and specialised medical care were both associated with the rate of unplanned hospital transfer. Harber et al (2017) identified that a change in usual primary care provider on entry into RAC may be associated with increased hospitalisation and ED transfers [77]; whereas improved access to primary care providers, and employment of a physician assistant or nurse practitioner within a care home, may be associated with few unplanned hospital admissions [77]. The role of specialist medical input has also been further

investigated with Miller et al (2017) finding palliative care consultations to be associated with fewer hospitalisations and acute ED transfers at the end of life for this population [80].

The effectiveness of current advanced care planning (ACP) modalities remains mixed. Street et al (2015) found only 26% of older people transferred from RAC to the ED had an ACP available at the time of presentation [84]. The investigators found the overall quality of ACP was poor with some providing conflicting directives [84]. Across a number of settings, ACP was found to be associated with reduced inpatient and intensive care admissions from ED, but no impact was observed on the rate of unplanned transfer to ED from RAC, or the rate of investigations or interventions performed in the ED [79, 82-84].

2.5 Summary

In this chapter, the outcomes of an emergency transfer to hospital were described and quantified, and the person specific and RAC facility characteristics associated with an unplanned ED presentation were identified. Highlighted in these findings was the high rate of adverse outcomes associated with an unplanned hospital transfer for both individuals and the health care system including new infection, delirium, decline in functional ability and elevated mortality. Additionally, it was clear that a number of the possible determinants of an unplanned transfer were modifiable, such as medication prescription patterns, facility models of care and staffing, access to primary care and specialist care teams and advance care planning.

Consistently, over 90% of unplanned transfers occurred via an emergency ambulance, however no investigators included an evaluation of this prehospital care within their studies. As well as care within the RAC home and ED, a considerable amount of assessment, intervention and the decision to proceed with a transfer to hospital occurs in the prehospital setting by paramedics. In this review, despite the inclusion of broad prehospital and paramedicine terms in the search strategy, only minimal evidence examining the prehospital care of this population was identified. This suggests a knowledge gap surrounding the care of people from RAC attended by an emergency ambulance. It was unclear how prehospital care may have contributed to both patient and health system outcomes. This evidence gap

has provided the basis for the three epidemiological studies described in this thesis. These studies are each a retrospective cohort design using population level, clinical and administrative data. The data management methods and analysis of data quality relating the subsequent studies are described in the following chapter.

Chapter Three: Data Sources, Data Quality and Data Management

3.1 Study Setting

The following studies presented in this thesis were conducted using state-wide data from Victoria, Australia. Victoria is the second most populous state of Australia, with over 6 million people spread over a geographical area of 237,629 km^2 [86]. In 2018, over 15% of Victorians were aged 65 years and over, with 2.1% of the population in 85 years and over age group [86]. Within Australia, 65% of people 65 years and over live in major urban regions [87]. The proportion of older people living in RAC increases from 1% of people aged 65 to 74 years, to over 24% of people aged 85 years and over [87]. Overall, there are a total of 62,073 older Victorians living in RAC [5]. In Victoria, in 2018, 53% of RAC places were under private ownership, 9.5% under government ownership and the remainder religious and charitable organisations [5].

3.2 Data Sources and Quality

3.2.1 Ambulance Victoria

Ambulance Victoria (AV) is the sole provider of emergency ambulance services to both metropolitan and rural Victoria [88]. Using the Victoria Ambulance Clinical Information System (VACIS), clinical and administrative parameters are entered by paramedics into an electronic patient record at time of patient contact. These records are then transmitted for storage in a secure data warehouse [88].

3.2.1.1 Data Variables and Recoding

Data were sought from AV for all patients aged 65 years and over who were attended by an emergency ambulance from 1st January 2008 to 31st December 2013, for the fields listed in Box 1.

Box 1: Data variables requested from Ambulance Victoria for all emergency ambulance attendances to people aged 65 years and over in Victoria, Australia from 1st January 2008 to 31st December 2013

Demographic Characteristics

- Age
- Sex
- Home postcode (postcode of the care home for those living in RAC)

Medical Characteristics

- Past medical history
- Current medications

Reason for ambulance call-out and initial patient assessment

- Case nature
- Final paramedic assessment
- Initial heart rate, systolic blood pressure, respiratory rate, blood glucose level
- Initial ECG rhythm and respiratory state
- Initial pain score
- Paramedic intervention and administration of medication
- Patient outcome
- Transport indicator
- Not transported reason
- Not treated reason
- Secondary survey – additional clinical signs recorded by paramedics

Administrative case data

- Case patient ID
- Scene location type
- Scene postcode
- Scene co-ordinates
- MPDS code
- Rural vs metropolitan
- Time and date of call-out
- Time of arrival / patient loaded / at destination / off stretcher
- Highest dispatch code
- Scene and transport times
- Treating crew
- Re-attendance (to designate an individual with multiple ambulance attendances during the study period)

Data were received from AV in the form of eight separate excel spreadsheets which were converted to STATA files for cleaning, coding and analysis. Many variables required extensive recoding. Once recoded, the files were merged using a unique identifier to produce the main file used in data analysis. Data coding, cleaning and primary analyses was conducted by Dr Dwyer with analysis assistance provided by Professor Gabbe and Dr Tran.

Ambulance Victoria provided data comprising a total of 1,210,869 episodes of care. Data were excluded, for transport originating at hospitals (secondary transfers and transfers back to home or RAC) leaving a total of 1,080,703 cases (Figure 5). Episodes of care for people living in RAC were identified using the scene location variable 'nursing home / supported accommodation', identifying 188,849 ambulance call-outs to RAC over the six-year period.

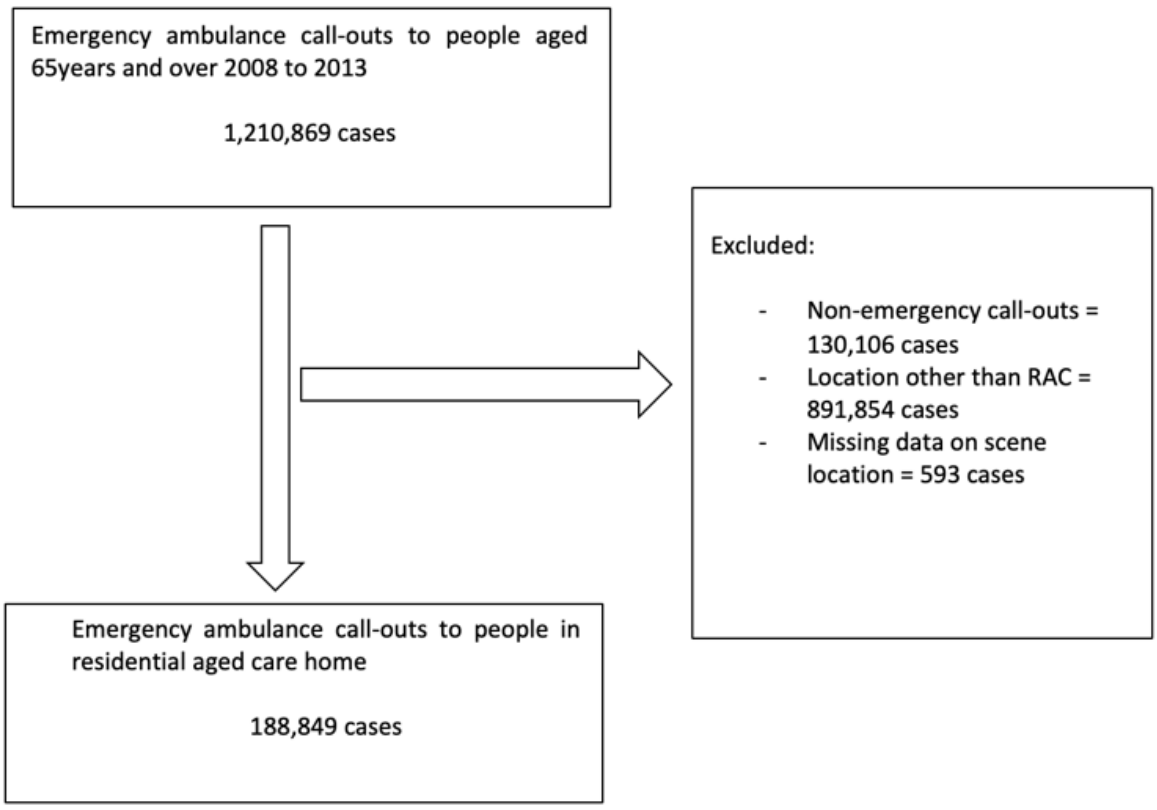

Figure 5: Case extraction and screening from data provided by Ambulance Victoria.

A full data dictionary outlining the recoded variables and values is available in Appendix 4.

i. Age was provided as a numerical value and converted to 5-year intervals for analysis, consistent with reporting by the Australian Bureau of Statistics [89].

ii. Sex was provided as a binary variable.

iii. Past medical history and current medications are recorded by paramedics for each patient at the time of patient interaction. These were provided in the research data as a list of conditions and medications. No additional data about the length, severity or acuity of these medical conditions, or dose of medications, was provided. The list of medications included both trade and generic names, with multiple variations for each agent (over 8,600 categories) requiring extensive recoding to pharmacologic categories.

iv. The past medical conditions also had multiple categories per condition and were provided in two separate files, one outlining drug and alcohol use and cardiovascular risk factors, and the other with a broader list of previous medical and surgical events. Compiled past medical history was used to calculate an age-adjusted Charlson Co-morbidity Index (CCI). This score provides a measure of short-term mortality risk which is a common outcome reported by studies of people transferred to hospital from RAC and has been validated for use in an older population and in older people living in residential aged care[90-92].

v. The case nature variable provides an indication of the cause of the acute complaint requiring emergency ambulance attendance and differentiates medical conditions from external cause of injury or illness such as fall, poisoning, assault or other trauma.

vi. The final paramedic assessment is a diagnosis given by the paramedics at the conclusion of the episode of care. These were re-coded to common diagnostic categories and then grouped for analysis [93].

vii. Initial vital signs including heart rate, systolic blood pressure, respiratory rate, blood glucose level, pain score and total Glasgow Coma Scale (GCS) score were provided as numeric values. The GCS, with a score ranging from 3 (deep coma/death) to 15 (normal) has been used in both medical illness and traumatic injury and gives a measure of a person's conscious state with moderate inter-rater reliability [94]. GCS component scores for motor, verbal, eyes were not provided.

viii. Initial ECG rhythm and respiratory status were provided as categorical variables with 50 and seven different labels respectively.

ix. The patient transport indicator was provided as a binary variable transported compared with not transported

x. For those 'not transported' with the categorical variable 'not transported reason' was completed.

xi. The paramedic intervention, and paramedic administered medication(s), were provided as two separate files. Both had multiple repeated categories per intervention or agent which were recoded to single categories per intervention or medication.

xii. Repeat presentations to individual patients were identified. A multilevel analysis method was used to control for the correlation between call-outs to the same person.

For the administrative variables:

- 'Case patient ID' provided a unique identifier for each episode of care with repeated episodes for the same individual designated by the 'repeat attendance variable'.
- Scene location indicated the type of location the ambulance was called to and was used to designate people in RAC from those in the community. Pick-ups from hospitals, secondary transfers and transfers back home were excluded from analysis.
- The dispatch code indicates the urgency of ambulance response and ranges from code 1 (life threatening, time critical), with an ambulance attendance time target of 15 minutes, to code 3 (non-urgent) [88].
- The treating crew variable indicates the crew base and differentiates general paramedics from those with extended-skills (Mobile Intensive Care Paramedics, MICA).

3.2.1.2 Data Quality and Limitations

i. Data quality was mixed. Reasons included missing values, limited values fields for a specific variable, and likely subjective recording of parameters. Missing data for each variable is provided in Appendix 4.

ii. Clinical data is entered by paramedics at the time of patient care, which may impact accuracy and completeness of these records. Clinicians completing electronic records at the time of patient care may be subject to factors such as time pressures and fatigue which may lead to errors in data entry. Additionally, some parameters such as 'time on scene' are key performance indicators and so these may be completed with an intention to reflect good performance instead of a truly accurate record of events.

iii. Many variables, including past medical history, medications, case nature, final paramedic assessment, respiratory status, ECG rhythm are entered using drop down list of a finite number of pre-defined terms. This may lead a clinician to select a term approximating a condition but may not truly reflect an individual patient's status. This may also result in certain conditions or medications to be omitted from the record if they are not detected at the time of patient encounter or not deemed relevant to this episode of care. Several of these variables also included an 'other' category which was uncharacterised.

iv. Variables such as vital signs and pain score are manually entered by clinicians (and not automatically uploaded from equipment monitors) and therefore rely on accurate transcription, observation and assessment into the electronic record at time of care and are unable to be verified retrospectively. Recording of these data may be subjective and impacted by individual clinician bias, for example pain scores may only be reported for patients given pain relief, or a procedure (such as intravenous cannulation) may only be recorded as conducted if successful.

Electronic records were introduced in 2007 to 2008, therefore during these years it is possible there were some residual handwritten records for attendances. These would not have been transcribed to the electronic records and therefore would not be captured within this data set.

3.2.2 Australian Bureau of Statistics

Population data and the Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) scores were extracted from the Australian Bureau of Statistics (ABS) website. The ABS is the independent, national statistical agency operating under the direction of the Australian Statistician [95]. Population estimates by region, age and quarter were obtained from the ABS Australian Demographic Statistics release. These estimates are based on the 2016 Census of Population and Housing [96].

The IRSAD provides an estimate of the relative socio-economic conditions of an area [97]. It is based on a number of aggregate measures across a defined area including household income, unemployment, occupation, education, long term disability and chronic disease and is provided per Postal Area [97]. The postcode was used to link IRSAD to the home location of a RAC home

3.2.3 Australian Institute of Health and Welfare

The Australian Institute of Health and Welfare (AIHW) is an Australian Government agency set up to provide reports and data examining health and welfare services and programs [98]. Data was sought from AIHW detailing the number of people living in residential aged care homes in Victoria by age, sex and remoteness, from 30th June 2007 to 31st December 2013 [99].

3.3 Data Management

Data were stored in de-identified form on the university managed secure network drive, accessible to co-researchers and supervisors through a university log-in. In line with university ethics requirements, data will be stored for a period of five years following completion of this research program.

3.4 Data Analysis

Data analyses were conducted using STATA Version-15 [100]. The detailed statistical analyses used for each study are described in each published manuscript. These analyses incorporated descriptive statistics, comparison of sub-groups and regression analysis.

3.5 Ethics Approval

Ethics and governance approvals were sought and gained from the Monash University Human Research Ethics Committee (CF14/2705-2014001396) and the Ambulance Victoria Research Governance Committee (R14-012), respectively (Appendix 5 and Appendix 6). Given the use of large volume, de-identified data extracted from routine electronic medical records, individual patient consent was not required by the ethics committee. As per the Ambulance Victoria Privacy Policy all data were sought and maintained in de-identified form [101].

3.6 Summary

This chapter provides a summary of research methods used, data sources and study setting. This includes a discussion of data quality, strengths and limitations. The methods, statistical techniques and data used for each individual study will be presented in further detail in the study specific chapters.

Chapter Four: Quantifying Ambulance Call-Outs to Older People Living in Residential Aged Care Homes

4.1 Introduction

In Chapter Two, the determinants and outcomes of an emergency transfer to hospital for older people living in RAC were examined. One key finding was the high rate of emergency ambulance use. However, current evidence arises largely from studies based in hospital using medical records or hospital administrative data. Previous studies have not included people who experience a call-out but are not transported to hospital, thus the absolute numbers of call-outs to older people living in RAC remains unclear. It is also likely that rates of ambulance call-out will differ across different countries with varying health systems. The study presented in this chapter addresses the third objective of this thesis which was to quantify the rate of emergency ambulance call-out to people living in RAC within a local Australian context.

4.2 Manuscript Three

This study is presented in the form of a manuscript *Patterns of emergency ambulance use, 2009–13: a comparison of older people living in Residential Aged Care Facilities and the Community*. Dwyer R, Gabbe B, Tran T, Smith K, Lowthian J. Age and Ageing 2018. 47 615-619[(102)].

Supplementary tables and figures for this paper are presented in Appendix 7.

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Patterns of emergency ambulance use, 2009–13: a comparison of older people living in Residential Aged Care Facilities and the Community

R. Dwyer[1], B. Gabbe[1], T. D. Tran[1], K. Smith[1,2], J. A. Lowthian[1,3]

[1]Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, Monash University, 553 St Kilda Road, Melbourne, Victoria 3004, Australia
[2]Ambulance Victoria, 375 Manningham Road, Doncaster, Melbourne, Victoria, 3108, Australia
[3]Bolton Clarke Research Institute, Level 1, 347 Burwood Highway Forest Hill, Melbourne, Victoria 3131, Australia

Address correspondence to: R. Dwyer, Pre-hospital, Emergency and Trauma research group, Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, Monash University, 553 St Kilda Road, Melbourne, Victoria 3004, Australia. Tel: +61 3 9903 9006. Email: rosamond.dwyer@monash.edu

Abstract

Objective: to examine demand for emergency ambulances by older people.
Design: retrospective cohort study using secondary analysis of routinely collected clinical and administrative data from Ambulance Victoria, and population data from the Australian Bureau of Statistics and the Australian Institute of Health and Welfare.
Setting: Victoria, Australia.
Participants: people aged 65 years and over, living in Residential Aged Care Facilities (RACF) and the community, attended by emergency ambulance paramedics, 2009–13.
Main outcome measures: rates of emergency ambulance attendance.
Results: older people living in RACF experienced high rates of emergency ambulance attendance, up to four times those for age- and sex-matched people living in the community. Rates remained constant during the study period equating to a consistent, 1.45% average annual increase in absolute demand. Rates peak among the 80–84-year group where the number of attendances equates to greater than one for every RACF-dwelling person each year. Increased demand was associated with winter months, increasing age and being male.
Conclusion: these data provide strong evidence of high rates of emergency ambulance use by people aged 65 years and over living in RACF. These results demonstrate a clear relationship between increased rate of ambulance use among this vulnerable group of older Australians and residence, sex, age and season. Overall, absolute demand continues to increase each year adding to strain on health resources. Additional research is needed to elucidate individual characteristics, illness and health system contributors to ambulance use to inform strategies to appropriately reduce demand.

Keywords: *residential aged care, ambulance, older people, emergency care, pre-hospital*

Introduction

Globally, older people are found to frequently engage with emergency medical services (EMS) with high rates of emergency department (ED) presentations and unplanned hospital admissions [1–4]. EMS use by residential aged-care facility (RACF)-dwelling people may differ considerably from those living in the community [5–7]. Additionally, due to the often-complex chronic health and social needs of this population, these patients are frequently referred to emergency-care for non-urgent complaints, a potentially inappropriate use [1, 8]. Ambulance services provide a vital, emergency, point-of-care health service, but are experiencing increasing demand, leading to potential problems with timely service delivery and adequate resource allocation across health systems [2, 9].

To date, the majority of urgent-care research has focused on management of these patients within the ED, however a considerable amount of emergency assessment and intervention occurs within the pre-hospital setting, largely by ambulance services. Almost all published data regarding acute-care for RACF-patients is from hospital records and databases. This, in-hospital documentation may be an incomplete indicator of pre-hospital emergency-care, not capturing important clinical interactions including patients treated without transport to hospital.

It is important to examine rates of ambulance usage by this population, to optimise service provision, to ensure appropriate use of finite health resources and to plan for future demand. In addition, understanding patterns of ambulance use allows for structured identification of potential avenues for alternate acute-care pathways. The aim of this study was to investigate rates of emergency ambulance attendance to older RACF-dwelling patients, to examine trends in demand over a 5-year period, and to compare rates with those for the community-dwelling population.

Methods

Study design

A retrospective cohort study was conducted, using analysis of routinely collected clinical and administrative data from Ambulance Victoria (AV), and population data from the Australian Bureau of Statistics (ABS) and the Australian Institute of Health and Welfare (AIHW). This study was approved by the Monash University Human Research Ethics Committee (CF14/2705-2014001396); and by the AV Research Governance Committee (R14-012).

Data sources

De-identified data were provided by AV for emergency-ambulance attendance for all patients aged 65 years and over, in Victoria, Australia from 1 January 2008 to 31 December 2013. Data fields encompassed patient's demographic characteristics including case-number, date, age, sex and scene-location [10].

Quarterly population age and sex estimates derived from the 2016 Census of Population and Housing, birth/death registration, and migration data were sourced from the ABS [11]. Data for population in RACF(2008–13) were sought from the AIHW National Aged Data Clearing House [12].

Data analysis

Ambulance attendance for RACF-residents were identified if the scene-locations were recorded as 'Nursing-home/Supported-Accommodation' and for community-dwelling people if the scene-locations were recorded as 'private residence', 'public place', 'recreation/sporting complex', 'vehicle' and 'workplace'.

Analyses were conducted using STATA-14 (StataCorp, College Station, TX, USA). The primary outcome, rate of ambulance attendance was calculated by the number of events divided by the population of that group in the specific time period. Rates were converted to attendances per 1,000-people. Rates were calculated for RACF- and community-dwelling groups by year, age-group, sex and quarter. Multiple crews attending the same case were considered a single attendance.

Results

Data included 1,018,810 emergency-ambulance attendances over the 6-year period. Rate estimates could not be calculated for 2008 as data were incomplete for the first half of that year and therefore excluded from analysis.

The average ambulance attendance rate for older RACF-dwelling people was greater than 770 per 1,000-people per year (Table 1). This was up to four-times higher than that of community-dwelling people, with the difference growing to 8-fold among the youngest age-group (65–69 years). The annual rate for this population was consistent over the 5-years, from 2009–13 indicating a yearly increase in absolute number of attendances (Table 1).

Among RACF-residents there was a persistently higher rate of ambulance attendances for men than women with a rate ratio of 1.39. This is in comparison to the community-dwelling population where the rate of attendances was similar between sexes (rate ratio 1.03; Supplementary Table S2, available in *Age and Ageing online*).

Demand peaked at over 1,000 attendances per 1,000-people among RACF-residents aged 80–84 years (Supplementary Table S3, available in *Age and Ageing online*), equating to at least one attendance per RACF-dwelling person of that age per-

Table 1. Rates per 1,000 population of emergency ambulance attendance for RACF- and community-dwelling population aged 64 years and over in Victoria, from 2009 to 2013

Year	RACF-dwelling population		Community-dwelling population	
	Number of ambulance call-outs	Rate per 1,000 population (95% confidence intervals (CI))	Number of ambulance call-outs	Rate per 1,000 population (95% CI)
2009	31,292	789 (785, 793)	138,527	200 (199, 201)
2010	31,530	777 (773, 781)	147,557	207 (206, 208)
2011	32,045	779 (775, 783)	155,758	212 (211, 212)
2012	33,062	795 (791, 799)	164,673	215 (214, 215)
2013	33,139	788 (784, 792)	167,675	211 (210, 212)

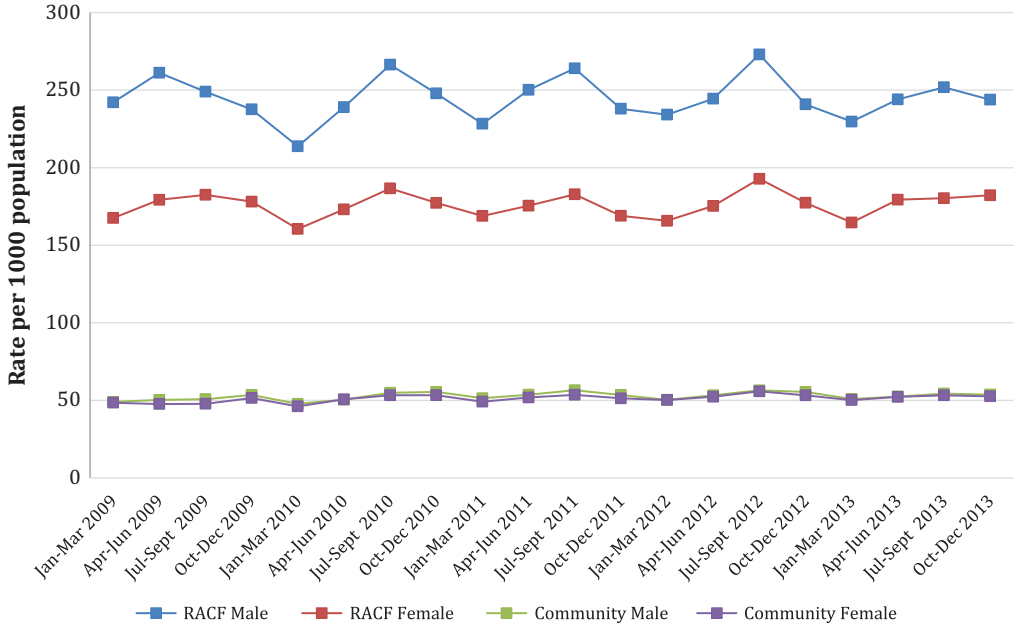

Figure 1. Rates per 1,000 population of ambulance attendance for 65+ year-old RACF-and community-dwelling population in Victoria *by quarter and sex* from 20.

year. With increasing age, RACF-residents experienced increased attendance rates up to 80–84 years (Supplementary Table S3, available in *Age and Ageing online*), rates then declined slightly. In comparison, the community-dwelling group experienced a consistent increase in demand with age, across all age-groups (Supplementary Figure S2, available in *Age and Ageing online*).

There was demonstrable variability in ambulance usage according to season with the highest rates during winter, July–September; and lower rates during summer, January–March (Figure 1). This variability in demand was far more pronounced among the RACF-population than the community-dwelling groups who experienced only slight rate fluctuations across the year (Figure 1).

Discussion

To our knowledge, this is the first study to describe rates of emergency-ambulance use by a highly vulnerable patient group, older people living in RACFs. It reveals whole-of-system demand, over a 5-year period for ambulance services by this sub-population and trends in rates over time. Ambulance attendance to RACF-dwelling people is up to four-times that of age- and sex-matched community-dwelling people and novel patterns in demand are described, in particular greater use by men, and during winter, with notable variation in attendance rates with age.

We acknowledge some limitations. This retrospective analysis of routinely collected data relies on accurate documentation by paramedics and administrators at the time of patient interaction. In this study, demand from older RACF-dwelling people was very high, but consistent with internationally reported rates of ED-presentation and unplanned hospital admissions [5, 13]. Therefore, it is likely that these findings reflect global trends.

Compared with community-dwelling people, those in RACFs experienced up to four-times greater ambulance usage. There are probable patient and health-system contributors to this disparity. Older RACF-dwelling people are likely to have poorer health, higher burden of chronic illness, frailty and cognitive impairment; all of which increase susceptibility to acute illness, falls and injury [4, 14]. Additionally, these conditions add complexity to clinical assessment, perhaps leading to a lower threshold to call an ambulance. This may be exacerbated by RACF-staffing patterns where personal-care attendants predominate alongside limited numbers of registered nurses and sessional doctors' visits [4, 15]. Physical and cognitive disabilities may also increase the logistical complexity of medical investigations such as x-rays. Some mobile services attend RACFs, but elsewhere these involve transport to a secondary site, necessitating additional equipment, vehicles and staff-escorts. This may lead RACF-staff to call an ambulance to facilitate assessment. Access to community services may also be limited to certain times and days. Ambulance use by RACF residents is relatively consistent across all days of the week with evening peaks in demand [16]. This may fall outside standard hours for General Practitioners and out-reach services, leading to alternate use of ambulances.

Our results demonstrate a seasonal effect with peak rates in winter and lowest demand in summer. This fluctuation was more pronounced for RACF-dwelling compared

community-dwelling people. Older RACF populations may be more vulnerable to infectious disease, have higher rates of resistant organisms, and variable prevalence of immunisations [7, 17, 18]. Seasonal variation may therefore reflect heightened susceptibility to illnesses such as influenza, or less health reserve leading to greater disease severity, necessitating emergency care. Additionally, with close-living quarters or limited staffing resources calling an ambulance may provide an easier alternative to ongoing care within the RACF.

Our study demonstrates a clear difference in ambulance attendance rates between older women and men living in RACF, but not the community. Similar differences have been suggested previously [2, 4, 19] though the cause remains unclear. It is possible that ambulances are being either under-utilised by one sex or over-utilised by the other. With higher rates of cognitive impairment, impaired mobility and institutionalised behaviour, older RACF-dwelling people are more dependent on staff to recognise an acute health deterioration and call an ambulance. The disparity suggests gender bias in the perception of, and response to, acute injury or illness in older RACF-patients by care- and/or health-workers. Factors contributing to this may include differences in clinical signs, behaviour patterns and coping strategies between women and men, which may influence interactions between patients and healthcare professionals. Previous studies have reported significant sex-differences in experience of illness, symptom-reporting and healthcare seeking behaviour [20, 21]. Whilst important, these factors are insufficient to adequately explain this difference in demand. The possibility that the threshold to seek emergency-care for men is lower than it is for women cannot be discounted.

Conclusion

This study provides robust evidence of very high rates of emergency-ambulance use by older RACF-dwelling people. Rates remained constant over the study period associated with a yearly increase in absolute ambulance use, a trend that is expected to persist. On a macro-level, these results provide clear evidence of associations between ambulance attendance and place of residence, sex, age and season, essential for effective health-service planning. Older RACF-dwelling people are a unique and growing patient group within the emergency healthcare system. Further research is needed to better describe clinical patterns of acute-illness and need for medical intervention to elucidate optimal modes of emergency-care for these vulnerable patients. This will also be beneficial in addressing gaps in training of RACF-staff to respond to acute health concerns, and in development of institutional guidelines for both RACFs and EMS. Additional studies are needed to evaluate individual healthcare interventions, including advanced care directives, on emergency ambulance demand.

Key points

- Older RACF dwelling people are highly vulnerable patients.
- Their emergency care may be complex and have unintended negative consequences for individual patients and health system.
- RACF dwelling older patients have a very high rate of ambulance use.
- Rate of ambulance use is greater than that of community-dwelling people and varies according to age, sex and time of year.

Supplementary data

Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

Conflict of interest

K. Smith is Director of the Centre for Research and Evaluation at Ambulance Victoria.

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4.3 Summary

The study findings showed high rates of emergency ambulance call-out to older people living in RAC. The call-out rates were up to four-times higher than observed for people of comparable age and gender living in the community. In addition, important associations with rates of call-out including age, gender and time of year were identified in this study. The number of call-outs continued to increase each year, thus people living in RAC were frequently interacting with these emergency medical services. The following chapter will describe the reasons for these call-outs, their acuity and outcomes in terms of prehospital interventions for this population.

Chapter Five: Clinical Case-Mix and Medical Intervention for Older People Living in Residential Aged Care Attended by an Emergency Ambulance

5.1 Introduction

As described in the previous chapter, the rate of emergency ambulance call-out to people living in RAC across the state of Victoria, Australia, is high. Therefore, a large proportion of this population will undergo clinical assessment and receive medical intervention by paramedics in the prehospital environment. The aim of this study, in line with objectives 4 and 5 of this thesis, was to quantify and describe this prehospital care and explore the clinical case-mix and acuity of people attended by an emergency ambulance. In Chapter Two and Chapter Four, the results presented identified that gender was associated with rate of ED attendance and ambulance call out [74, 102-109]. Thus, this study also aimed to explore gender differences in the reason for ambulance call out and frequency of prehospital intervention.

5.2 Manuscript Four

This study is presented in the form of a manuscript *Residential Aged Care Homes – Why they call '000'. A study of the emergency prehospital care of older people living in residential aged care homes*. Dwyer R, Gabbe BJ, Tran T, Smith, K, Lowthian JA. Emergency Medicine Australasia (under review).

Residential Aged Care Homes – Why they call '000'. A study of the emergency prehospital care of older people living in residential aged care homes

Authors and Affiliations:

Rosamond A Dwyer[1,2] MBBS BMedSci FACEM
Belinda J Gabbe[1] BPhysio MAppSci PhD
Thach Tran[1] BA(Hons) MSc PhD
Karen Smith[1,3] BSci (Hons) PhD
Judy A Lowthian[1,4] BAppSci MPH PhD

[1] Monash University, School of Public Health and Preventive Medicine, 553 St Kilda Road, Melbourne, 3004, Victoria, Australia

[2] Peninsula Health, 2 Hastings Road, Frankston 3199, Victoria, Australia

[3] Ambulance Victoria, 31 Joseph Street, Blackburn North, 3130, Victoria, Australia

[4] Bolton Clarke Research Institute, Suite 1.01, 973 Nepean Highway Bentleigh, 3204, Victoria, Australia

Corresponding Author:

Dr Rosamond Dwyer
Monash University, School of Public Health and Preventive Medicine, 553 St Kilda Road, Melbourne, 3004, Victoria, Australia

Email: rosamond.dwyer@monash.edu
Mob: +61 409 991 778

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Health Systems

ABSTRACT

Objective

To describe the clinical characteristics, medical interventions, and patterns of ambulance service use related to the emergency, prehospital care of older people living in Residential Aged Care Homes(RAC).

Design

Retrospective cohort study using secondary analyses of routinely collected clinical and administrative data from Ambulance Victoria(AV), and population data from the Australian Bureau of Statistics(ABS).

Setting

Victoria, Australia

Participants

People aged 65-years and over, attended by emergency ambulances from 2008-2013, with data captured in the AV electronic record.

Results

The mean (SD) age of RAC residents attended by emergency ambulance was 85(7.3) years and 63% were women. Common comorbidities included dementia(32.7%), ischaemic heart disease(27.7%) and osteoarthritis(24.6%). Polypharmacy was prevalent with 70% currently

prescribed antibiotics, over 20% prescribed sedatives and a further 14.9% antipsychotics. Fifteen percent of attendances were for falls, which were more frequent among women than men. Other common reasons for ambulance call-out included uncontrolled pain, respiratory tract infection, non-specific febrile illness and altered conscious state. Almost 90% of people were transported to hospital from the RAC, with just over half of call-outs occurring out-of-hours.

Conclusion

This is the first study to describe emergency pre-hospital care, case-mix and intervention of frail, older people living in RAC. These results demonstrate a clinically complex group of people with high rates of comorbidity, cognitive impairment and polypharmacy. These valuable data will inform education and training of prehospital clinicians, assist in targeting preventative medicine and primary care programs and further development of alternate, acute and emergency care pathways for this unique patient group.

Introduction

Older people comprise a significant proportion of people requiring emergency medical care[1]. Within high-income countries, it has been demonstrated that older adults, often defined as people aged 65-years and over, contribute to an escalating demand in acute medical services and in particular emergency ambulance call-outs[2].

A subgroup of older adults live in Residential Aged-Care Homes(RAC). Within emergency departments (EDs) and hospitals, people living in RAC have been identified as unique in terms of clinical presentation, case-mix, admission rates, intervention, and goals-of-care[3]. They frequently have multiple medical co-morbidities, are frail, and have cognitive impairment and other disabilities[3, 4].

In addition to direct presentations to hospital EDs, RAC residents frequently experience emergency prehospital care and transport to hospital via the ambulance service, accounting for one fifth of all emergency ambulance call-outs to older people[3, 5]. In Victoria, Australia, people living in RAC experience over 770-emergency ambulance call-outs per 1000-population per year, up to four-times greater than older people living in the community[6]. Up to 95% of RAC residents seen in EDs are transported to hospital by emergency ambulances[3-5].

Prehospital care is a vital part of the acute care pathway. It allows clinicians to assess and treat people at the scene, often earlier in their course of injury or illness. Currently, in most well-established emergency health systems, there are differences in the scope of practice and

human and technical resources available in emergency ambulance services and hospital EDs. There may also be differences in patterns of injury and illness and clinical acuity between people seen by emergency ambulance clinicians and those seen in hospital, but these are under-documented[3]. Little is known about the characteristics and health of RAC residents assessed and treated by prehospital clinicians but discharged on scene or referred to other care providers and not transported to hospital.

Despite consistently high rates of emergency medical care, there is a paucity of evidence internationally regarding the prehospital medical care, case-mix and resource requirements for this unique group of older people[3, 7]. Understanding of these clinical and administrative patterns is essential to inform improvements in the delivery of emergency medical care to frail and vulnerable older people, including alternate acute care pathways and targets for preventative healthcare.

The aims of this study are to describe the clinical characteristics and medical interventions related to the emergency, prehospital care of older people living in RAC. As rates of emergency ambulance call-out and frequency and clinical presentation of some acute illness and injuries have been found to vary between men and women there was a specific objective to establish whether there were gender differences in rate of transport to hospital and case-mix[2, 6-9].

Methods

Design and Setting

We conducted retrospective analysis of prospectively collected routine clinical and administrative data from Ambulance Victoria (AV) and the Australian Bureau of Statistics (ABS). AV is the primary provider of emergency ambulance services across rural, regional and metropolitan Victoria, Australia.

Victoria, Australia has a population of approximately six-million people, of which 839,000 are aged 65-years and over[10]. During the study period there were up to 43,601 people living in RAC in Victoria per year, accounting for approximately 5% of the total population aged 65-years and over[6, 11].

Study sample size was expanded to include all ambulance call-outs to people aged 65-years and older living in RAC in Victoria, Australia during the period 1st January 2008 to 31st December 2013. This was to ensure inclusion of people from diverse geographical areas of the state and a timeframe broad enough to avoid skewing by epidemic illness such as flu and to ensure temporal consistency.

Data sources

De-identified data were provided by AV and included the parameters listed in Box-1. Case nature details the cause for the call-out such as mechanism of trauma whereas the final

paramedic assessment is documented at the end of the episode of care and details the primary acute complaint. These diagnoses made by prehospital clinicians are often preliminary and made without the benefit of additional investigations. Data were derived from routine clinical electronic records and are reliant on manual entry by clinicians. Many fields include the use of drop-down boxes of predefined values and include an 'other' category.

Compiled past medical history was used to calculate an age-adjusted Charlson Co-morbidity Score which provides a measure of mortality risk and has been found to be a valid measure of short term mortality in older people acutely admitted to hospital[12, 13].

Data linking the Index of Relative Socio-economic Advantage and Disadvantage(IRSAD) with RAC postcode was obtained from the ABS[14] IRSAD provides a summary measure of both social and economic advantage and disadvantage, from variables including mean income, education and employment within a defined geographic area[15]. Higher scores indicate greater features of advantage and fewer of disadvantage and vice versa[15].

Data management and analysis

Data analyses were conducted using STATA Version-14. Descriptive analyses included mean and standard deviation(SD), frequencies and percentages. Gender groups were compared using independent t-tests and chi-square statistics.

Ethics

The study was approved by the Monash University Human Research Ethics Committee (CF14/2705-2014001396) and AV Research Governance Committee (R14-012)

Results

Over the 5-year study period, there were 188,849 emergency ambulance call-outs to people aged 65-years and over living in RAC in Victoria, Australia.

Data Quality

Data quality was limited by the use of 'other' categories; in particular during the recording of diagnosis and intervention. Numbers of missing values were small for most variables with the exception of initial vital signs, respiratory status, and ECG rhythm, where large numbers of missing values existed (Tables 1-5).

Demographics and Medical Characteristics

The mean (SD) age of patients was 85 (7.3)-years with 7% of people aged 95-years and above. A greater proportion of the cohort were women (63%), and three quarters lived in metropolitan regions. Almost 60% of call-outs were to people residing in geographic areas with higher IRSAD scores(Table 1).

This group had high rate of medical co-morbidity with an average of 5.4 medical diagnoses per patient(Table 2). Over a third of the population had a documented history of dementia with other frequently reported co-morbidities including ischaemic heart disease, osteoarthritis, diabetes and depression. When translated to an age-adjusted Charlson Comorbidity Index score, over 70% of residents scored 5 and above indicating a comorbidity profile with a high risk of mortality(Table 2).

Polypharmacy was common with residents reported to have an average of 7.9 different prescribed medications(Table 2). Over 70% of people were currently receiving antibiotics. In addition, prescription of potentially psychoactive and hypnotic agents was common with 25% of residents prescribed opioids, 24% prescribed sedatives (predominantly benzodiazepines), 20% receiving antidepressants and over 14% prescribed antipsychotics(Table 2). Women were more frequently prescribed opioids, sedatives and antidepressants, with antipsychotic agents more frequently prescribed in men.

Clinical Case Mix and Acuity

Fifteen percent of call-outs were for falls with most remaining ambulance attendances for acute medical complaints(Table 3). The final paramedic assessment was most frequently categorised as uncontrolled pain, superficial injury, suspected respiratory infection, shortness of breath, altered conscious state or febrile illness/presumed infection. Women were more commonly found to have pain, injury or fracture with dyspnoea and suspected respiratory tract infection more common in men(Table 3).

Most recorded vital signs were within normal limits with the exception of the Glasgow Coma Scale(GCS) score where 47% of people had a GCS score consistent with an altered conscious state. Initial pain scores were missing for 12% of cases(Table 4). The initial pain score was none to mild (0-3/10) in over 80% of people with 7.2% recorded as having moderate pain (3.1-6.9/10) and 7% as having severe pain (7-10/10). Initial readings of oxygen saturation, blood glucose, respiratory status and ECG findings were missing for over 40% of cases(Table 4).

Interventions and Medications Administered by Paramedics

Overall, excluding the provision of advice or reassurance, half received a medical intervention. One third of residents received supplemental oxygen, 23% received an intravenous cannula and 22% had cardiac monitoring(Table 5). Less than 1% of people were reported as receiving a resuscitative procedure such as airway management or cardiopulmonary resuscitation. Provision of prehospital medication or fluid was uncommon; intravenous fluids were administered in 8% of residents, intravenous opioids, morphine or fentanyl in 8% and 4% of people, respectively, and antiemetics in 4%(Table 5).

Emergency Ambulance Service Usage

Ninety percent of residents were transported to hospital. Of those not transported, most were deemed not to require acute medical care(52%) and 14% were referred to community care providers(Table 1).

A third of call-outs were attended with the highest dispatch code, requiring the most rapid response. This was more common for acute medical conditions than for falls. Less than 4% of call-outs were attended by paramedics with extended skills(Table 1).

Ambulance call-outs were evenly distributed by day of the week, including weekends. Frequency of call-outs increased during the day with a peak from 9am to 11am, and extending to 9pm. Fifty-eight percent of call-outs occurred outside of normal business hours (0800 to 1800, Monday to Friday)(Table 1, Supplementary Figure 1).

Discussion

This study is the first to provide a descriptive overview of the emergency prehospital medical case-mix and intervention of older people living in RACs across both a metropolitan and rural setting. Key findings include a high rate of polypharmacy and antibiotic prescription and frequent transport to hospital but a low rate of prehospital intervention.

Consistent with studies from in-hospital settings, this group were clinically complex at baseline with frequent co-morbidity and medication prescription[3, 7, 16]. Over a third had a documented history of cognitive impairment, with other common co-morbidities including ischaemic heart disease, stroke and chronic lung disease. It may be surmised that this incidence of comorbidity will contribute to increased frequency of acute illness and greater complexity of clinical assessment and treatment. There were gender differences in frequency of past medical illness in particular musculoskeletal complaints and heart disease and in final

paramedic diagnosis with pain, falls and fractures more frequent in women and respiratory complaints more common in men.

People living in RAC have been identified as being at risk of potentially inappropriate prescribing[7, 17]. One of the key findings from this study was the high rate of polypharmacy; notably the use of sedatives, anti-psychotic and anti-depressant agents, which are frequently used for the control of behavioural symptoms or as a form of chemical restraint. Among other consequences, frequent prescription of these agents may contribute to acute delirium, adverse drug reactions and increased risk of falls, which frequently lead to ambulance call-out[18] .

Additionally, the prevalence of antibiotic prescription was very high. A proportion of these may be due to acute infectious illness which precipitated the ambulance call-out, however previous reports have concluded significant the rates of inappropriate antibiotic prescribing in RAC[19]. These prescriptions may be due to complexity of clinical assessment and atypical clinical signs (such as delirium) leading to presumption of infection without adequate diagnosis, enhanced difficulty in obtaining investigations such as chest x-rays and pressures from family members or other clinical staff to provide medical treatment for an otherwise undefined change in physical or behavioural state. For individuals, overuse of these medications may increase the risk of medication-related adverse event and heighten individual risk of resistant infection, which often adds complexity to the provision of medical and nursing care as well as exacerbating severity and prolonging duration of illness[20]. More broadly, for the health system, frequent use of these agents may contribute to the growing

concerns of antimicrobial resistance and the resultant public health and economic consequences which include increased use of acute medical resources[20, 21)].

Among this patient group, the most common reasons for ambulance attendance included a fall with or without related injury, shortness of breath and respiratory tract infection, other suspected infection/febrile illness, pain and altered conscious state. These findings complement those from studies conducted in hospital settings and reinforce the observation of this patient group as unique[3, 4]. RAC residents are distinct from older people living in the community who present more commonly with cardiovascular complaints and less commonly for falls and associated injury[3, 4]. Ambulance attendance for falls may be necessary if the fall results in significant injury or occurs as a result of physical decline from a co-existent acute illness. Some falls may also be preventable with programs such as minimisation of prescription of sedative medications, exercise programs and attention to environmental settings and features[22]. However, the decision to call an ambulance may also be influenced by non-patient factors such as the ability of RAC staff to assess and treat injury, by accessibility of primary care teams to review patients and by financial or medicolegal concerns of staff or facility leadership groups, where the responsibility for patient care is rapidly and potentially inappropriately shifted to the readily accessible emergency care providers[23].

The high number of residents reported to have impaired conscious state on initial assessment by ambulance clinicians warrants discussion, as this feature adds complexity to clinical assessment, diagnosis and management, as noted in ED studies[3, 4, 24]. An altered conscious state, as measured here by the GCS, may relate to the acute event such as head injury or delirium complicating an acute illness, or may reflect a baseline reduction in cognitive ability

such as dementia. In the current system of acute care, it may be difficult for clinicians to differentiate acute from chronic reduction in cognition which may add complexity to identification of other symptoms and signs of injury and illness and impact decision-making surrounding additional interventions and investigations. Previous studies have suggested that a great proportion of elderly people presenting to emergency medical services will have an atypical presentation of disease[25, 26] . It has been estimated that over 50% of people aged 80 and above presenting to the ED may have an uncharacteristic clinical presentation and up to 15% may not describe any symptoms of the underlying acute disease[26].

Additionally, it is likely these factors confound the assessment and management of pain[27]. Pain is common among people living in RAC and there is concern that this symptom is both under recognised and under treated[28]. In emergency care, in both a prehospital and hospital setting, pain is frequently measured with a simple numeric scale. However, in these circumstances there are both patient factors such as delirium or chronic cognitive deficits and environmental factors such as background noise and clinician workload that may negatively influence the accuracy of these measures[29, 30]. Results of this study show over 80% of residents were assessed as having mild or no pain (<3/10), yet it is possible this underrepresents the true incidence of acute pain and discomfort in this population. In this population and in particular for those patients with cognitive impairment these protocols should be expanded to mandate additional training in and use of multidimentional pain assessment methods which may include observational tools, additional self-report tools and care-giver reporting[30].

In contrast to in-hospital settings, we observed a low rate of prehospital medical intervention with only 25% of people receiving fluid or medication and only 50% receiving an intervention other than reassurance or advice. This differs from studies conducted in inpatient and ED cohorts which frequently describe high rate of intervention, investigation and medication administration[3, 5]. The observed low rate of intervention associated with high patient complexity and frequent need for transport to hospital appears paradoxical. From the data provided it is not clear if these interventions are delayed and subsequently occur within hospital, if the need for intervention is under-recognised due to atypical presentations or heightened patient complexity, or if the required intervention is not available to clinicians working in strictly protocol driven practice. Alternatively, these findings may also reflect call-outs for non-urgent conditions where nil intervention is required yet the lack of an alternative results in the use of an emergency ambulance. Further, likely prospective studies are needed to adequately investigate these alternatives.

Strengths and Limitations

This was a retrospective epidemiological study, encompassing an entire state of Australia including metropolitan, regional and rural areas over a period of five years. There is a single service provider for emergency ambulances across the state and thus all presentations during this time period were captured within the data.

Further analysis of clinical acuity was limited by missing data for many of the vital signs. No data were provided on medication dosing or duration, functional abilities and frailty. Additionally, there were no data on severity of current medical diagnoses, degree of

associated disability or chronic symptomatology. Values are manually inputted by clinicians at time of patient care and are therefore subject to clinical biases and time pressures that may influence accuracy of inputs. Some of these factors could be improved in future with direct transmission of values from monitors to electronic records. Use of the 'other' category may be minimised in future with optimisation of drop-down lists for completion of variables. Additionally, some routine measures such as a numerical rating scale to detect pain and use of the GCS score to reflect conscious state, may not provide a true reflection of these parameters in this patient population.

Conclusion

Overall these findings provide an important clinical picture of prehospital case-mix for this vulnerable group, frequently encountered in prehospital care. This is useful in guiding clinician training and protocol development as well as highlighting key concerns such as polypharmacy, suspected infection, pain and confusion that may become foci for both preventative and early intervention programs. These should also inform primary care service groups, such as GPs in encouraging them to adapting their training, clinical care and service provision to the needs of this unique patient group. In addition to the clinical descriptors above, the low rates of common prehospital medical interventions and the consistent patterns of call-outs both within and out-side of usual business hours provide valuable data to inform development of alternate, specific, acute and emergency care pathways for this people. This may include hospital outreach emergency care clinicians, upskilling of some paramedics to extend skills and creation of multidisciplinary prehospital care teams, mobile radiology and pathology services and telemedicine support for RAC staff. Additionally, those

programs currently in use such as Hospital-in-the-Nursing Home must be appropriately evaluated as to their impact on emergency ambulance call-outs to allow for appropriate adaption or expansion of these services. Further studies are needed to investigate key contributing factors not captured in this data that influence the frequency and need for emergency ambulance services in this population. This includes clinical features such as frailty and functional ability, role of advance care plans and influence of community healthcare teams, specialist clinicians, residential care home resources and staffing, and hospital outpatient and outreach services.

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TABLES AND FIGURES - Residential Aged Care Homes – Why they call '000'. A study of the emergency prehospital care of older people living in residential aged care homes

Box 1: Data variables requested from Ambulance Victoria

Demographic Characteristics
- Age
- Sex
- Home postcode

Medical Characteristics
- Past medical history
- Current medications

Reason for ambulance call-out and initial patient assessment
- Case nature
- Final paramedic assessment
- Initial heart rate, systolic blood pressure, respiratory rate, blood glucose level
- Initial ECG rhythm and respiratory state
- Initial pain score
- Paramedic intervention and administration of medication
- Patient outcome
- Transport indicator
- Not transported reason

Administrative case data
- Scene postcode
- Rural vs metropolitan location
- Time and date of call-out
- Highest dispatch code
- Scene and transport times
- Treating crew

Table 1: Age, location, Index of Relative Socio-economic Advantage and Disadvantage (IRSAD), call time and outcome for RAC residents attended by emergency ambulances in Victoria, by gender from 2008 to 2013

	Women n= 120,807	**Men n= 67,991**	**All n= 188,849**
Age Groups (years) (%)			
65 to 69	2.7	5.8†	3.8
70 to 74	4.6	8.6	6.1
75 to 79	9.9	14.1	11.4
80 to 84	20.9	23.2	21.7
85 to 89	30.3	27.3	29.2
90 to 94	22.4	16.1	20.1
95 to 99	8.1	4.4	6.8
100+	1.1	0.5	0.9
Location* (%)			
Metropolitan	75.1	73.9†	74.6
Rural	24.9	26.1	25.4
IRSAD* (%)			
lowest 50%	38.9	42.9†	40.3
highest 50%	61.1	57.1	59.7
Outcome - transported to hospital (%)			
Yes	89.6	89.8ns	89.7
No	10.4	10.2	10.3
Highest Dispatch Code* (%)			
1 (time critical)	34.4	34.8†	34.6
2 (urgent)	46.0	43.7	45.1
3 (non-urgent)	18.1	19.4	18.6
4	1.5	2.1	1.7
Transporting team (%)			
ALS Paramedics	96.5	96.1†	96.4
Mobile Intensive Care Ambulance (MICA) paramedic	3.5	3.9	3.6

*Missing data for gender, location and IRSAD and dispatch code were 51 cases (0.03%), 519 cases (0.3%) 577 cases (0.31%), 131 cases (0.07%) respectively

†p<0.001 ‡p<0.05

Table 2: Recorded past medical history, age adjusted Charlton Comorbidity Index and recorded current medications of RAC residents attended by emergency ambulances in Victoria from 2008 to 2013

	All n= 188,849
Past medical history - Recorded medical diagnoses (%)	
Hypertension	47.3
Dementia	32.7
Ischaemic heart disease	27.7
Osteoarthritis	24.6
Diabetes	20.9
Depression	19.1
Cerebrovascular disease	18.4
Chronic obstructive pulmonary disease	18.3
Atrial fibrillation	17.0
Cardiac failure	16.8
Osteoporosis	13.2
Cancer	11.6
Other genitourinary disorder	11.2
Falls	8.5
Fracture	8.2
Anxiety	7.6
Chronic renal impairment	6.3
Chronic pain	5.4
Age Adjusted Charlson Comorbidity Score (%)	
Low (0 to 1)	0
Medium (2-4)	25.9
High (5+)	74.1
Number of recorded medications -mean(SD)	7.9 (0.01)
Recorded medications (%)	
Antibiotics	73.8
Cardiovascular (antihypertensives and antiarrhythmics)	47.9
Diuretics	31.4
Opioid	25.2
Sedative other	24.3
Antidepressants	20.4
Antipsychotics	14.9
Antiplatelets	7.1
Anticoagulants	6.9
Oral Hypoglycaemic Agents	4.1
Insulin	3.8
Nil current medications recorded	0.7

Table 3: Recorded reason for call out and final paramedic assessment for RAC residents attended by emergency ambulances in Victoria, by gender from 2008 to 2013

	Women n= 120,807	Men n= 67,991	All n= 188,849
Reason for Call Out* (%)			
Medical	71.0	76.9 †	73.1
Fall	17.2	12.7	15.6
Other	11.8	10.4	11.3
Final Paramedic Assessment Diagnosis* (%)			
Pain	15.0	12.0 †	13.9
Superficial injury	9.8	9.0	9.5
Other	8.9	9.4	9.1
Other gastrointestinal complaint	7.8	8.2	7.8
Lower respiratory tract infection	6.1	8.5	6.9
Fracture	6.8	3.5	5.6
Altered conscious state	5.1	5.5	5.3
Shortness of breath	4.3	5.1	4.5
Febrile illness	3.7	5.1	4.2
No problem identified	4.0	3.9	4.0
Dizziness/unsteadiness/collapse	4.0	3.6	3.8
Stroke/Transient ischaemic attack	4.0	3.3	3.7
Other cardiovascular complaint	2.8	2.4	2.7
Acute coronary syndrome	2.2	2.1	2.2
Congestive cardiac failure	2.3	1.9	2.1
Other genitourinary complaint	0.9	4.3	2.1
Cardiac arrhythmia	2.2	1.7	2.0
Urinary tract infection	1.9	1.8	1.9
Other respiratory complaint	1.4	2.0	1.7
Other neurological complaint	1.4	1.6	1.5
Head injury	1.2	0.8	1.1
Epistaxis	0.9	0.9	0.9
Other psychiatric complaint	0.6	0.9	0.7
Deceased	0.6	0.8	0.7
Other endocrinological complaint	0.7	0.7	0.7
Anxiety	0.8	0.5	0.7
Cardiorespiratory arrest	0.4	0.6	0.4
Other rheumatological complaint	0.3	0.3	0.3

*Missing data for reason for call-out and final paramedic assessment 9147 (4.84%) and 9882 (5.23%) respectively

†p<0.001 ‡p<0.05

Table 4: Recorded initial vital signs, cardiac rhythm, respiratory status and pain score for RAC residents attended by emergency ambulances in Victoria from 2008 to 2013

	All n= 188,849
Initial heart rate (bpm)* - mean (SD)	84.9 (19.9)
Initial systolic blood pressure (mmhg)* - mean (SD)	135.2 (30.7)
Initial respiratory rate (bpm)* - mean (SD)	19.6 (7.1)
Initial Glasgow Coma Scale score*- median (IQR)	15 (14-15)
Initial oxygen saturation*- median (IQR)	96 (94-98)
Initial blood glucose level (mmol/L)* - mean (SD)	8.5 (4.0)
*Initial respiratory status** (%)	
Normal respiratory status	68.4
Apnoeic / Decreased Respiration	0.8
Respiratory Distress	0.4
Assisted Ventilation	17.2
*Initial cardiac rhythm** (%)	
Normal sinus rhythm	51.9
Cardiac Arrest	23.5
Atrial fibrillation / flutter	0.0
Other tachycardia	12.4
Other	3.5
*Pain Score** (%)	
Zero	72.9
Mild (1 to 3)	13.3
Moderate (3.1 to 6.9)	7.2
Severe (7 to 10)	6.6

*Missing data for initial heart rate, systolic blood pressure, respiratory rate, Glasgow Coma Scale, oxygen saturation, blood glucose level, pain score, initial respiratory status, initial cardiac rhythm were 13267 (7.0%), 14698 (7.8%), 11469 (6.1%), 10893 (5.8%), 120357 (63.7%), 132112 (70.0%), 23182 (12.3%), 107765 (57.1%), 73720 (39.0%) respectively

Table 5: Recorded medications given, and medical interventions made by paramedics attending RAC residents in Victoria from 2008 to 2013

	All n= 188,849
Medical intervention (%)	
Advice and reassurance	77.9
Supplemental oxygen	36.5
Intravenous cannula	23.1
Cardiac monitoring	22.2
Repositioning	9.9
Spinal immobilisation	5.7
Bandage or dressing	4.0
Sling / Splint / Ice	4.0
Pulse oximetry	2.6
Airway manoeuvres and/or adjuvant device	2.1
Cardiopulmonary resuscitation (CPR)	0.5
Bag valve mask ventilation	0.4
Endotracheal intubation	0.3
Non-invasive ventilation	0.3
Defibrillation	0.2
Pelvic binder	0.2
Medication administration (%)	
Intravenous fluids (crystalloids)	7.9
Morphine	7.2
Methoxyflurane	7.0
Glyceryl Trinitrate	5.6
Aspirin	5.1
Fentanyl	3.8
Salbutamol or ipratropium bromide (inhaled)	3.5
Antiemetic	3.4
Frusemide	0.7
Glucose	0.8
Adrenaline (intravenous or intraosseous)	0.4
Benzodiazepines	0.4
Paracetamol	0.01
Medication administration by paramedic (%)	24.2
Advanced medical intervention by paramedic (all interventions excluding advice or reassurance only)(%)	50.2

5.3 Summary

The findings of the study presented in this chapter were novel; describing for the first time the clinical characteristics, case mix and prehospital intervention for older people living in RAC. Examination of common comorbidities and prescriptions revealed significant medical complexity with over 70% of patients having an age-adjusted Charlson Co-morbidity Index score over five. On average, individuals were prescribed 7.9 medications in the RAC setting. In addition, common reasons for ambulance call-out include a high proportion of falls at ground level and frequent call-outs for pain and suspected infectious illness. These findings will guide training of prehospital clinicians as well as primary care and RAC clinicians. Additionally, they highlight clinical areas of focus for preventive health and targeted early intervention programs.

The findings of this study also demonstrated minimal difference in ambulance call-outs between business hours and after hours. Further studies are needed to examine facility and staffing characteristics that may influence patterns of call-out. These characteristics are not available in the data provided. Additionally, a low rate of complex medical intervention was identified, with most frequent prehospital care including provision of supplemental oxygen, monitoring of vital signs and intravenous fluids and analgesia. It is unclear from the data whether this reflected low need for medical intervention, whether certain interventions were needed but not available to clinicians, or whether interventions were delayed until arrival in hospital. These characteristics would best be examined with prospective investigation. However, overall these findings are important in directing and refining provision of emergency and prehospital care to this population and in guiding development of alternative acute models of care.

Chapter Six: Predicting Emergency Transfer to Hospital after Ambulance Call-out

6.1 Introduction

Through the studies described in Chapters Four and Five, high rates of emergency ambulance call-out to people living in RAC were evident. Additionally, the RAC population had frequent medical complexity in terms of co-morbidity and polypharmacy, yet a low rate of prehospital intervention was observed. A key outcome of emergency ambulance attendance is the decision to transfer a person to hospital. As described in Chapter Two, emergency transfer to hospital may have considerable unintended consequences for an individual, and for the functioning of the broader emergency care system. This transition point in care - the decision by paramedics to transport a person from RAC to hospital - remains under-investigated. Only one previous study was identified that examined this transition point for this population; a qualitative study which explored paramedics' experiences of transferring older people living in RAC to hospital at the end of life [110]. Murphy-Jones et al (2016) described three predominant themes including feeling uncertain about a person's wishes with regard to hospital transfer , difficulty in evaluating whether hospital transfer is in the patient's best interests, and the considerable influence from others including RAC staff and family members compelling transport of the individual to ED [110].

Thus, to further examine this transition point in care, the aim of the study presented in this chapter was to quantify clinical, sociodemographic and temporal associations with an outcome of transport to hospital for older people living in RAC attended by an emergency ambulance. This study addresses the fifth and final objective for this thesis.

6.2 Manuscript Five

This study is presented in the form of a manuscript *Predictors of Transport to Hospital After Emergency Ambulance Call-Out for Older People Living in Residential Aged Care.* Dwyer R, Gabbe BJ, Tran T, Smith, K, Lowthian JA. Australasian Journal on Ageing (published online 18th June 2020). Supplementary data for this paper are presented in Appendix 8.

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RESEARCH ARTICLE

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Predictors of transport to hospital after emergency ambulance call-out for older people living in residential aged care

Rosamond A. Dwyer[1,2] | **Belinda J. Gabbe**[1] | **Thach Tran**[1] | **Karen Smith**[1,3] | **Judy A. Lowthian**[1,4]

[1]School of Public Health and Preventive Medicine, Monash University, Melbourne, Vic., Australia

[2]Peninsula Health, Frankston, Vic., Australia

[3]Ambulance Victoria, Blackburn North, Vic., Australia

[4]Bolton Clarke Research Institute, Bentleigh, Vic., Australia

Correspondence
Dr Rosamond A. Dwyer, School of Public Health and Preventive Medicine, Monash University, 553 St Kilda Road, Melbourne, 3004, Vic., Australia.
Email: rosamond.dwyer@monash.edu

Abstract

Objectives: People living in residential aged care (RAC) frequently experience ambulance call-out. These episodes may have unintended consequences, yet remain under-investigated. Our aim was to examine clinical and sociodemographic features associated with transfer to hospital for this population.

Methods: Retrospective cohort study using 6 years of clinical data from Ambulance Victoria (AV). Data analysis included multilevel multivariable logistic regression analysis of factors associated with transport to hospital.

Results: Odds of transfer were greater for people in rural areas, those with a history of depression, cardiovascular disease and osteoporosis, and residents prescribed antipsychotic and antidepressant medication. Ambulance call-out for trauma (commonly low-level fall) was less frequently transferred to hospital than that for a medical complaint.

Conclusion: These results will improve prediction of call-outs likely to require transfer. Findings include identification of clinical features to be targeted by community and preventative health programs to reduce risk of acute health deterioration and requirement for emergency hospital transfer.

KEYWORDS

emergency care, older people, prehospital care, residential aged care

1 | INTRODUCTION

In Australia, as with many high-income countries, there is an escalating demand for emergency ambulance services, which is disproportionate to population growth.[1] This mounting demand is particularly pronounced for older patients, where rate of ambulance transport is up to eight times that for younger people.[1]

A subgroup of these older people live in residential aged care (RAC) homes. Older people living in RAC experience up to 4 times more emergency ambulance call-outs than people living independently in the community.[2] This population is frequently medically complex, with high rates of polypharmacy, co-morbidity, frailty and cognitive impairment.[3,4]

Once on scene, an emergency ambulance paramedic may perform a number of medical interventions and then either transport the patient to hospital, refer them to another community care provider or discharge them from care. Transport to a hospital emergency department (ED) may be associated with a number of unintended adverse consequences for both patients and the health-care system.[5-8] These include delirium, pressure areas, nosocomial infection, functional decline, long strays within the ED and high rates of representation to hospital.[5-8] Additionally, it has been suggested a number of these transports and associated

ED presentations are 'avoidable', occur for non-urgent reasons or because viable alternative pathways are not appropriate or readily accessible.[8,9]

The decision to call an ambulance by RAC staff is influenced by many factors including clinical condition, family expectations, skill mix and training, administrative, staffing and resourcing influences.[10] A complex combination of similar influences will impact paramedics as they decide whether or not to transfer a person from RAC to the hospital ED.[11] Factors associated with the 'prehospital transition point' of whether to transfer a patient living in RAC to hospital are largely under-investigated.[11] Improved understanding of this transition point will allow ambulance service providers to better predict the outcome of call-outs, as well as contributing to the development of alternative acute care pathways and preventative health-care programs aimed at avoiding acute hospital transfer.

Therefore, the aim of this study was to examine the clinical, sociodemographic and temporal factors associated with transfer to hospital for older people living in RAC who are attended by an emergency ambulance.

Policy Impact Statement

These results will assist service providers to predict which call-outs are likely to result in transport to hospital and inform community and primary care providers on key targets for preventive programs and alternative care pathways.

Practice Impact Statement

These results inform primary care clinicians on targets for preventative programs to reduce risk of emergency hospital transfer.

2 | METHODS

2.1 | Design and setting

This was a retrospective observational study using routinely collected clinical and administrative data from Ambulance Victoria (AV) and the Australian Bureau of Statistics (ABS). The study was conducted in Victoria, Australia, and encompassed all emergency ambulance call-outs to RAC across both metropolitan and rural regions during the period from 2008 to 2013.

2.2 | Data sources

Ambulance Victoria provided de-identified data of all emergency ambulance call-outs to people aged 65 years and over and living in residential aged care home in Victoria, Australia, during the study period. Parameters included the following:

- Age;
- Sex;
- Location, home and scene postcode;
- Date and time of call-out;
- Past medical history;
- Current medications;
- Final paramedic assessment and case nature;
- Outcome of ambulance attendance;
- Patient transport indicator; and
- Initial vital signs and pain score.

Age, initial heart rate and initial blood pressure were provided as continuous variables, age was subsequently transformed to 5-year intervals. Sex, location, medical history, current medication, final assessment and outcome of ambulance attendance were provided as categorical variables. Transport to hospital was determined by the binary variable 'patient transport indicator' (yes, patient was transported to hospital; or no, patient was not transported to hospital). Temporal characteristics included whether call-out occurred within standard business hours or after hours, time of day and day of week of call-out. Additional data were sought from the Australian Bureau of Statistics to provide a sociodemographic profile of the study population, the Index of Relative Socio-economic Advantage and Disadvantage (IRSAD).[12] Based on RAC postcode, the IRSAD provides an estimate of overall socio-economic level based on average income, education and employment measures.[13]

2.3 | Data extraction and screening

Details of the data screening are presented in Figure 1. Using age and date of call-out, all ambulance call-outs to people aged 65 years and over living in Victoria during the study period were extracted from the AV electronic patient record system and provided to the study team in a de-identified form.

Using the scene location function, call-outs were limited to those people in a residential aged care home. Data were excluded for non-emergency ambulance call-outs, those in the community (non-RAC) and those with missing scene location values.

2.4 | Data analyses

Analyses included two stages. Firstly, descriptive examinations of clinical, sociodemographic and temporal characteristics

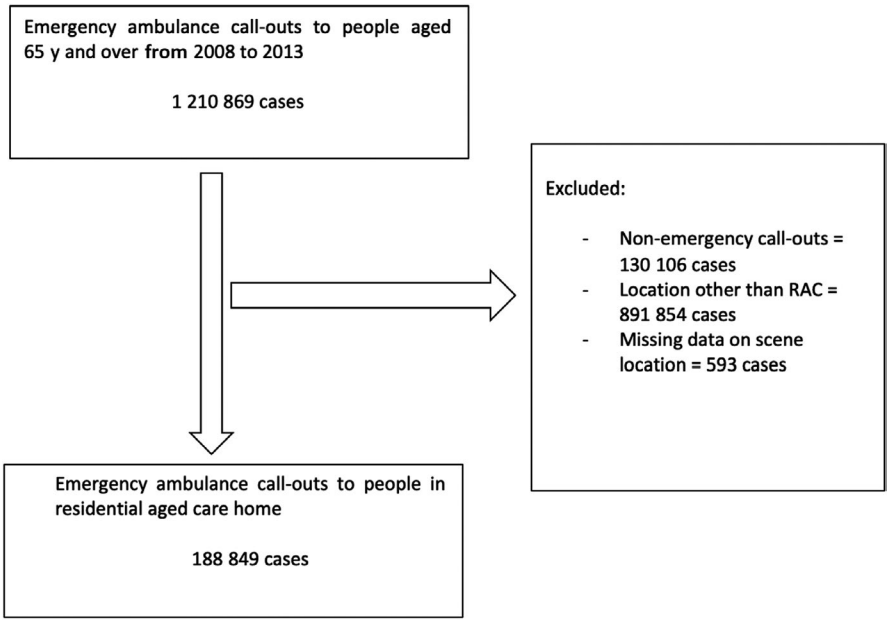

FIGURE 1 Data extraction from Ambulance Victoria and screening

in both transported and non-transported groups were carried out using proportions and mean (SD). Transported and non-transported groups were then compared using χ^2 and t tests. Secondly, a multilevel multivariable logistic regression analysis was conducted to determine important factors associated with the odds of transport to hospital. The analysis unit was the call-out. A person could have many call-outs over the study time. Therefore, we used the multilevel analysis method to control for the correlation between the call-outs to the same person. Only complete data were included in the Multivariable analysis. Data analyses were conducted using STATA version 15.[14]

2.5 | Ethics

This study was approved by the Monash University Human Research Ethics Committee (CF14/2705-2014001396) and Ambulance Victoria Research Governance Committee (R14-012).

3 | RESULTS

During the 6-year study period, there were 188,849 emergency ambulance call-outs to people living in RAC in Victoria, of which 169,360 (89.7%) were transported to hospital.

3.1 | Sociodemographic characteristics

Compared with patients not transported to hospital, patients in the transported group were of similar age, sex and living in care homes in areas with comparable sociodemographic measures. A greater proportion of people living in rural areas were transported to hospital (Table 1).

3.2 | Clinical characteristics

The prevalence of certain co-morbidities was higher in patients transported to hospital. The most common were cardiovascular conditions, and in particular ischaemic heart disease and atrial fibrillation, as well as dementia, depression osteoarthritis, osteoporosis and fracture, chronic pulmonary disease and previous stroke. This corresponded to higher Charlson Comorbidity Index score in this group (Table 2, Appendix S1—Table S1).

People transported to hospital had a greater average number of prescribed medications. Antibiotics, cardiovascular agents and inhalers were more commonly prescribed in the transported group, as were psychoactive medications including sedatives, opiates and antipsychotics (Table 2, Appendix S1—Table S2).

Transport rates varied according to the reason for ambulance call-out, with call-outs for falls experiencing lower rates than call-outs for medical conditions. Diagnoses were similar across both the transported and non-transported groups with pain, shortness of breath, suspected infection, suspected fracture and altered conscious state slightly more frequent in the transported group. Superficial injury, dizziness, psychosocial concern and anxiety were less common compared with the non-transported group (Table 2, Appendix S1—Table S3).

Full examination of acuity was limited by missing data. Overall, average initial vital signs were remarkably similar, and in the normal range, between both the transported and non-transported groups, with the exception of abnormal Glasgow Coma Scale (GCS) and higher respiratory rate,

TABLE 1 Demographic characteristics and initial vital signs of patients transported to hospital vs discharged at scene for older people living in residential aged care homes from 2008 to 2013

	Total population (n = 188 849)	Not transported (n = 19 489)	Transported (n = 169 360)
Age (years), mean (SD)	84.89 (7.35)	84.7 (7.67)	84.9 (7.31)‡
Age groups (years), n (%)			
65 to 69	7282 (3.9)	943 (4.9)	6339 (3.7)†
70 to 74	11 461 (6.1)	1223 (6.3)	10 238 (6.1)
75 to 79	21 503 (11.4)	2217 (11.4)	19 286 (11.4)
80 to 84	40 987 (21.7)	4130 (21.2)	36 857 (21.8)
85 to 89	55 118 (29.2)	5491 (28.2)	49 627 (29.3)
90 to 94	38 032 (20.1)	3878 (19.9)	34 154 (20.2)
95 to 99	12 826 (6.8)	1372 (7.0)	11 454 (6.8)
100+	1640 (0.9)	235 (1.2)	1405 (0.8)
Gender[a], n (%)			
Female	120 807 (64.0)	12 543 (64.4)	108 264 (63.9) ns
Male	67 991 (36.0)	6940 (35.6)	61 051 (36.1)
Location of residential care home, n (%)			
Metropolitan	140 934 (74.6)	15 582 (80.0)	125 352 (74.0)†
Rural	47 915 (25.4)	3907 (20.0)	44 008 (26.0)
Residential care home IRSAD binary[a], n (%)			
Lowest 50%	75 921 (40.3)	7232 (37.2)	68 689 (40.9)†
Highest 50%	112 351 (59.7)	12 189 (62.8)	100 162 (59.3)
Time of call-out, n (%)			
After hours	110 587 (58.6)	12 852 (65.9)	97 735 (57.7)†
Business hours (M-F, 0800-1800)	78 262 (41.4)	6637 (34.1)	71 625 (42.3)
Scene time duration (mins), mean (SD)	24.9 (157.4)	52.8 (39.9)	21.7 (165.3)†
Highest dispatch code, n (%)			
1 (time critical)	65 216 (34.6)	8481 (43.8)	56 735 (33.5)†
2 (urgent)	85 148 (45.1)	7823 (40.4)	77 325 (45.7)
3 (non-urgent)	35 121 (18.6)	2896 (15.0)	32 225 (19.0)
Initial heart rate (beats per min)[a], mean (SD)	84 (19.91)	79 (15.93)	85 (20.28)†
Initial systolic blood pressure (mmHg)[a], mean (SD)	135 (30.69)	134 (24.12)	135 (31.28)†
Glasgow Coma Score[a], normal (14-15), n (%)	93 680 (52.6)	11 396 (62.3)	82 284 (51.5)†
Pain score[a], n (%)			
Nil pain	120 650 (72.8)	13 162 (83.7)	104 488 (71.7)†
Mild (1 to 3)	22 114 (13.4)	2132 (13.6)	19 982 (13.3)†
Moderate (3.1 to 6.9)	12 001 (7.2)	335 (2.1)	11 666 (7.8)†
Severe (7 to 10)	10 902 (6.6)	90 (0.6)	10 812 (7.2)†

Abbreviation: IRSAD, Index of relative socio-economic advantage and disadvantage.

[a]Missing data for gender, location, IRSAD, initial heart rate, systolic blood pressure, Glasgow Coma Scale and pain score were 51 (0.03%), 519 (0.3%), 577 (0.31%), 13 267 (7.0%), 14 698 (7.8%), 10 893 (5.8%)and 23 182 (12.3%), respectively

†$P < .001$; ‡$P < .05$.

which were both more frequent in the transported group. Average pain score was slightly higher in patients transported to hospital but remained low, with transport rates increasing for residents with reported moderate-to-severe pain (Table 1, Appendix S1—Table S4).

3.3 | Temporal and service characteristics

There was minimal fluctuation in transport rates according to time of day or day of week, with the rate of transport to hospital marginally higher, up to 91.5% during business hours

TABLE 2 Past medical history, prescribed medications and paramedic diagnoses for people living in residential aged care homes by transportation outcome in Victoria from 2008 to 2013

	Total population (n = 188 849)	Not transported (n = 19 489)	Transported (n = 169 360)
Past medical history, n (%)			
Dementia	61 773 (32.7)	5803 (29.8)	55 970 (33.1)†
Ischaemic heart disease	52 396 (27.7)	4600 (23.6)	47 796 (28.2)†
Osteoarthritis	46 423 (24.6)	4391 (22.5)	42 032 (24.8)†
Depression	35 973 (19.1)	3342 (17.2)	32 631 (19.3)†
Stroke/transient ischaemic attack	34 808 (18.4)	2835 (14.6)	31 973 (18.9)†
Chronic obstructive pulmonary disease	34 479 (18.3)	2990 (15.3)	31 489 (18.6)†
Other cardiovascular complaint	34 159 (18.1)	2878 (14.8)	31 281 (18.5)†
Atrial fibrillation	32 127 (17.0)	2789 (14.3)	29.338 (17.3)†
Congestive cardiac failure	31 753 (16.8)	2802 (14.4)	28 951 (17.1)†
Osteoporosis	24 870 (13.2)	2005 (10.3)	22 865 (13.5)†
Cancer	21 850 (11.6)	1839 (9.4)	20 011 (11.8)†
Fracture	15 425 (8.2)	1030 (5.3)	14 395 (8.5)†
Urinary tract infection	14 343 (7.6)	1107 (5.7)	13 236 (7.8)†
Anxiety	14 300 (7.6)	1530 (7.9)	12 770 (7.5)ns
Chronic renal failure	11 950 (6.3)	919 (4.7)	11 031 (6.5)†
Age-adjusted Charlson Comorbidity Index score, n (%)			
Medium (2-4)	50 619 (26.8)	6564 (33.7)	50 619 (26.0)†
High (5+)	138 230 (73.2)	12 925 (66.3)	138 230(74.0)†
Current medications, n (%)			
Antibiotics	139 439 (73.8)	13 409 (68.8)	126 030 (74.4)†
Cardiovascular (antihypertensives and antiarrhythmics)	90 420 (47.9)	8636 (44.3)	81 784 (48.3)†
Diuretic	59 232 (31.4)	5262 (27.0)	53 970 (31.9)†
Opioid	47 508 (25.2)	3959 (20.3)	43 549 (25.7)†
Sedatives (including benzodiazepines)	45 939 (24.3)	4063 (20.9)	41 876 (24.7)†
Antidepressants	38 477 (20.4)	3489 (17.9)	34 988 (20.7)†
Inhalers for asthma/ COPD	35 820 (19.0)	2904 (14.9)	32 916 (19.4)†
Antipsychotics	28 236 (15.0)	2479 (12.7)	25 757 (15.2)†
Antiplatelet agents	13 486 (7.1)	1278 (6.6)	12 208 (7.2)‡
Anticoagulants	13 098 (6.9)	1169 (6.0)	11 929 (7.0)†
Final paramedic assessment diagnosis, n (%)			
Pain	24 898 (13.9)	1572 (8.5)	23 326 (14.5)†
Superficial injury	17 058 (9.5)	2224 (12.0)	14 834 (9.3)†
Suspected fracture or dislocation	10 083 (5.6)	90 (0.5)	9993 (6.2)†
Altered conscious state	9423 (5.3)	436 (2.4)	8987 (5.6)†
Shortness of breath	8150 (4.6)	222 (1.2)	7928 (4.9)†
Febrile illness	7476 (4.2)	353 (1.9)	7123 (4.4)†
Dizziness/unsteadiness/collapse	6893 (3.9)	1024 (5.5)	5869 (3.7)†
Stroke/transient ischaemic attack	6668 (3.7)	138 (0.7)	6530 (4.1)†
Acute coronary syndrome	3936 (2.2)	234 (1.3)	3702 (2.3)†
Congestive cardiac failure	3828 (2.1)	100 (0.5)	3728 (2.3)†

†$P < .001$; ‡$P < .05$.

(Table 1, Appendix S1—Figure S1). A lower proportion of people transported to hospital were attended with the highest dispatch code (code 1) compared with people not transported. 'On-scene' time was almost twice as long for residents not transported to hospital (Table 1).

3.4 | Multivariable analysis

Results of the Multivariable analysis are displayed in Table 3. There was no association between age, gender or IRSAD and odds of transport to hospital. Living in a rural area remained significant with an odds ratio (OR) of 1.9 (95% CI 1.80-2.04). Ambulance call-out within business hours was associated with greater odds of transport to hospital than out-of-hours calls (OR of 1.50, 95% CI 1.43-1.57).

Odds of transport to hospital were higher for people with a past history of depression, cardiovascular disease, stroke, osteoporosis or previous fracture, and lower for people with chronic pulmonary disease and congestive cardiac failure. Residents with higher combined co-morbidity, as measured by the Charlson Comorbidity Index scores, had greater odds of transport to hospital with an OR of 1.14 (95% CI 1.06-1.21) compared with residents with a lower score.

With regard to current medications, antibiotics and anticoagulants, psychoactive agents and opioids remained significantly associated with transport to hospital, with the greatest effect seen for antipsychotics OR of 1.20 (95% CI 1.13-1.29). Results were non-significant for the presence of cardiovascular medications and antiplatelet agents.

Compared with a primary medical complaint, people presenting with a physical trauma had lower odds of being transported to hospital with an OR of 0.68 (95% CI 0.64-0.72). Paramedic diagnosis associated with higher odds of being transported to hospital included suspected fracture/dislocation, stroke, head injury, febrile illness and genitourinary complaint. Whereas odds of transport were lower for people deemed to have no problem identified, people with superficial injuries, non-specific dizziness or collapse and anxiety. Residents with vital signs outside of the normal range were all more frequently transported to hospital, as were residents with higher recorded pain scores.

4 | DISCUSSION

This study is unique in describing predictors of emergency transport to hospital for older people living in RAC. In addition to finding a very high rate of patient transport, we have identified patient, clinical and temporal factors that influence the odds of emergency transport to hospital for this population.

Of the sociodemographic factors, only extreme old age (>100 years) demonstrated significant association with transport to hospital. This contrasts with some in-hospital studies

TABLE 3 Multilevel Multivariable logistic regression analysis of factors associated with transport to hospital following an emergency ambulance call-out to residential aged care homes

	Odds ratio (95% CI)	*P* value
Age (ref 65-69)		
70 to 74	1.06 (0.93-1.22)	.387
75 to 79	1.08 (0.95-1.22)	.244
80 to 84	1.05 (0.93-1.19)	.400
85 to 89	1.06 (0.94-1.20)	.308
90 to 94	1.09 (0.96-1.23)	.185
95 to 99	1.00 (0.87-1.15)	.980
100+	0.75 (0.59-0.94)	.012
Male gender (ref female)	1.00 (0.95-1.05)	.981
Rural (ref metro)	1.91 (1.80-2.04)	<.001
Higher RAC IRSAD (ref low RAC IRSAD)	0.97 (0.93-1.02)	.279
Business hours (ref after hours)	1.50 (1.43-1.57)	<.001
Past medical history (cond. present ref cond. absent)		
Dementia	1.05 (0.99-1.12)	.087
Ischaemic heart disease	1.03 (0.97-1.08)	.348
Osteoarthritis	1.05 (0.99-1.10)	.087
Depression	1.09 (1.03-1.16)	.004
Stroke/ transient ischaemic attack	1.21 (1.13-1.28)	<.001
Chronic obstructive pulmonary disease	0.91 (0.85-0.98)	.016
Other cardiovascular	1.24 (1.17-1.32)	<.001
Atrial fibrillation	1.09 (1.03-1.17)	0.006
Congestive cardiac failure	0.93 (0.87-0.99)	.027
Osteoporosis	1.22 (1.14-1.31)	<.001
Cancer	1.22 (1.14-1.32)	<.001
Other genitourinary	1.38 (1.28-1.49)	<.001
Fracture	1.49 (1.36-1.62)	<.001
Chronic renal failure	1.30 (1.18-1.44)	<.001
High Charlson Comorbidity Index (5+) (ref mod CCI)	1.14 (1.06-1.21)	<0.001
Current medications (med presc. ref med not presc.)		
Antibiotic	1.12 (1.06-1.18)	<.001
Cardiovascular	1.02 (0.97-1.07)	.478
Diuretic	1.09 (1.03-1.15)	.003
Opioid	1.06 (1.01-1.12)	.025
Sedative	1.16 (1.10-1.23)	<.001
Antidepressant	1.09 (1.03-1.16)	.002
Inhalers	1.10 (1.02-1.18)	.012
Antipsychotic	1.20 (1.13-1.29)	<.001

(Continues)

TABLE 3 (Continued)

	Odds ratio (95% CI)	*P* value
Antiplatelet	1.00 (0.92-1.09)	.982
Anticoagulant	1.17 (1.07-1.29)	.001
Reason for call-out—trauma (ref 'medical')	0.68 (0.64-0.72)	<.001
Final paramedic assessment (ref 'not otherwise specified')		
Pains	1.39 (1.28-1.52)	<.001
Superficial injury	1.27 (1.12-1.38)	<.001
Other gastrointestinal	1.47 (1.34-1.62)	<.001
Lower respiratory tract infection	1.14 (1.00-1.30)	.043
Suspected fracture/ dislocation	11.22 (8.84-14.24)	<.001
Shortness of breath	1.20 (1.01-1.43)	.035
No problem identified	0.09 (0.08-0.10)	<.001
Dizziness/ unsteadiness/ syncope	0.84 (0.76-0.93)	.001
Stroke/ transient ischaemic attack	3.05 (2.47-3.77)	<.001
Acute coronary syndrome	0.31 (0.26-0.38)	<.001
Altered conscious state and confusion	1.40 (1.22-1.61)	<.001
Other genitourinary complaint	5.17 (4.17-6.41)	<.001
Cardiac arrhythmia	1.86 (1.45-2.37)	<.001
Urinary tract infection	1.86 (1.56-2.21)	<.001
Febrile illness	1.91 (1.67-2.20)	<.001
Other neurological complaint	0.81 (0.67-0.98)	.034
Chronic obstructive pulmonary disease	0.88 (0.63-1.22)	.450
Congestive cardiac failure	0.74 (0.57-0.97)	.027
Hypertension	1.76 (1.44-2.15)	<.001
Head injury	3.14 (2.33-4.25)	<.001
Epistaxis	1.13 (0.96-1.33)	.142
Other psychosocial concern	0.66 (0.52-0.83)	<.001
Other endocrine complaint	1.66 (1.27-2.15)	<.001
Anxiety	0.16 (0.14-0.19)	<.001
Other respiratory complaint	0.71 (0.54-0.97)	.028
Gastroenteritis	0.95 (0.73-1.23)	.680
Other rheumatologic complaint	2.50 (1.74-3.61)	<.001
Cardiorespiratory arrest	0.02 (0.014-0.04)	<.001
Deceased	0.003 (0.001-0.004)	<.001

(Continues)

TABLE 3 (Continued)

	Odds ratio (95% CI)	*P* value
Vital signs (ref normal values[a])		
Bradycardia[a]	1.43 (1.25-1.65)	<.001
Tachycardia[a]	1.68 (1.53-1.85)	<.001
Hypotension[a]	1.10 (1.03-1.16)	.002
Hypertension[a]	1.36 (1.29-1.42)	<.001
Abnormal GCS[a]	1.90 (1.80-2.00)	<.001
Pain (ref none)		
Mild	1.13 (1.07-1.21)	<.001
Moderate	2.29 (2.00-2.61)	<.001
Severe	6.80 (5.36-8.63)	<0.001

[a]Vital sign definitions: heart rate = bradycardia <60 beats per min, tachycardia > 100 beats per min, normal heart rate = 60-100 beats per min, systolic blood pressure = hypotension <120 mmHg, hypertension > 140 mmHg, normal = 120-140 mmHg, Glasgow Coma Scale = abnormal <14, normal 14-15.

where both age and male sex were associated with higher rates of hospitalisation.[4,15,16] Previously, we have demonstrated these associations with rates of ambulance call-out,[2] and so the lack of an association here indicates that these factors influence the decision to call an ambulance more so than the decision to transfer the person, and that most call-out results in transfer to hospital. The higher transport rates in the rural areas may reflect less access to community services or alternate care providers in areas of greater remoteness or geographical spread.[17]

The increased transport rates for people with multiple chronic diseases and people with chronic cardiac conditions are consistent with studies from in-hospital settings where these are associated with increased risk of ED presentation.[4,18,19] Additionally, across inpatient settings, chronic mental illness has also been associated with increased rate of emergency health system use and supports the higher rate of transport for patients with a diagnosis of depression.[20] Studies from hospital settings have produced varying results regarding the impact of cognitive impairment and dementia on presentation to hospital, with some reporting increased and some reporting decreased presentation rates in these groups.[4,18-21] This variation may reflect unmeasured differences in resources of RACs such as specialist dementia care units, availability of outreach and community care services and prevalence of advance care directives between different study settings.[4] In our study, there was no significant association between dementia and odds of transport to hospital. Such variation between studies likely reflects unmeasured factors such as community- and home-specific resources.

Consistent with studies from ED settings, these results demonstrate that both polypharmacy and prescription of certain agents such as psychoactive medication are associated with transfer to hospital.[4,19,22] From these data, a direct causal relationship cannot be determined. The increased odds of

transport may relate to direct adverse effects of these medications, such as confusion resulting from use of sedatives, or may reflect prescription of medications in response to an acute health deterioration such as inhalers for worsening dyspnoea.

Understandably, some of the most notable associations with transport to hospital were the cause of the acute episode or reason for ambulance call-out. In this population, trauma, which largely represented ground-level falls, had lower odds of being transport to hospital than a primary medical condition. Fewer requirements for transport to hospital might suggest some of these low-level falls may be appropriate for non-ambulance community response programs.

From the available data, it is not possible to explore why some diagnoses are more highly associated with transport than others. Some may be due to requiring an intervention outside a paramedic's scope of practice such as reduction of dislocation or fracture or genitourinary complaint, necessitating manipulation of a urinary catheter device. Other diagnoses such as suspected stroke, cardiac arrhythmia and respiratory tract infection may be due to acuity of associated symptoms such as pain, dyspnoea or neurological deficit or requirement for investigations such as CT and X-ray, less accessible by prehospital or community clinicians.

People with abnormal vital signs, in particular respiratory rate, initial pain score and conscious state had higher odds of being transported to hospital; however, transport rates remained high even for people with vital signs within normal limits. Although appropriateness of transport to hospital is difficult to determine with this limited, retrospective data set, these findings may suggest frequent transport of patients with non-emergent conditions. It is unclear whether these transports occur due to the need for clinical investigations, interventions or decision-making outside of a paramedic's current protocols or scope of practice or whether other RAC and health system characteristics influence this decision to transport to hospital. Further research is needed to prospectively investigate true acuity and appropriateness of these transports and examine clinician and health system factors contributing to these potentially non-emergent transports.

4.1 | Strengths and limitations

This study is strengthened by the breadth of the data, which encompass an entire state of Australia, including both rural and metropolitan regions, over a six-year period. Ambulance Victoria is a single-service provider, and therefore, all emergency ambulance attendances to older people living in RAC during this period are captured within this data set.

Data fields are inputted by clinicians and administrators at the time of patient contact and with the primary aim of forming an electronic patient record. This therefore limits the detail and data fields collected. Record of co-morbidity and current prescription is limited by the absence of a measure of severity or time course of reported illness. Many values are limited to those presented in drop-down boxes. Additionally, data entry may be subject to the biases of clinicians with certain values or data fields intentionally omitted. For example, it could be presumed that active co-morbidities and those relevant to the presenting concern may be more likely to be recorded by clinicians, and thus be present in the data.

The IRSAD was used to provide a broad measure of socio-economic level for a defined geographical area and in this study was linked to the RAC postcode. This is therefore a crude measure, and it is unclear how well this reflects the socio-economic level of individuals within each home.

5 | CONCLUSION

There are key patient, clinical and temporal associations with transport to hospital of older people living in RAC attended by ambulance. In an immediate sense, these insights may assist service providers to predict which call-outs to RAC are likely to result in transport to hospital. Additional clinical implications include the identification of patients who may be at heightened risk of experiencing an unplanned ED transfer. These patients may benefit from closer surveillance by primary and community care teams to allow for earlier detection and management of acute health events within the community to mitigate the need for emergency ambulance use.

On a broader level, this study provides data on the key influences on the transition point between prehospital and intrahospital care for people living in RAC. This includes temporal data, which may inform timing of provision of community support services and clinical data identifying key medications, co-morbidities and acute conditions to be targeted by community care and preventive health programs. These results may assist in refining the care provided by emergency ambulance services to ensure adequate training, guidelines and protocols for care of this unique and vulnerable patient group. Findings will also inform the development of alternative acute care pathways to reduce the numbers of people requiring emergency ambulance care and hospital transport. Further studies are needed to elicit RAC home, primary health care and prehospital care team characteristics, which also influence this care transition point.

ETHICAL APPROVAL

This study was approved by the Monash University Human Research Ethics Committee (CF14/2705-2014001396) and Ambulance Victoria Research Governance Committee (R14-012).

ORCID

Rosamond A. Dwyer https://orcid.org/0000-0002-2220-8457
Judy A. Lowthian https://orcid.org/0000-0002-9780-5256

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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6.3 Summary

Five years of ambulance call-outs were examined across Victoria and revealed fundamental clinical, patient and temporal associations with the outcome of transport to hospital for older people living in RAC. A number of these factors are potentially modifiable through enhanced primary care. For example, regular medication reviews to reduce the consequences of inappropriate polypharmacy, including prescription of certain medications such as antipsychotic agents. Other contributory factors may be mitigated with addition of new or improved service delivery such as the increase odds of transfer for people living in rural RACs which may reflect a relative deficiency of alternate acute care services in these areas.

The study findings may assist emergency ambulance services in predicting need for transport and, therefore, in refining the efficient and timely allocation of resources. Additionally, some associations with greater odds of transport such as a diagnoses of suspected head injury or febrile illness may be suitable for targeted referral to alternate, in-home service providers to moderate the frequency of emergency hospital transfer.

Chapter Seven: Discussion and Conclusion

7.1 Introduction

Older people living in residential aged care (RAC), frequently experience acute, unplanned transfers to hospital; and yet there has only been limited evidence surrounding the appropriateness, determinants and outcomes of these episodes of acute care. Previous research has predominantly focused on medical care within the emergency department or hospital environment. To date there has been little evidence examining the prehospital care of older people living in RAC.

This program of research has addressed this evidence shortfall. Two systematic reviews of peer reviewed evidence were undertaken to investigate the outcomes and determinants of unplanned, transfers to the emergency department. These were examined from both a person and health system perspective. Subsequent studies in this research program used epidemiological methods to describe the frequency, case-mix and outcomes of prehospital emergency care of older people, living in RAC, attended by an emergency ambulance.

Novel findings from this research program include quantifying the high rate of emergency ambulance call-out to older people living in RAC in Australia, up to four times that of older people living in the community. Frequent emergency ambulance call-out were described for low level falls with or without related injury, uncontrolled pain and suspected respiratory infection. Findings also included a low rate of prehospital intervention and a high rate of emergency transfer to hospital.

Within this chapter these key findings will be further reflected upon in the context of the current health system. A discussion of the implications of these findings for future research and health system development is provided. The specific strengths and weaknesses, and the findings relative to the published literature for individual studies are detailed in each chapter, however the strengths and limitations of this overall program of research are discussed.

7.2 Strengths and Limitations

Strengths of this program of work include the novel focus on prehospital emergency care, the use of population-based data and a focus on a defined Australian jurisdiction. The strengths and limitations of each individual study are presented in the relevant chapters and a discussion of data quality is found in Chapter Three.

This program of research has included both systematic review and epidemiological research methods. This combination of techniques has allowed both a comprehensive evaluation of international peer-reviewed studies as well as a current, in depth examination of state-based Australian prehospital care. The methods for each study have been well described allowing for reproducibility.

The three studies presented in Chapters Four, Five and Six used data encompassing state-wide ambulance call-outs. The use of this large dataset improves the specificity of findings as well as the applicability and validity of results when applied to this population of older people living in RAC. Use of state-wide data reduces the potential for bias arising from variations in RAC home characteristics, in local health and community supports and across areas of differing geographic and population density characteristics. Examination of these macro patterns of care allows appraisal of this system of prehospital care and furthers our understanding of population level outcomes of care. In addition, use of data over a six-year period enabled an examination of the temporal stability of these outcomes.

Much of the previous evidence surrounding the emergency care of people living in RAC arises from the United States of America, Canada and the United Kingdom. Although, some concepts such as an ageing population, polypharmacy and frailty are comparable to the Australian setting, there may be important differences in population characteristics and systems of healthcare between different countries. The studies described in this thesis provide important data pertaining to the local, Australian prehospital care environment. These data will be essential for design of future Australian research studies and the development of relevant, population specific systems of acute care.

In consideration of the impact of this research, it is also important to reflect on the additional limitations of this program of study. All studies were retrospective and used routine clinical and administrative date. It was therefore not possible to confirm accuracy of variables such as diagnosis or to examine appropriateness of outcomes such as intervention performed or decision to transport to hospital. Use of observational data means conclusions can only be drawn regarding associations and not causation.

In addition to the data limitations outlined in Chapter Three, data fields were restricted to those used by the ambulance service and therefore could not include all relevant variables. This includes additional clinical variables such as frailty, functional abilities and extent of cognitive impairment, and RAC home characteristics such as staffing and access to primary care services. Therefore, these were not able to be considered in the analysis.

Within Victoria, Australia most emergency ambulance services are provided by a single organisation; and prehospital care is predominantly performed by a single health discipline, paramedics. These findings may therefore not be generalisable to areas where alternate care providers or multidisciplinary teams assist in provision of prehospital care or where other differences in the emergency care system exist.

7.3 Summary of Key Findings and Contribution to Previous Knowledge Gaps

The key findings of this program of research are presented in Box 2 and subsequently discussed with respect to the five objectives of this research program of outlined in Chapter One.

Box 2: Key findings with regard to older people living in residential aged care homes

Chapter Two	Systematic review	Identified the predictors of emergency hospital attendance	More frequent transfer to ED associated with: - Polypharmacy - Prescription of sedatives and psychoactive agents - Certain co-morbidities - 'For profit' residential care homes - Poorer staffing profiles
Chapter Two	Systematic review	Identified the clinical and health system outcomes of emergency transfer to hospital	Potential outcomes of unplanned hospital transfer include: - High rate of potentially invasive procedures - Pressure ulcer development - Delirium - Functional decline - Frequent use of emergency ambulance - Long strays in the ED - Frequent inpatient admission
Chapter Four	Epidemiological retrospective analysis	Quantified the Victorian rates of emergency ambulance call-out	Emergency ambulance call-outs to people living in RAC up to four times those for people living in the community More frequent call-outs for men living in RAC Fluctuation in rates according to season
Chapter Five	Descriptive analysis	Described prehospital case-mix and clinical acuity of people attended by an emergency ambulance Described outcomes of emergency ambulance call-out including prehospital intervention, medication administration and disposition	People living in RAC attended by ambulance had high medical complexity Frequent call-outs for low-level falls, respiratory illness and uncontrolled pain and altered conscious state Low rate of prehospital intervention High rate of transfer to hospital following ambulance call-out
Chapter Six	Multivariable analysis	Identified characteristics associated with decision to transfer to hospital compared with discharge on scene	Greater odds of transfer to hospital after ambulance call-out for people living in RAC - In rural areas - Certain co-morbidities and prescription of psychoactive agents - Suspected diagnosis of fracture, head injury or febrile illness

Objectives

1. *To examine the predictors of emergency transport to hospital*

2. *To describe the outcomes of an emergency transport to hospital*

Previous literature has examined patient and health system determinants and outcomes of emergency hospital transfer from the perspective of a single organisation, setting or characteristic. The two reviews presented in Chapter Two are among the first, internationally to systematically examine evidence surrounding these predictors and outcomes and meet the first two objectives outlined in Chapter One. These syntheses of current, peer reviewed literature are novel in providing a comprehensive overview of the impact of sociodemographic, clinical, pharmacological and health system factors on risk of experiencing emergency transfer and the patient and health system outcomes of these events.

Results of the review '*Unplanned Transfer to Emergency Departments for Frail Elderly Residents of Aged Care Facilities: A Review of Patient and Organizational Factors'*, published in JAMDA, included a description of patient and health system factors that may influence rate of emergency hospital transfer. It was found that for an individual, both gender and race may impact frequency of transport to the ED. Additionally, potentially modifiable features such as co-morbidity, polypharmacy and prescription of certain agents such as antipsychotics, anxiolytics and hypnotics were also associated with increased the rate of ED transfer. These may be addressed with health system improvements through enhanced primary care, specialist out-reach to the RAC, and prescription monitoring and review programs. From a RAC home perspective, characteristics such as ownership, size and staffing impact were relevant, with 'for profit' organisations and those with reduced access to primary care physicians, lower registered nurse hours and those with poorer staff to patient ratios exhibiting more frequent unplanned hospital transfers. These features are important in identifying RAC homes at risk of frequent ambulance call-outs and in guiding both RAC and government policies and regulations with regard to care home design and staffing.

Older people living in RAC may experience a number of unintended consequences of an emergency transfer to ED. Through the systematic review, '*A systematic review of outcomes*

following emergency transfer to hospital for residents of aged care facilities', published in Age and Ageing, a number of patient and health system outcomes of emergency transfer to hospital were described. This review found a high rate of reported in-hospital intervention, including potentially painful and invasive procedures such as insertion of intravenous cannulas, arterial blood gas sampling and insertion of a urinary catheter. Prescription of both medication and intravenous fluids was common and more frequent than for people who resided in the community. In addition, frequent investigations were ordered, including both radiological and pathological testing. People transferred to hospital were susceptible to in-hospital complications with over 19% developing new pressure injuries and 38% developing delirium. Both in-hospital and post-discharge, these residents experienced accelerated functional decline and had higher risk of development of a new infection. Overall mortality remained high with up to 52% of people dying within three months of an ED transfer. These results highlight the risks to an individual associated with experiencing an unplanned emergency hospital attendance. These potential harms must now be considered by those including emergency, prehospital and community clinicians when deciding to call an ambulance or transfer a resident to hospital. These findings will be valuable in guiding improvements in the care provided to older people, in the development of enhanced clinical guidelines and optimising population-specific healthcare systems to improve patient-orientated outcomes and reduce risk of iatrogenic harm.

For the broader health system, these frequent transfers added additional burden to limited resources with frequent use of emergency ambulances and longer stays within the ED and hospital contributing to hospital to overcrowding. Additional economic costs also resulted from long inpatient stays, frequent investigation and intervention and high ambulance use. These findings highlight the need for future development of alternate pathways of care which include improved efficiency in use of these scarce emergency care resources such as hospital beds and emergency ambulances.

Objectives

3. *To describe local Australian rates of emergency ambulance use*

4. *To describe the case-mix and acuity of older people living in RAC attended by an emergency ambulance*

5. *To investigate the outcomes of emergency ambulance attendance including medical intervention and decision to transport to hospital*

Emergency ambulance use and prehospital care of older people living in RAC has not previously been described in Australia. In addition, international evidence examining the rate of ambulance call-out, prehospital clinical case mix and medical intervention is scarce. Studies presented in Chapters Four, Five and Six are unique in providing original examination of the rates of emergency ambulance use, description of case-mix and acuity, and investigation of medical intervention and outcomes of emergency ambulance call-out. Results of these studies are specific to our local, Australian context but are translatable to other Australian States, and to similar health systems across other high-income countries. These findings address objectives three, four and five of this program of research.

Using five years of state-wide Victorian data, older people living in RAC were found to have a high rate of emergency ambulance use with over 770 emergency ambulance call-outs per 1000 population. This rate was up to four times that observed for people living in the community. Rates of ambulance call-out fluctuated with season, increasing during winter months. For people living in RAC emergency ambulance call-out was consistently more frequent for men than women, whereas rates were similar across genders for people living in the community. Ambulance call-outs were evenly distributed across days of the week with 59% of call-outs occurring after hours. Less than 4% of call-outs were attended by paramedics with extended clinical skills. These identified patterns in ambulance call-out will help inform and optimise prehospital service delivery by ensuring staffing, training and protocols match the clinical case mix and demand.

Results of these studies indicate aged care residents attended by emergency ambulance are clinically complex, with frequent co-morbidity as evidenced by an average Charlson Comorbidity Index score greater than 5, and polypharmacy with an average of 7.9 medications per person. Common reasons for ambulance call-out included a ground level fall (both with and without injury), suspected infection, shortness of breath and altered conscious state. These reasons varied by gender, with women more frequently experiencing falls and pain, and men reporting shortness of breath. Vital signs were under-reported, but the most frequent abnormality on initial paramedic assessment was an altered conscious state. Compared with research undertaken using ED data, these studies found a low rate of medical intervention during prehospital care with 36% of patients receiving supplemental oxygen, 22% having an intravenous cannula inserted and 8% receiving intravenous fluid. Incidence of advanced resuscitative intervention including endotracheal intubation, cardiopulmonary resuscitation or defibrillation was rare.

The above findings reported in Chapter Four and Five are important in guiding training of prehospital care clinicians and in optimising treatment protocols and practice development. Despite this low rate of intervention, rate of transport to hospital was high with 90% of people transported. Characteristics associated with increased frequency of decision to transport to hospital, as described in Chapter Six, include living in a rural area, high combined comorbidity score, a history of depression, cardiovascular disease, stroke, osteoporosis or previous fracture, prescription of anticoagulants and psychoactive agents and a paramedic diagnosis of suspected fracture, stroke, head injury or febrile illness. People diagnosed with 'no problem identified', dizziness or collapse and anxiety were found to have lower odds of transport to hospital. The clinical complexity of people undergoing prehospital care and the limited range of prehospital intervention suggests the need for enhanced, multidisciplinary teams in order to optimise care provided in the prehospital setting and potentially negate the need for transfer to hospital.

7.4 Relevance of Findings to the Current Australian Health System

Over the last decade, a growing awareness of the frequent hospitalisation of older people living in RAC has led to the development of a range of strategies aimed at avoiding unplanned admission and improving care [111]. Peer-reviewed and published reports of interventions vary between single hospital areas and districts, yet many are similar in content [111]. Common types of intervention programs include the use of nurse practitioners (NP), specialist geriatric outreach, education of primary care physicians and RAC staff and provision of acute care within the RAC [111-117].

Nurse Practitioners

A number of studies have examined the impact of nurse practitioners in either a primary care, outreach or embedded RAC setting [112, 115, 117-119]. The training and scope of practice of nurse practitioners (NP) may vary, however, in general a NP is a registered nurse who has undertaken additional training, often including the completion of a Master's degree and who can practice independently with an extended range of skills and competencies [120]. Although NP's were found to be feasible within the RAC or outreach, the presence of a NP was not found to be associated with reduced rates of emergency transfer to hospital [112, 115, 117-119]

Specialist Geriatric Care

A range of models of specialist geriatric outreach have been described including preventive assessment and management within the care home, attendance for acute illnesses or injuries, and facilitated advance care plan documentation [27, 113, 116, 121-123]. For example, within Victoria, across a single health service, Hutchinson et al (2015), found an outreach program of geriatricians and geriatric specialist nurses was associated with reduced inpatient length of stay, however the impact on rate of ambulance call-out and ED transfer remained unclear [113]. These models of care have been frequently described as feasible and may improve quality of care within RAC, however the impact on rate of ED transfer is minimal and none of the identified studies examined association with frequency of emergency ambulance call-out [27, 113, 116, 121-123].

Telephone Support Services

A number of hospital sites have trialled telephone or telemedicine support services, providing RAC staff with advice and coordination of care between hospital and the care home [124-127]. These strategies may reduce the ED length of stay and rate of inpatient admission, however have not been associated with a reduction in rate of ED transfer, and the impact on emergency ambulance call-out remains uncharacterised [125, 127].

Primary Health Care

The Australian Medical Association (AMA) has described considerable gaps in the current provision of primary care to people living in RAC [23]. In their 2018 survey of Medical Practitioners, they identified that the proportion of General Practitioners (GPs) visiting people to provide care within a care home has decreased by 13% over the last two years, and over 36% of doctors currently providing care to people living in RAC are either unable to take on new patients or will reduce their number of visits within the next two years [23]. They identified barriers to provision of care within the RAC as the absence of dedicated examination rooms within care homes, inadequate rebates for RAC visits resulting in large amounts of unpaid work, and difficulty in accessing adequate medical investigations in particular radiology services [23]. These findings were reiterated in the 2019 AMA submission to the Australian Royal Commission into Aged Care Quality and Safety [128].

Programs to improve primary care to people in RAC have included improved access to GPs with associated attention to appropriate examination facilities at the RAC and after hours on call rosters [129, 130], and education of doctors with attention to safe prescribing and deprescribing [131]. Peer-reviewed reports of evaluation of these programs is limited but has described an associated reduction in polypharmacy and ED presentations [129-131].

RAC Staff

A number of programs incorporate strategies to train or upskill RAC staff in the recognition and management of acute deterioration and in communication with both primary care and hospital care teams. These are often well received by RAC staff [132] yet most have demonstrated minimal association with rate of ED transfer [125, 133-135]. The INTERACT program from the United States, is one of the most comprehensively evaluated programs and one of the few published RCTs of interventions to reduce unplanned transfers [134]. Authors describe the intervention as training and support, alongside providing a set of tools provided to RAC staff with the aim of improving recognition of acute deteriorations, improved communication and focus on appropriate advance care planning [134]. They found no significant difference in rate of hospital admission or ED presentation between intervention and control arms [134]. Authors postulated this may reflect staff motivation, medicolegal concerns and the specific nature of the training bundle provided [134].

Provision of Acute Care within the RAC

There have been a growing group of services aimed at provision of acute care by hospital based clinical teams, often known as Hospital in the Home or InReach services. Care for patients by these teams in the care home as an alternative to inpatient admission has been found to be both safe and effective [136]. These services have been associated with reduced inpatient admission and inpatient length of stay, however the impact on ED presentation is less clear [114, 136, 137]. Many of these programs do not enrol people until they are already in the ED, however there is some suggestion they may reduce future representation to ED [114, 136, 137]. The impact of these programs on emergency ambulance use has not been characterised.

7.5 Future Directions – Recommendations for Research and Implications for Health System Planning

Findings from this program of study provide a foundation for further research and system development. These implications are outlined in Figure 6 and are discussed below regarding the current system of emergency and acute care. To enhance patient-centred care, and grow the evidence base, it is recommended future research programs address the following concerns.

Improved program monitoring and evaluation

Several interventions for reducing emergency hospital transfers have been described in this chapter and include nurse practitioners (NP), specialist geriatric outreach, education of primary care physicians and RAC staff and provision of acute care within the RAC. Overall the quality of evidence for these programs has been poor [27, 111]. Most have been evaluated with a retrospective, pre and post design with limited numbers of prospective studies or controlled trials. Few studies examined the impact of the program on unplanned emergency department transports and no studies could be identified examining association of intervention with rate of emergency ambulance call-out.

Most studies have focused on health system outcomes, reporting rates of ED attendances, inpatient admission, lengths of stay. Few described a measure of quality of life, and there was a scarcity of other patient -orientated outcomes such as association of intervention with change in functional ability, pain, anxiety or other symptom control and autonomy in healthcare decision making.

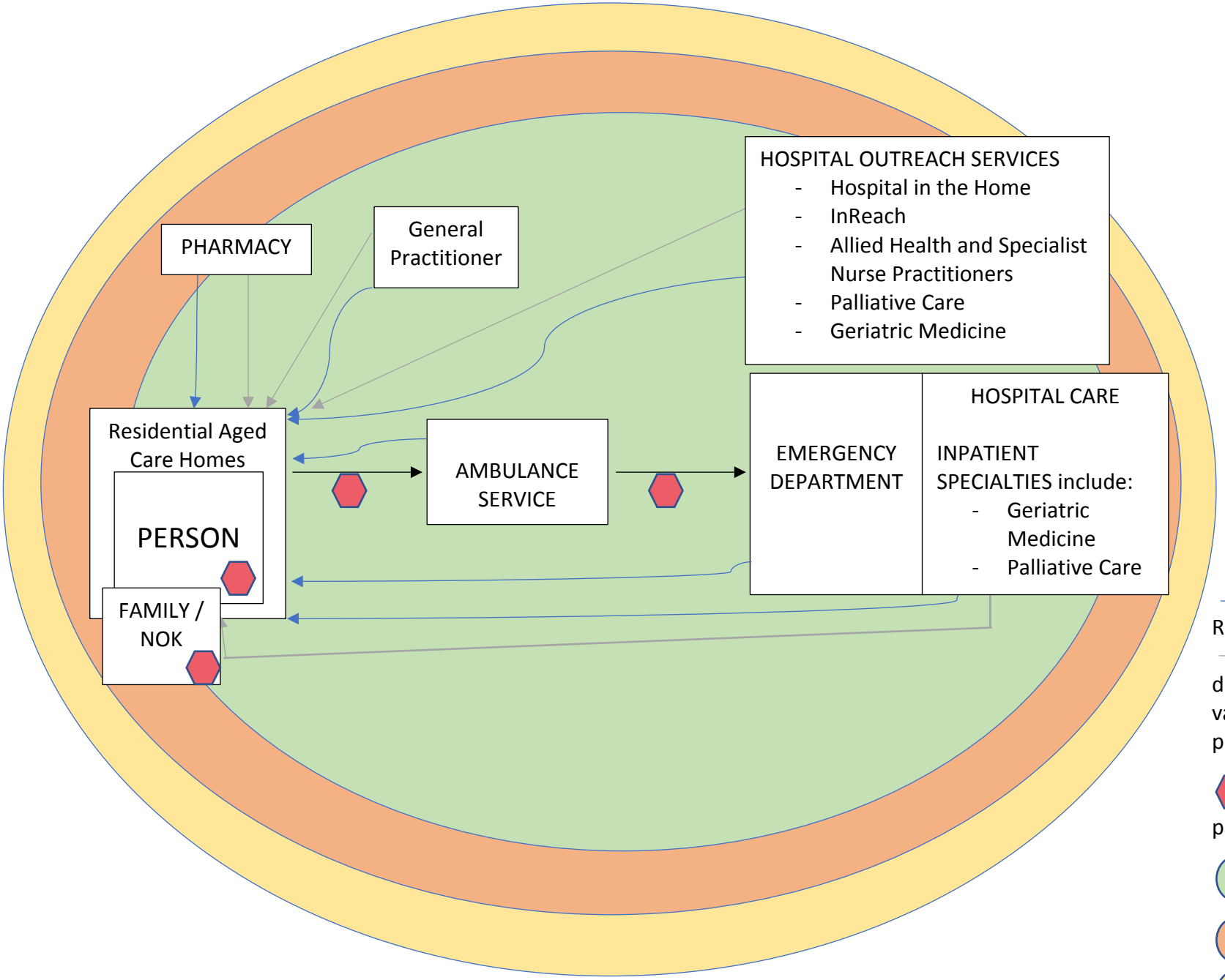

Figure 6: Key stakeholders, relation and scope of research recommendations and implications

Examination of More Comprehensive Clinical and Health System Characteristics

Further research is required to better characterise the impact of additional clinical characteristics such as frailty, functional disability, malnutrition and severity of cognitive impairment on frequency and outcome of prehospital emergency care. These features are unmeasured or poorly quantified in the existing peer-reviewed evidence base. In addition, within an Australian context, there needs to be an examination of how health system characteristics such as resourcing of RAC homes, staffing profiles, access to and composition of primary care teams, impact on rate and outcomes of ambulance call-out. These will likely require prospective data collection.

Inclusion of Patient-Oriented Outcomes

It is vital that there is further investigation of patient oriented outcomes of care in both a short and medium term, this includes symptom control, quality of life, autonomy in decision making, experience of care and deterioration in functional and cognitive capacity that may result from interaction with the acute healthcare system. These are likely to be more important to individuals than gross measures of mortality and morbidity, and would be complementary measures, providing a more patient-oriented and holistic assessment of medical care.

Appropriateness of Emergency Care

Research presented in Chapter Five demonstrated a high rate of ambulance use by older people living in RAC, yet a low rate of recorded intervention. These findings suggest that either intervention wasn't needed or perhaps that the appropriate intervention was not available to clinicians on scene. These alternatives must be clarified with prospective studies and investigation should include concurrent examination of the suitability of current ambulance service structure, protocols and procedures for care of this population.

Enhanced Design of Future Interventions

The findings detailed in this thesis will be highly beneficial in providing a basis for future design of patient oriented interventions and alternate pathways of acute care. Results of this program of research have identified specific foci for targeted prevention and management of acute deterioration which include assessment and management of injury post fall, management of acute and acute on chronic pain and investigation and management of febrile illness. Throughout this program of research, the frequent role of emergency and prehospital services in the acute care of this population has been highlighted. Therefore, it would be highly prudent to include specialist emergency and prehospital clinicians in the development and delivery of subsequent interventions. These findings suggest that to optimise care it will be essential to adapt the emergency and acute care systems including emergency department and prehospital services, to deliver models of care designed specifically for this vulnerable, older population.

Future programs and pathways of care must address patient, health system and RAC home predictors of requiring acute transfer. Additionally, any evaluation of an intervention must include assessment of patient orientated outcomes of care including incidence of negative consequences, as identified in Chapter Two such as medication error, delirium and functional decline. This will undoubtedly require consumer input into design. It is essential these interventions are trialled with adequate scientific rigour to allow proper understanding of which elements may truly provide benefit for people living in RAC.

7.6 Conclusion

Through the research presented in this thesis, the nature of emergency, prehospital care for older people living in RAC homes, in an Australian context, has been comprehensively examined. These studies have explored the predictors and outcomes of emergency, unplanned transfer to hospital and have described and investigated the patterns, case mix and outcomes of prehospital care for this population.

Older people living in RAC are frequent consumers of emergency medical care, yet under the current system of care they risk experiencing considerable adverse consequences. This population frequently undergoes prehospital care by the emergency ambulance service yet low rate of intervention and high frequency of transfer to hospital suggests this service could be better adapted to provide patient-orientated acute care for this group of older Australians.

Findings of this program of research have identified foci for improvement of both preventative and reactive health systems. This would allow optimisation of person centred acute and emergency care to improve the experience and outcomes of people living in RAC and mitigate iatrogenic adverse events.

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Appendices

Appendix 1: Search Strategy for Systematic Reviews

1. exp Nursing homes/
2. nursing hom*.mp.
3. exp Residential Facilities/
4. residential facilit*.mp.
5. exp Long-Term Care/
6. long term care .mp.
7. exp Skilled Nursing Facilities/
8. skilled nursing facilit*.mp.
9. exp Housing for the Elderly/
10. housing for the elderly .mp.
11. exp Homes for the Aged/
12. homes for the ages .mp.
13. residential aged care .mp.
14. exp Geriatric Nursing/
15. geriatric nurs*.mp.
16. exp Geriatrics/
17. geriatri*.mp.
18. exp Aged/
19. aged .mp.
20. elderly .mp.
21. exp Frail Elderly
22. frail elderly .mp.
23. exp “Aged, 80 and over”/
24. “Aged, 80 and over” .mp.
25. gerontolo .mp.
26. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
27. 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25
28. 26 and 27
29. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 28
30. exp Emergency Medical Services/
31. emergency medical servic* .mp.
32. exp Emergencies/
33. emergenc*.mp.
34. exp Emergency Treatment/
35. emergency treatmen*.mp.
36. exp Emergency Service, Hospital/
37. emergency servic* .mp.
38. exp Trauma Centers/
39. trauma servic* .mp.
40. trauma cent* .mp.
41. exp Emergency Nursing/

42. emergency nurs*.mp.
43. exp Emergency Medicine/
44. emergency medicine.mp.
45. “accident and emergency”.mp.
46. emergency department.mp.
47. exp Ambulances/
48. ambulanc*.mp.
49. paramedi*.mp.
50. prehospital.mp.
51. prehospital care.mp.
52. pre-hospital.mp.
53. 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52
54. 29 and 53

Appendix 2: Full Table of included references for 'A systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities'

Table of included references

STUDY	COUNTRY	SETTING	SAMPLE	METHODS
Bowman et al, 2001[138]	England	Admissions to single hospital site Over 12 months 1994	323 acute admissions to hospital from RACF Of these 116 were admissions to medical unit 58 selected for more detailed review	Medical record review
Godden et al, 2001[48]	England	One local health district Over 12 months 1996/7	3204 residents of RACF 847 admissions to hospital by residents of RACF	Retrospective review of hospital admissions dataset (NHS MDS) Department of Health accommodation statistics
Aminzadeh et al, 2004[49]	Canada	Sample of residential aged care facilities in City of Ottawa 6 months 2002/3	178 residents of RACF	Cross-sectional survey Interview with participant and completion of screening assessment Medical record review
Chou et al, 2009[139]	Taiwan	Single Veterans Home Over 12 months	368 Residents of RACF 635 ED visits	Medical record review

		2006		
Jensen et al, 2009[140]	Canada	Single district (19 RACF and 3 EDs) Over 12 months 2000	2473 residents of RACF 606 ED visits More detailed review of records of subset of 52 residents	Retrospective review of hospital administrative datasets Review of paramedic and hospital medical record
Codde et al, 2010[141]	Australia	Single hospital site Over 12 months 2007	1350 visits to ED by residents of RACF More detailed medical record review of 235 ED visits	Retrospective review of electronic hospital administrative data Medical record review for discharged patients
Gruneir et al, 2010[51]	Canada	Single district 6 months 2005	64,589 residents of RACF 21,773 ED visits	Review of administrative datasets (Levels of Care classification, National Ambulatory Care Reporting System, NACRS)
Tang et al 2010[106]	Hong Kong	Selection of 14 RACF within one city 90 days	1820 residents of RACF	Interview with RACF resident participants and with staff caring for them Medical record review
Graverholt et al, 2011[50]	Norway	One district (2 hospitals, 38 RACF) 24 months 2007/8	2451 emergency hospital admissions by residents of RACF (by 1668 individual patients)	Review of electronic administrative data (Acute Medical Information System, AMIS)

				Review of electronic hospital patient records and ambulance records
Gruneir et al, 2012[142]	Canada	Single district 2005	64,589 residents of RACF	Review of electronic administrative data (Levels of Care census, National Ambulatory Care Reporting System)
Walsh et al, 2012[143]	USA	National dataset 12 months 2005	382,846 hospitalisations of RACF residents dually eligible for Medicare and Medicaid (for conditions classified as potentially avoidable hospitalisations)	Retrospective review of Medicare and Medicaid datasets
Graverholt et al, 2013[108]	Norway	Single district 2007/8	2451 hospital admissions for residents of RACF	Review of hospital datasets, hospital and ambulance patient records
Vossius et al, 2013[144]	Norway	Single Hospital Site 12 months 2011	940 acute hospital admissions of residents of RACF	Review of electronic hospital administrative datasets, medical record review
Carter et al, 2006[145]	USA	Representative sample of national dataset 36 months 2000/02	10 586 Hospital transfers of residents of RACFs	Review of administrative data set (National hospital Ambulatory Care Survey, NHAMCS)

Ingarfield et al, 2009[146]	Australia	Single city 36 months 2003/6	6,167 RACF residents presenting to an ED	Review of hospital administrative datasets
D'Arcy et al, 2013[147]	USA	Sample drawn from nationally representative sample 14 months 2003/4	66,551 residents of RACF	Sample of Medicare enrolled residents with history of ACS and at least one geriatric condition
Quinn et al, 2011[148]	Scotland	Single hospital site 3 months 2007	83 residents of RACF admitted to general medicine and orthopedic surgery units	Contemporaneous medical record review during inpatient admission
Yeung et al, 2011[149]	Hong Kong	Single hospital site 12 months 2006/7	2942 fall related presentations to hospital by people aged 60 years and older	Medical record review
Close et al, 2012[150]	Australia	Single hospital site 24 months 2007/9	3220 fall related presentations to hospital by people aged 70 years and older (by 2703 individual patients)	Hospital administrative dataset Medical record review
Schurch et al, 1996[151]	Switzerland	Single hospital site 12 months 1992/3	437 patients admitted with fracture of proximal femur	Medical record review
Brennan nee Saunders et al, 2003[152]	Wales	Single city 12 months 1999	1305 people aged 65 years and over who presented to ED with a fracture	Electronic hospital datasets and population based surveillance system (All Wales

				Injury Surveillance System, AWISS)
Carter et al, 2008[153]	USA	National dataset 36 months 2001-04	6650 injury related ED visits by adults aged 65 years and older	Review of national administrative dataset (National Hospital Ambulatory Care Survey, NHAMCS)
Crilly et al, 2008[154]	Australia	Single hospital site 12 months 2002/03	9624 presentations to ED by people aged 65 years and older (1,788 by RACF residents)	Review of medical records
Ronald et al, 2008[105]	Canada	Single province 36 months 1996/9	130,000 hospitalisations of people aged 65 years and older (6826 by residents of RACFs)	Review of administrative datasets
Watson et al, 2011[155]	Australia	Single state 12 months 2006/7	Estimated 143,000 falls requiring medical treatment	Review of administrative dataset
Wang et al, 2011[52]	USA	Representative sample of national dataset 36 months 2005/8	2,276,184 ED visits by RACF residents (Calculated national estimates)	Review of national dataset (National Hospital Ambulatory Medical Care Survey, NHAMCS)
Ginde et al, 2013[156]	USA	Representative sample of national dataset 5 years 2005/9	174,020 ED visits	Review of national dataset (National Hospital Ambulatory Medical Care Survey, NHAMCS)

Barker et al, 1994[103]	USA	Single county (33 RACFs) 12 months 1982	2120 residents of RACF, 892 hospitalisations	Administrative datasets, review of case management records
Romero-Ortuno et al, 2012[157]	Ireland	Single hospital site 8 years 2002/10	1938 admissions to hospital of residents of RACF (1035 individual patients)	Hospital administrative datasets and medical record review
Garcia-Vidal et al, 2011[158]	Spain	Single hospital site 8 years 2001/9	2245 patients admitted with pneumonia	Follow up of prospectively recruited cohort
Wu et al, 2012[159]	Canada	Single province 4 years 2003/7	6040 to 7222 ED visits with adverse drug reactions by patients aged 65 years and older per year	Review of five linked medical administrative datasets
Street et al, 2012[160]	Australia	Single district (3 hospital EDs) 12 months 2009	4637 presentations to ED by residents of RACF (3184 individual patients)	Review of hospital administrative datasets
Cwinn et al, 2009[161]	Canada	Single hospital site 6 months 2004	457 transfers to hospital of 380 individual RACF residents	Review of medical records and transfer documentation
Arendts et al, 2012[162]	Australia	Sample of 6 EDs in single state 12 months 2006/7	4680 ED presentations by residents of RACFs	Review of hospital administrative data and
Bennett et al, 2004[163]	USA	Single hospital site	185 people aged 75 years or older	Retrospective medical record review

		1 month 2007	admitted to hospital	
Han et al, 2009[164]	USA	Single hospital site 12 months 2008	341 people aged 65 years and older presenting to the ED	Prospective identification of patients in ED and completion of interview and screening tools. Review of medical record
Caterino et al, 2012[165]	USA	Representative sample of national dataset 7 years 2001/8	7,730 records of ED presentations for urinary tract infection (estimated to represent 25.4 million ED visits)	Review of national dataset (National Hospital Ambulatory Medical Care Survey, NHAMCS)
Girio-Fragkoulakis et al, 2011[166]	England	Single hospital site 6 months 2007	11760 presentations to ED by people aged 65 years and older, 1163 by residents of RACF	Review of hospital administrative dataset. Medical record review
Lee et al, 2000[167]	USA	Single hospital site 2 months 1995	75 patients aged 65 years and older, transferred to ED from RACF	Prospective recruitment of patrticipants in the ED, review of medical records and analysis of blood specimens
Jayasinghe et al, 2007[168]	Australia	Single hospital site 8.5 months 2004	147 residents of RACF transferred to ED	Prospective recruitment of participants in the ED Follow-up phone interviews post discharge
Keelaghan et al, 2008[169]	USA	2 hospital sites 1998-2001	3,230 people aged 65 years and older admitted to	Prospective recruitment of participants in the ED and follow-up

			hospital (283 transferred from RACF)	3 days into inpatient admission
Lane et al, 2013[170]	Australia	Single hospital site 6 months 2009/10	228 presentations to hospital by residents of RACF (186 individual patients)	Medical record review
Jones et al, 1997[171]	USA	2 hospital EDs	1012 presentations to ED by RACF residents (709 individual patients)	Contemporaneous review of medical record and patient transfer form during ED admission Completion of questionnaire by treating physician in hospital
Finn et al, 2006[172]	Australia	Single hospital site 6 months 2002	541 ED presentations by residents of RACFs	Review of emergency department and ambulance records
Carter et al, 2009[173]	Scotland	Single hospital site 1 month 2007	114 residents of RACF who attended the ED	Review of medical record Completion of questionnaire by ED care provider
Nelson et al, 2013[174]	USA	Single hospital site 4 months 2011	100 residents of RACF who attended the ED	Completion of survey by treating physician in ED Review of medical record
Ackerman et al, 1998[104]	USA	Single county (4 EDs, 10 RACF) 12 months 1995	1488 ED visits by residents of RACF (873 individual patients)	Medical record review

Lee et al, 2003[175]	Singapore	Single hospital site 3 months 2001	201 residents transferred to ED	Contemporaneous completion of questionnaire whilst patient in ED by treating physician
Baumgarten et al, 2006[176]	USA	2 hospital sites 1998-2001	3233 people aged 65 years and older admitted to hospital form ED	Prospective recruitment of participants and follow-up on day 3 of admission
Boockvar et al, 2005[177]	USA	59 RACFs in one state 24 months 1992/5	2,153 residents of RACFs	Prospective recruitment and follow-up of participants. Interviews with participants and review of medical records Interviews with facility staff
Bergstrom et al, 2008[178]	USA	102 RACFs 12 months 1996/7	774 residents of RACFs	Medical record review Interview with and examination of participants
Han et al, 2010[179]	USA	Single hospital site 14 months 2007/8	628 people aged 65 years and older presenting to ED	Prospective recruitment and follow up of participants in ED to 6 months post presentation Patient interview and assessment Review of medical records and administrative datasets
Quach et al, 2012[180]	Canada	22 RACFs 24 months	424 residents of RACF who visited the ED and 845 who did	Review of medical records and infection outbreak records

		2006/8	not experience a visit to ED during study period	
Benenson et al, 2005[181]	Israel	Single hospital site 12 months 2000/1	245 patients with positive blood cultures taken in the ED	Prospective recruitment, and survey of participants with review of medical records
Lautenbach et al, 2002[182]	USA	2 hospital sites 18 months 1998/9	75 patients with resistant bacteria and 67 control participants	Review of medical records and culture specimen results
Rezende et al, 2002[183]	USA	Single hospital site 18 months 1996/8	297 patients with bacteremia at time of hospital admission (51 were residents of RACFs)	Review of medical records and laboratory results
Gopal Rao et al, 2007[184]	England	Single hospital site 12 months 2004/5	6469 patients presenting to ED (184 RACF residents)	Prospective recruitment of participants and collection of specimens Review of medical records
Stuart et al, 2011[185]	Australia	3 RACFs 2 months 2010	119 residents of RACFs	Prospective recruitment of participants and collection of samples Completion of questionnaire Medical record review
Stuart et al, 2012[186]	Australia	5 RACFs 1 month 2009/10	257 RACF residents	Cross-sectional survey Review of records and medication prescriptions

Ho et al, 2007[187]	Hong Kong	Sample of RACFs in one city 1 month 2005	949 RACF residents	Cross-sectional survey, completion of questionnaire and collection of samples
Huang et al, 2012[188]	Taiwan	Single hospital site 24 months 2006/8	1636 patients admitted with positive blood cultures (480 were RACF residents)	Review of medical records and pathology results
Kruse et al, 2013[189]	USA	Nationally representative dataset 12 months 2006/7	40,128 residents of RACFs who survived the index hospitalisation	Review of administrative datasets (Minimum Data Set, MDS and Medicare records)
Binder et al, 2003[190]	USA	36 RACF in one state 36 months 1995/8	781 episodes of lower respiratory tract illness among residents of RACFs	Prospective recruitment and follow-up of participants through interview and review of medical record
Fried et al, 1997[191]	USA	Single RACF 15 months 1991/3	312 episodes of pneumonia in RACF residents	Review of medical records and routine nursing assessments
Saliba et al, 2000[192]	USA	One state (8 RACF and 10 hospitals) 12 months 1994/5	100 RACF transferred to hospital during study period	Review of RACF and hospital administrative data Review of medical records (Structured implicit record review)
Mitchell et al, 2010[193]	Scotland	Single hospital site	873 EV presentations by RACF residents	Review of hospital administrative data

		12 months 2006	(615 individual patients)	Medical record review
Ahearn et al, 2010[194]	England	Single hospital site 3 months 2007	3518 patients admitted to medical unit during study period (62 RACF residents)	Review of hospital administrative data Medical record review
Alrawi et al, 2013[195]	England	Single hospital site 36 months 2005/7	314 residents of RACF admitted to inpatient medical unit	Contemporaneous review of medical records during inpatient admission
Kaplan et al, 2002[196]	USA	National dataset 12 months 1997	623,718 people aged 65 years and over hospitalized with pneumonia	Four linked administrative and hospital datasets
Barker et al, 2011[197]	Australia	Single state 24 months 2006/8	1 008 816 patient discharge episodes in low-mortality diagnoses related groups	Hospital administrative dataset
Depuydt et al, 2011[198]	Belgium	Single hospital site 12 months 2006/7	287 admissions with pneumonia (269 individual patients)(33 RACF resdients)	Review of hospital administrative dataset Medical record review
Finucane et al, 2000[199]	Australia	Single hospital site 3 months 1998	184 inpatient admissions of RACF residents (153 individual patients)	Review of medical record and transfer documentation Follow-up telephone interviews with staff caring for residents post discharge

Man et al, 2011[200]	Hong Kong	Single hospital site 18 months 2004/5	767 RACF residents diagnosed with pneumonia in the ED	Review of medical records and investigation results
Bercovitz et al, 2005[201]	USA	59 RACFs in single state 24 months 1992/5	2,153 RACF residents	Prospective recruitment, interviews with and assessment of participants. Review of medical records and administrative datasets Follow-up of participants for 2 years or until death
Chen et al, 2010[202]	Taiwan	Single RACF 12 months 2006	559 RACF residents	Prospective recruitment of participants, completion of interview and assessments, follow-up
Ouslander et al, 2010[203]	USA	Single state 15 months 2005/6	377 RACFs with detailed record review of 20 RACFs	Review of administrative datasets (Minimum Data Set, Medicare dataset) Medical record review (Structured implicit record review)
Finucane et al, 1999[204]	Australia	Single hospital site 3 months 1998	300 RACF residents transferred to ED	Review of medical records and referral documentation

Hillen et al, 2011[205]	Australia	Single hospital site 6 years 1999-2005	3310 admissions to hospital of residents of RACF (2130 individual patients)	Review of hospital administrative data
Bisharat et al, 2012[206]	Israel	Single hospital site 12 months 2009	292 patients readmitted to inpatient medical unit during study period (25 RACF residents)	Medical record review
Chiang et al, 2012[207]	Taiwan	Single RACF 12 months 2006	609 RACF residents	Prospective recruitment of participants, completion of interview and screening assessments and follow-up for study period
Kruse et al, 2003[208]	USA	Single state (36 RACFs) 18 months 1997/8	2010 episodes of lower respiratory tract infection in residents of RACF (1341 individual participants)	Prospective recruitment, completion of initial assessment and follow-up of participants for study duration Review of medical records
Boockvar et al, 2008[209]	USA	Single state (60 RACFs) 24 months 1992/5		Prospective recruitment of participants, completion of initial interview and assessment, follow-up for duration pf study period Review of Medical record and Medicare data

Caplan et al, 2006[210]	Australia	Single district (2 hospital sites, 19 RACFs) 1999-2004	19 RACFs	Evaluation of an advance care planning education and hospital in the home service Review of hospital and ambulance administrative data

Appendix 3: Full List of References for Study 'A systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities' (64)

Supplementary Data:

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Appendix 4: Data Variables, Values and Missing data

Variable Name	**Value Labels**	**Description of variable**	**Missing values** n (% of total)
Case date	Date variable	Date of ambulance call out	0
Case patient ID	(numeric)	Unique identifier. Used for linking the datasets. Unique number for every individual patient - ambulance interaction.	0
Service ID	11 = metro 12 =rural	Identifies if rural or metro ambulance service	0
Age years	(numeric)	Patient's age (years)	0
Gender	1 = female 2 = male	Pt Gender	51 (0.03)
Pt postcode	(numeric)	Home postcode of patient	577 (0.31)
Final event type code		Medical Priority Dispatch System (MPDS) Code. A coding system used to dispatch ambulances to scene.	0
Highest dispatch code	1 = time critical 2 = urgent 3 = Non-urgent 4 = Other		131 (0.07)
Call received time	Time Date Variable	Time the call to the ambulance service was received	
At scene time	Time Date Variable	Time the crew first arrive on scene	

At patient time	Time Date Variable	Time the patient first assess / get to patient	
Patient loaded time	Time Date Variable	Time the patient is loaded into the ambulance ready for transport	
At destination time	Time Date Variable	Time the ambulance reaches the final destination (e.g. hospital)	
Clear time	Time Date Variable	Time the ambulance crew has finished unloading the patient and restocking the ambulance and is ready to receive another job	
Off stretcher time	Time Date Variable	At the destination (e.g. hospital) - the time the patient is moved from the ambulance stretcher to the hospital bed, and care is transferred and handed over from paramedics to the hospital staff	
Scene duration time	(numeric)	Derived time from 'At scene' to ' Patient loaded'(if patient transported) or 'clear time'(if patient not transported)	

Transport duration time	(numeric)	Derived time from 'Patient loaded' to ' At destination time'	
Case nature	1= Medical 2= Trauma 3= Other	Used to categorise the diagnosis for the patient. Represents the cause' of the final diagnosis, for example 'bicycle collision',	9147 (4.84)
Initial pulse rate	(numeric)	Initial heart rate (HR) on first assessment	13267 (7.03)
Initial blood pressure systolic	(numeric)	Initial blood pressure (BP) on first assessment	14698 (7.8)
Initial respiratory rate	(numeric)	Initial respiratory rate (RR) on first assessment	11469 (6.1)
Initial Glasgow Coma Scale	(numeric)	Initial Glasgow Coma Scale (GCS) Score on first assessment. GCS is a measure of consciousness from 3 (lowest possible score = deeply unconscious), to 15 = normal	10893 (5.8)
Initial pulse oximetry percentage	(numeric)	Initial oxygen saturation - measure of oxygen level of the blood, as a percentage, normal = >95%	120357 (63.7)
Initial blood glucose level	(numeric)	Initial blood sugar level	132112 (70.0)

Heart rate (categorical)	1= Bradycardic 2= Normal 3= Tachycardic	<60 = bradycardic 60-100 = normal >100 = tachy	13267 (7.03)
Blood pressure (categorical)	1= Hypotensive 2=Normal 3= Hypertensive	<120 = hypotensive 120-140 = normal >140 = hypertensive	14698 (7.8)
Initial respiratory status	1 = Normal 2 = Respiratory distress 3 = Apnoea / decreased respiration 4 = Assisted ventilation		107765 (57.1)
initial ECG rhythm	1= Asystole 2= AF/flutter 3= Atrial tachycardia and SVT 4= Bradyarrhythmia 5= Normal sinus rhythm 6= Tachycardia NOS 7= PEA 8= VF 9= VT 10= Other 11= Paced		73720 (39.0)
Initial pain score	(numeric)	Initial pain score. Patients are asked to rate their pain out of 10 (10 = worst ever pain, 0 = no pain)	23182 (12.3)
xcoord_llwgs84	(numeric)	Longitude value of scene location. For point identification of scene location.	
ycoord_llwgs84	(numeric)	Latitude value of scene location. For point identification of scene location.	
Scene postcode		Postcode of the scene (where the ambulance	

		picked up the patient)	
Scene Location Type		1. RAC 2. Other	0
Patient outcome	1= Died - at scene, en route, in ED 2= Deteriorated 3= Improved 4=No Change 5= Unknown	Observed clinical outcome of the patient after assessment, treatment and transport by paramedics	11 431 (6.1)
Patient transport indicator	1 = No 2 = Yes	Indicates if a patient was transported to hospital OR left at the scene (e.g. treated and left at home). If patient is NOT transported to scene the time variables will only include 'call received time', 'At scene time', 'At patient time', 'clear time'.	0
Not transported reason	1= Dead on arrival 2= Died on scene 3= Patient for palliative care only 4= Referred to other healthcare provider 5= Treatment not required 6= Patient refused 7= Transport by other means 8= Other	Gives a reason the crew did not transport the patient	165 (0.9) (of those not transported)
Treating Team	1= General 2= MICA	Skillset of paramedic clinician treating patient.	19486 (10.3)
Re-attendance	Numeric	Designates repeat attendances to the same individual	

Final Paramedic Diagnosis	1 = Other 2 = Pain 3 = No problem identified 4 = SOB 5 = LRTI 7 = Superficial injury and open wound 8 = Fracture/dislocation 9 = Arrhythmia 10 = GI Other 11 = Stroke/TIA 12 = Dizziness /unsteadiness/weakness/syn 13 = ACS 14 = Altered conscious state and confusion 15 = UTI 18 = Anxiety 19 = Febrile illness 20 = COPD 21 = CCF 22 = HT 23 = Epistaxis 24 = Deceased 26 = Head injury 27 = Cardioresp arrest 29 = GU Other 30 = Endo other 31 = Resp other 32 = Neuro Other 33 = Psychosocial other 34 = Rheum other 36 = CVS Other 37 = Gastroenteritis	The final diagnosis given to the patient by paramedics	9882 (5.2)
Current Medications	1 =Y 0=N		
numpharm		broad number of different medications	
Antibiotics			
Anti-platelet			
Anti-coagulant			

Antipsychotic			
Sedative other			
Antidepressant			
OHG			
Insulin			
Cardiovascular			
Diuretic			
Paracetamol			
NSAID			
Opioid			
Other analgesic			
Other			
Anticholesterol agents			
Inhalers Asthma / COPD			
Aperient			
Antiepileptics			
Steroids			
Other psych			
Nil current meds			
Meds Unknown			
Ambulance clinical interventions	1 =Y 0=N		
Advice and reassurance			
Supplemental oxygen			
Intravenous cannula			
Cardiac monitoring			
Repositioning			
Spinal immobilisation			
Bandage or dressing			
Sling / Splint / Ice			
Pulse oximetry			
Airway manoeuvres and/or adjuvant device			

Cardiopulmonary resuscitation (CPR)			
Bag valve mask ventilation			
Endotracheal intubation			
Non-invasive ventilation			
Defibrillation			
Pelvic binder			
Ambulance Administered Medication	1 =Y 0=N		
Intravenous fluids (crystalloids)			
Morphine			
Methoxyflurane			
Glyceryl Trinitrate			
Aspirin			
Fentanyl			
Salbutamol or ipratropium bromide (inhaled)			
Antiemetic			
Frusemide			
Glucose			
Adrenaline (intravenous or intraosseous)			
Benzodiazepines			
Paracetamol			
Broader categories PMHx	1 =Y 0=N		
Hypertension			
Dementia			
Ischaemic heart disease			
Osteoarthritis			
Diabetes			
Depression			
Cerebrovascular disease			

Chronic obstructive pulmonary disease			
Other cardiovascular			
Dyslipidaemia			
Atrial fibrillation			
Cardiac failure			
Gastro-oesophageal reflux			
Other gastrointestinal disorder			
Osteoporosis			
Other neurological disorder			
Cancer			
Other genitourinary disorder			
Major surgery			
Falls			
Fracture			
Recurrent urinary tract infections			
Anxiety			
Other respiratory disorder			
Chronic renal impairment			
Other rheumatological disorder			
Hip or Knee replacement			
Other psychiatric disorder			
Other endocrinological disorder			
Chronic pain			
Anaemia			
Recurrent skin infections			
Nil past medical history recorded			
Age Adjusted Charlson Comorbidity Score	1 = Low (0 to 1) 2 = Medium (2-4) 3 = High (5+)		
Day of the week	0 =Sunday 1 =Monday	Day of the week of call-out	

	2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 6 = Saturday		
AHvsBH	1 =BH (Businesshrs 0800-1759 M-F) 0 = AH (weekend and 1800-0759)	After hours vs business hours call-out	
IRSAD decile	1 = 1st 2 = 2nd 3 = 3rd 4 = 4th 5 = 5th 6 = 6th 7 = 7th 8 = 8th 9 = 9th 10 = 10th	Pt's home address IRSAD decile	577 (0.3)

Appendix 5: Monash University Human Research Ethics Committee Approval

MONASH University

Monash University Human Research Ethics Committee (MUHREC)
Research Office

Human Ethics Certificate of Approval

This is to certify that the project below was considered by the Monash University Human Research Ethics Committee. The Committee was satisfied that the proposal meets the requirements of the *National Statement on Ethical Conduct in Human Research* and has granted approval.

Project Number:	**CF14/2705 - 2014001396**
Project Title:	**Emergency pre-hospital care of elderly people residing in aged care facilities Chief**
Investigator:	**Dr Judy Lowthian**
Approved:	**From: 30 September 2014 to 30 September 2019**

Terms of approval - *Failure to comply with the terms below is in breach of your approval and the Australian Code for the Responsible Conduct of Research.*

1. This research has been approved with a waiver of consent under the Statutory Guidelines on Research issued for the purposes of HPP 1.1(e)(iii) and 2.2(g)(iii) – *Health Records Act 2001 (Vic.)*
2. The Chief investigator is responsible for ensuring that permission letters are obtained, if relevant, before any data collection can occur at the specified organisation.
3. Approval is only valid whilst you hold a position at Monash University.
4. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval and to ensure the project is conducted as approved by MUHREC.
5. You should notify MUHREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
6. The Explanatory Statement must be on Monash University letterhead and the Monash University complaints clause must include your project number.
7. **Amendments to the approved project (including changes in personnel):** Require the submission of a Request for Amendment form to MUHREC and must not begin without written approval from MUHREC. Substantial variations may require a new application.
8. **Future correspondence:** Please quote the project number and project title above in any further correspondence.
9. **Annual reports:** Continued approval of this project is dependent on the submission of an Annual Report. This is determined by the date of your letter of approval.
10. **Final report:** A Final Report should be provided at the conclusion of the project. MUHREC should be notified if the project is discontinued before the expected date of completion.
11. **Monitoring:** Projects may be subject to an audit or any other form of monitoring by MUHREC at any time.
12. **Retention and storage of data:** The Chief Investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

Professor Nip Thomson Chair, MUHREC

cc: Dr Rosamond Dwyer; Prof Belinda Gabbe; Prof Just Stoelwinder; Assoc Prof Karen Smith

Postal – Monash University, Vic 3800, Australia
Building 3E, Room 111, Clayton Campus, Wellington Road, Clayton
Telephone +61 3 9905 5490 Facsimile +61 3 9905 3831
Email muhrec@monash.edu http://www.monash.edu.au/researchoffice/human/ ABN 12 377 614 012 CRICOS Provider #00008C

Ambulance Victoria

11th September 2014

To Dr Judy Lowthian
Department of Epidemiology and Preventive Medicine Monash University
Level 6, The Alfred Centre 99
Commercial Road
Melbourne VIC 3004

File Ref: REC14-012

Dear Judy

Re: Research Proposal "R14-012: Emergency pre-hospital care of elderly people residing in aged care facilities" dated August 2014.

I am pleased to inform you that Ambulance Victoria (AV) has approved participation in the above study, subject to:

- HREC Approval
- Return of Confidentiality Deed

The researchers will need to sign a confidentiality agreement (attached) and return via email to the AV Research Governance Manager, Emily Andrew at emily.andrew@ambulance.vic.gov.au prior to receiving any data.

Note, that any changes to the original application will require submission of a protocol amendment to the AV Research Committee for consideration. Please ensure that AV is informed of any protocol changes as soon as possible.

As a component of ongoing communication processes, AV requires annual progress reports and a final report on completion of the study. You will be emailed the progress report approximately four weeks prior to the due date. Progress reports are required to be submitted by email.

We look forward to working with you on this project.

Yours sincerely

SUE CUNNINGHAM
General Manager Strategy, Research and Innovation Ambulance Victoria

Appendix 7: Supplementary Data 'Patterns of emergency ambulance use, 2009–13: a comparison of older people living in Residential Aged Care Facilities and the Community'

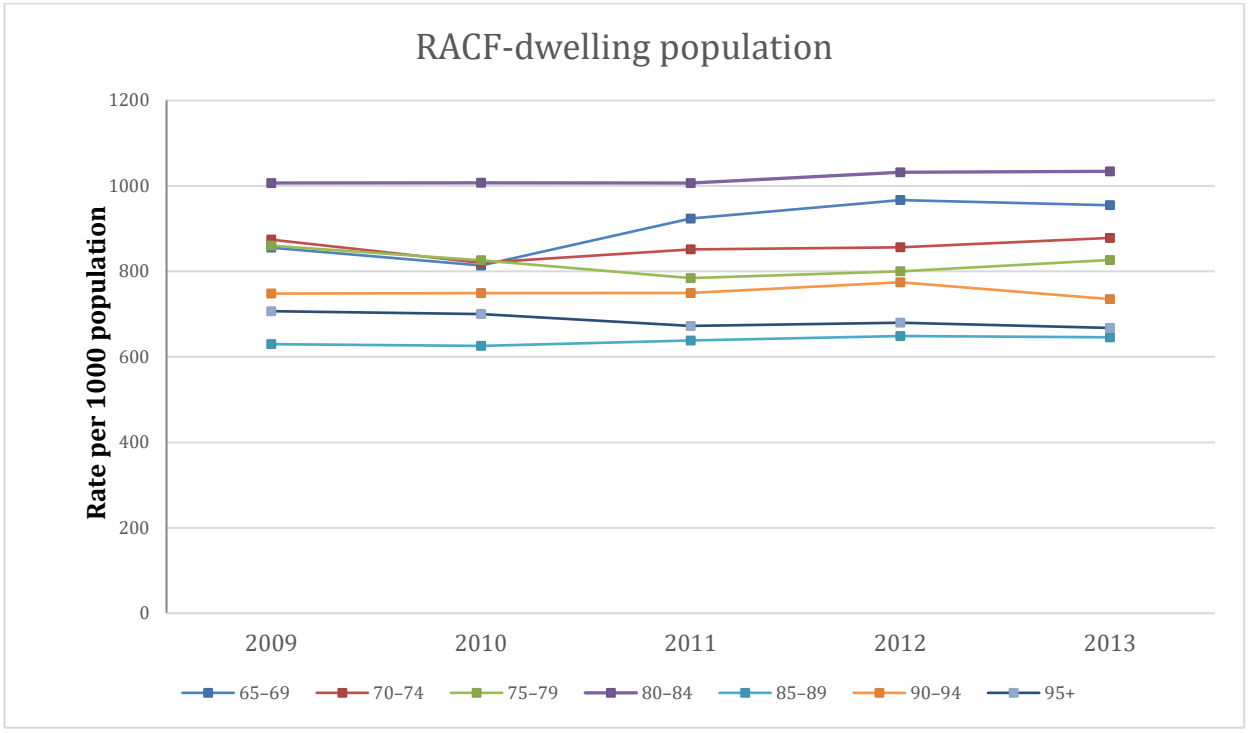
Table 2 Rates per 1,000 population of emergency ambulance attendance for 65+ year-old RACF- and community-dwelling population in Victoria **by gender** from 2009 to 2013

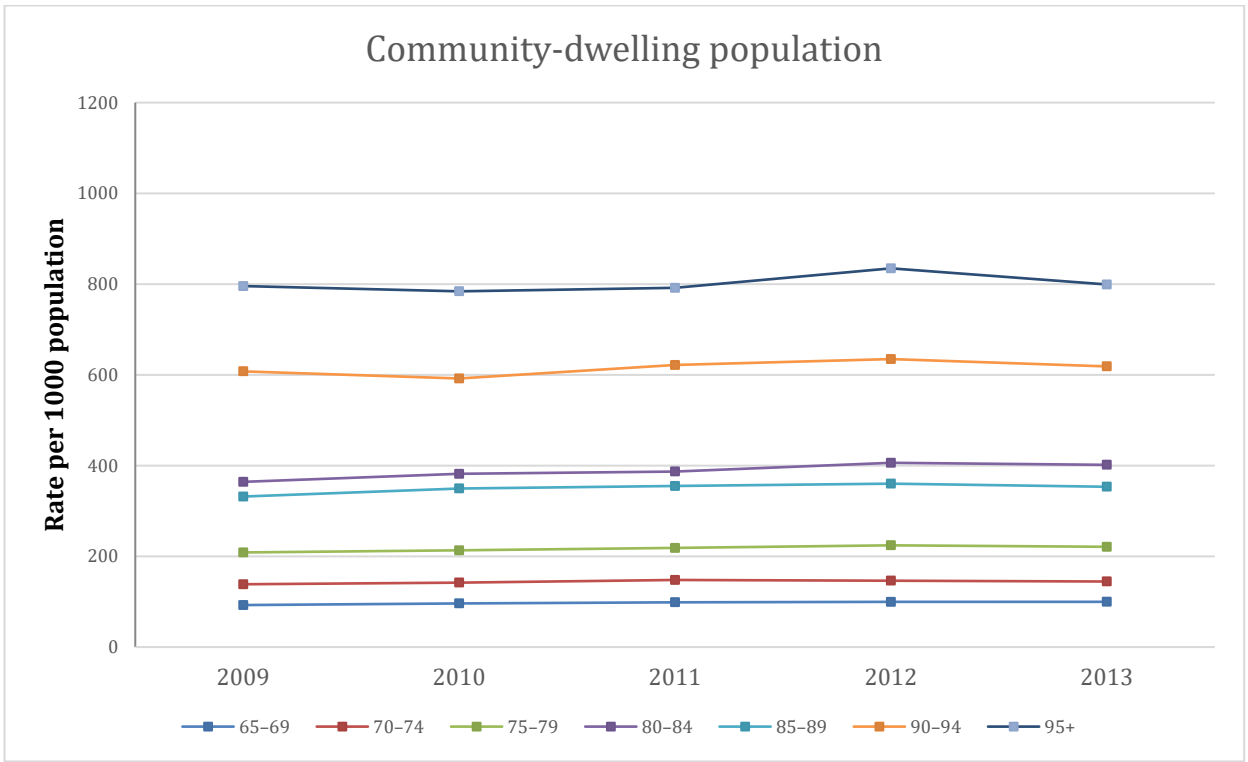
Year	RACF-dwelling population			Community-dwelling population		
	Males (rate per 1000 population)	Females (rate per 1000 population)	Rate ratio males to females (95% CI)	Males (rate per 1000 population)	Females (rate per 1000 population)	Rate ratio males to females (95% CI)
2009	995	709	1.40 (1.36, 1.45)	205	196	1.04 (1.03, 1.05)
2010	975	699	1.39 (1.35, 1.44)	210	204	1.03 (1.02, 1.04)
2011	984	696	1.41 (1.37, 1.45)	216	207	1.05 (1.04, 1.06)
2012	997	712	1.40 (1.36, 1.44)	217	213	1.02 (1.01, 1.03)
2013	974	709	1.37 (1.33, 1.41)	212	209	1.02 (1.01, 1.03)

Table 3 Rates per 1000 population of emergency ambulance attendance for 65+ year-old RACF- and community-dwelling population in Victoria **by age groups** from 2009 to 2013

Year	RACF-dwelling population							Community-dwelling population						
	65–69	70–74	75–79	80–84	85–89	90–94	95+	65–69	70–74	75–79	80–84	85–89	90–94	95+
2009	856	874	860	1007	630	748	707	93	138	209	364	332	608	796
2010	814	820	826	1007	626	749	700	96	142	213	382	350	592	784
2011	924	852	784	1007	638	750	672	99	148	218	387	355	622	792
2012	967	856	800	1032	649	775	680	100	146	224	406	360	635	835
2013	955	878	827	1034	646	735	668	100	145	221	402	353	619	799

Figure 2 Rates per 1000 population of emergency ambulance attendance for 65+ year-old RACF- and community- dwelling population in Victoria **by age groups** from 2009 to 2013





Appendix 8: Supplementary Data 'Predictors of Transport to Hospital After Emergency Ambulance Call-Out for Older People Living in Residential Aged Care'.

Supplementary Table 1: Past Medical History and age adjusted Charlson Comorbidity Index score for people living in Residential Aged Care Homes by transportation outcome in Victoria from 2008 to 2013

Past Medical History	Total population (n=188,849) n(%)	Not transported (n=19,489) n(%)	Transported (n=169,360) n(%)
Hypertension	89,371 (47.3)	8,936 (45.9)	80,435 (47.5)†
Dementia	61,773 (32.7)	5,803 (29.8)	55,970 (33.1)†
Ischaemic Heart Disease	52,396 (27.7)	4,600 (23.6)	47,796 (28.2)†
Osteoarthritis	46,423 (24.6)	4,391 (22.5)	42,032 (24.8)†
Diabetes	39,445 (20.9)	3,909 (20.1)	35,536 (21.0) ‡
Depression	35,973 (19.1	3,342 (17.2)	32,631 (19.3)†
Stroke / Transient Ischaemic attack	34,808 (18.4)	2,835 (14.6)	31,973 (18.9)†
Chronic Obstructive Pulmonary Disease	34,479 (18.3)	2,990 (15.3)	31,489 (18.6)†
Other Cardiovascular Complaint	34,159 (18.1)	2,878 (14.8)	31,281 (18.5)†
Dyslipidaemia	33,578 (17.8)	3,386 (17.4)	30,192(17.8) ns
Atrial Fibrillation	32,127 (17.0)	2,789 (14.3)	29.338 (17.3)†
Congestive Cardiac Failure	31,753 (16.8)	2,802 (14.4)	28,951 (17.1)†
Gastroesophageal Reflux Disease	27,146 (14.4)	2,700 (13.9)	24,446 (14.4)‡
Other Gastrointestinal Complaint	26,626 (14.1)	2,134 (11.0)	24,492 (14.5)†
Osteoporosis	24,870 (13.2)	2,005 (10.3)	22,865 (13.5)†
Other Neurologic Complaint	24,232 (12.8)	2,256 (11.6)	21,976 (13.0)†
Cancer	21,850 (11.6)	1,839 (9.4)	20,011 (11.8)†
Other Genitourinary Complaint	21,111 (11.2)	1,470 (7.5)	19,641 (11.6)†
Major Surgery	17,448 (9.2)	1,309 (6.7)	16,139 (9.5)†
Falls	16,034 (8.5)	1,548 (7.9)	14,486 (8.6)‡
Fracture	15,425 (8.2)	1,030 (5.3)	14,395 (8.5)†
Urinary Tract Infection	14,343 (7.6)	1,107 (5.7)	13,236 (7.8)†
Anxiety	14,300 (7.6)	1,530 (7.9)	12,770 (7.5) ns
Other Respiratory Complaint	14,216 (7.5)	1,076 (5.5)	13,140 (7.8)†
Chronic Renal Failure	11,950 (6.3)	919 (4.7)	11,031 (6.5)†
Other Rheumatologic Complaint	11,798 (6.3)	1,074 (5.5)	10,724 (6.3)†
Previous Joint Replacement	11,323 (6.0)	988 (5.1)	10,335 (6.1)†
Other Psychiatric / Psychological Complaint	11,050 (5.8)	1,194 (6.1)	9,856 (5.8) ns
Other Endocrine Complaint	10,602 (5.6)	919 (4.7)	9,683 (5.7)†
Chronic Pain	10,118 (5.4)	895 (4.6)	9,223 (5.5)†
Anaemia	8,282 (4.4)	619 (3.2)	7,663 (4.5)†
Skin Infection	5,727 (3.0)	462 (2.4)	5,265 (3.1)†
Nil Past Medical History Reported	522 (0.3)	93 (0.5)	429 (0.3)†
Age-Adjusted Charlson Comorbidity Score			
Low (0 to 1)	0	0	0
Medium (2-4)	50,619 (26.8)	6,564 (33.7)	50,619 (26.0)†
High (5+)	138,230 (73.2)	12,925 (66.3)	138,230(74.0)†

†p<0.001 ‡p<0.05

Supplementary Table 2: Current prescribed medications for people living in Residential Aged Care Homes by transport outcome for period 2008 to 2013, in Victoria, Australia

	Total population (n=188,849)	**Not transported (n=19,489)**	**Transported (n=169,360)**
Number of prescribed medications - mean (SD)	7.94 (4.96)	6.76 (4.60)	8.07 (4.98) †
Frequency of prescribed medications n(%)			
Antibiotics	139,439 (73.8)	13,409 (68.8)	126,030 (74.4)†
Cardiovascular (antihypertensives and antiarrhythmics)	90,420 (47.9)	8,636 (44.3)	81,784 (48.3)†
Paracetamol	78,523 (41.6)	6,583 (33.8)	71,940 (42.5)†
Diuretic	59,232 (31.4)	5,262 (27.0)	53,970 (31.9)†
Opioid	47,508 (25.2)	3,959 (20.3)	43,549 (25.7)†
Sedatives (including benzodiazepines)	45,939 (24.3)	4,063 (20.9)	41,876 (24.7)†
Antidepressants	38,477 (20.4)	3,489 (17.9)	34,988 (20.7)†
Cholesterol lowering agents	37,775 (20.0)	3,831 (19.7)	33,944 (20.0) ns
Inhalers for Asthma / COPD	35,820 (19.0)	2,904 (14.9)	32,916 (19.4)†
Aperients	35,673 (18.9)	2,701 (13.9)	32,972 (19.5)†
Antipsychotics	28,236 (15.0)	2,479 (12.7)	25,757 (15.2)†
Steroids	14,967 (7.9)	1,196 (6.1)	13,771 (8.1)†
Antiplatelet agents	13,486 (7.1)	1,278 (6.6)	12,208 (7.2) ‡
Anticoagulants	13,098 (6.9)	1,169 (6.0)	11,929 (7.0)†
Non-steroidal anti-inflammatories	8,143 (4.3)	838 (4.3)	7,305 (4.3) ns
Antiepileptic agents	8,098 (4.3)	829 (4.3)	7,269 (4.3) ns
Oral hypoglycaemic agents	7,694 (4.1)	749 (3.8)	6,945 (4.1) ns
Insulin	7,142 (3.8)	747 (3.8)	6,395 (3.8) ns
Medications not known	5,371 (2.8)	1,665 (8.5)	3,706 (2.2)†
Other analgesic agents	3,146 (1.7)	267 (1.4)	2,879 (1.7)‡
Nil current medications	1,400 (0.7)	339 (1.7)	1,061 (0.6)†
Other psychotropic agents	713 (0.4)	82 (0.4)	631 (0.4) ns

†p<0.001 ‡p<0.05

Supplementary Table 3: Paramedic assessment and reason for emergency ambulance call-out for people living in Residential Aged Care Homes by transport outcome for period 2008 to 2013, in Victoria, Australia

	Total population (n=188,849)	**Not transported (n=19,489)**	**Transported (n=169,360)**
Reason for Call Out* n(%)			
Medical	131,446 (73.2)	11,778 (63.1)	119,668 (74.3)†
Fall	27,956 (15.6)	3,842 (20.6)	24,114 (15.0)†
Final Paramedic Assessment Diagnosis* n(%)			
Pain	24,898 (13.9)	1,572 (8.5)	23,326 (14.5) †
Superficial injury	17,058 (9.5)	2,224 (12.0)	14,834 (9.3)
Other	16,236 (9.1)	1,889 (10.2)	14,347 (8.9)
Other gastrointestinal complaint	13,256 (7.4)	1,114 (6.0)	12,142 (7.6)
Lower respiratory tract infection	12,422 (6.9)	472 (2.5)	11,950 (7.5)
Suspected fracture or dislocation	10,083 (5.6)	90 (0.5)	9,993 (6.2)
Altered conscious state	9,423 (5.3)	436 (2.4)	8,987 (5.6)
Shortness of breath	8,150 (4.6)	222 (1.2)	7,928 (4.9)
Febrile illness	7,476 (4.2)	353 (1.9)	7,123 (4.4)
No problem identified	7,128 (4.0)	4,588 (24.7)	2,540 (1.6)
Dizziness/unsteadiness/collapse	6,893 (3.9)	1,024 (5.5)	5,869 (3.7)
Stroke/Transient ischaemic attack	6,668 (3.7)	138 (0.7)	6,530 (4.1)
Acute coronary syndrome	3,936 (2.2)	234 (1.3)	3,702 (2.3)
Congestive cardiac failure	3,828 (2.1)	100 (0.5)	3,728 (2.3)
Other genitourinary complaint	3,784 (2.1)	125 (0.7)	3,659(2.3)
Cardiac arrhythmia	3,619 (2.0)	98 (0.5)	3,521 (2.2)
Urinary tract infection	3,358 (1.9)	205 (1.1)	3,153 (2.0)
Other cardiovascular complaint	2,787 (1.6)	120 (0.7)	2,667 (1.7)
Other neurological complaint	2,669 (1.5)	215 (1.2)	2,454 (1.5)
Chronic obstructive pulmonary disease	2,284 (1.3)	57 (0.3)	2,227 (1.4)
Hypertension	1,972 (1.1)	145 (0.8)	1,827 (1.1)
Head injury	1,894 (1.1)	59 (0.3)	1,835 (1.1)
Epistaxis	1,639 (0.9)	273 (1.5)	1,639 (0.9)
Other psychosocial complaint	1,249 (0.7)	152 (0.8)	1,097 (0.7)
Deceased	1,219 (0.7)	1,194 (6.4)	25 (0.02)
Other endocrinological complaint	1,212 (0.7)	91 (0.5)	1,121 (0.7)
Anxiety	1,200 (0.7)	551 (3.0)	649 (0.4)
Cardiorespiratory arrest	789 (0.4)	589 (3.2)	200 (0.1)
Other respiratory complaint	644 (0.4)	84 (0.5)	560 (0.4)
Gastroenteritis	643 (0.4)	107 (0.6)	536 (0.3)
Other rheumatological complaint	550 (0.3)	39 (0.2)	511 (0.3)

*Missing data for reason for call-out and final paramedic assessment 9147 (4.84%) and 9882 (5.23%) respectively
†p<0.001 ‡p<0.05

Supplementary Table 4: Acuity for people living in Residential Aged Care Homes attended by emergency ambulances by transport outcome for period 2008 to 2013, in Victoria, Australia

	Total population (n=188,849)	**Not transported (n=19,489)**	**Transported (n=169,360)**
Initial heart rate (beats per min)* – mean (SD)	84 (19.91)	79 (15.93)	85 (20.28) †
Initial systolic blood pressure (mmHg)* – mean (SD)	135 (30.69)	134 (24.12)	135 (31.28) †
Initial respiratory rate (breaths per min)* – mean (SD)	19 (7.09)	16 (6.33)	20 (7.04) †
Initial Oxygen saturation (%)*– mean (SD)	94 (6.88)	95 (8.61)	94 (6.70) †
Initial blood glucose level (mmol/L)* – mean (SD)	9 (3.95)	8 (3.81)	9 (3.96) †
*Glasgow Coma Score** - n(%)			
Normal (14-15)	93,680 (52.6)	11,396 (62.3)	82,284 (51.5)†
Abnormal (<14)	84,276 (47.4)	6,886 (37.7)	77,390 (48.5)
*Pain Score** n(%)			
Nil pain	120,650 (72.8)	13,162 (83.7)	104,488 (71.7) †
Mild (1 to 3)	22,114 (13.4)	2,132 (13.6)	19,982 (13.3)
Moderate (3.1 to 6.9)	12,001 (7.2)	335 (2.1)	11,666 (7.8)
Severe (7 to 10)	10,902 (6.6)	90 (0.6)	10,812 (7.2)

*Missing data for initial heart rate, systolic blood pressure, respiratory rate, Glasgow Coma Scale, oxygen saturation, blood glucose level, pain score were 13267 (7.0%), 14698 (7.8%), 11469 (6.1%), 10893 (5.8%), 120357 (63.7%), 132112 (70.0%), 23182 (12.3%) respectively

†p<0.001 ‡p<0.05

Supplementary Figure 1: Proportion of people transported to hospital by time of day and day of week for people living in Residential Aged Care Homes attended by emergency ambulances for period 2008 to 2013, in Victoria, Australia