CHRISTCHURCH AIR RETRIEVAL SERVICE: A RETROSPECTIVE DESCRIPTIVE STUDY

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ABSTRACT

Introduction: With New Zealand's South Island classified as 80% mountainous terrain, inter-hospital air ambulance transport is necessary to ensure patients can have the most appropriate specialist treatment. Christchurch Air Retrieval Service (CARS) transports urgent or critical patients from smaller hospital facilities who require a higher level of care, with or without intensive care interventions. Other transport reasons include relocating or returning patients to their domicile DHB after an admission or specialist treatment, or relocating patients to areas with available bed spaces. The transport crew consists of an experienced intensive care flight nurse with or without an intensive care registrar. Less frequently, also utilised are other specialist services such as midwives, paramedics, paediatric, obstetric, surgical, anaesthetic or intensive care specialists.

Aim: To analyse and describe the CARS inter-hospital workload, over a 10 year period, to develop an epidemiological profile of the CARS' patients and describe the services provided for this population.

Method: A simple, descriptive, retrospective study design was selected for this research. This included the analysis of an electronic dataset, from 1st January 2008 to 31st December 2017, which was originally collected for purposes other than this research.

Results: Over the ten year study period, CARS completed 4365 inter-hospital patient transports. An increase in inter-hospital patient transports from 1.04 patients per day to 1.81 patients per day was seen over the study period, with the transport requests noting a similar increase. The average duration for each transport was 5 hours 34 minutes, and the most frequent transport crew was 'doctor and flight nurse', with a clear trend towards more 'flight nurse only' transports in the later study years. The majority of patients were brought to Christchurch Hospital and Christchurch Women's Hospital. The most frequently recorded mode of transport was that of fixed-wing aircraft, at 82.0% (n= 3570), helicopter transports were used on average 13.8% (n=595) of the time and road transports accounted for a mere 4.2% (n=198) of the workload. Despite this, helicopter and road only transports were more urgent in nature. Most transport missions started between 07:00 hrs and 14:59 hrs (68.2%, n=2971), and overall transport urgency has increased over the ten year study period. The most frequent medical reason for patient transport was cardiology services at 18.1% (n=789) followed by those needing ICU services at 16.2% (n=707).

Conclusion: The workload of CARS is increasing and patient's inter-hospital transport needs continue to become more urgent. Continuation and expansion of the data collection and further examination of the transport information discussed is required to fully evaluate future service requirements.

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LIST OF ABBREVIATIONS

CARS: Christchurch Air Retrieval Service

CDHB: Canterbury District Health Board

COASTN: College of Air and Surface Transport Nurses

DHB: District Health Board

EAAS: Emergency Air Ambulance Services

ICU: Intensive Care Unit

NASO: National Ambulance Sector Office

NHI: National Health Index

NICU: Neonatal Intensive Care Unit

NZFDS: New Zealand Flying Doctor Service

WFS: Wellington Flight Service

CHAPTER ONE: BACKGROUND

Introduction

This dissertation presents an outline of the Christchurch Air Retrieval Service (CARS), identifying the core features of this population and providing the first epidemiological profile that has been determined for the inter-hospital service provision. Elements of the history of air ambulance and the establishment of the New Zealand service, and in particular that within the Canterbury region, are outlined in this introductory chapter. A review of the literature is presented and significant gaps that exist are identified.

Air medical transport

An air ambulance is described as a uniquely outfitted helicopter or fixed-wing aircraft, specifically designed to transport patients who are ill, wounded, injured or otherwise mentally or physically incapacitated. A transport crew must be present and able to accommodate the medical needs of the patient. This includes having the capacity to perform emergency medical care in-flight (Ambulance New Zealand, 2013; Ministry of Health, 2018c; Swarbrick, 2010). The goal of the air ambulance aircraft is to respond in the shortest time possible, without compromising flight safety. The air ambulance services are particularly valuable when responding to life-threatening and/or time-critical clinical conditions, when ground transportation is impractical, uncomfortable, or when no other means are available to transport the patient (Ambulance New Zealand, 2013; Mehra, 2000; Ministry of Health, 2018c; Swarbrick, 2010).

There are many different terms used to describe air medical transport which is used in response to health care needs. These include terms such as air medical services, aeromedical retrieval services, air ambulance services, and aeromedical evacuation, amongst many others. The terminology indicates the various forms of air medical transport services that exist internationally, as well as the different focus that may be taken in different countries (Blumen, 2018; Ewington, 2016; Ramadas, Hendel, & Mackillop, 2016; Shirley & Hearns, 2006).

Within the literature, there are also different ways to describe or classify the types or purpose of air medical transports. In the United Kingdom, for example, military air medical evacuations are classified into three types. ‘Forward’ air medical evacuations are those transports from point of injury to a hospital. ‘Tactical’ air medical evacuation moves patients between medical facilities for specialist care when this is not locally available, while ‘Strategic’ air medical evacuation is described as repatriation of the patient to their home base (Ewington, 2016). Air medical transport can also be classified according to the level of medical care provided, such as critical care transport and specialty care transport or where distinctions are made between advanced life support and basic life support (Blumen, 2018).

A wider use of air medical transport classification separates transports into primary, secondary and occasionally tertiary transport. Primary transport is defined as the movement of a patient from the initial scene of an accident or injury to the first receiving hospital. This hospital could be the nearest hospital geographically, or a more distant hospital, for the patient requiring more specialised care, such as transport to a trauma centre. Secondary transport involves the movement of a patient from one hospital facility to another hospital facility with a higher level of clinical expertise, such as paediatric, neurosurgery, interventional cardiology and/or intensive care. These patient transports are often referred to as retrievals. Some of the literature also supports the term tertiary transport, where the patient is moved between two similar specialised hospital facilities (Ambulance New Zealand, 2013; Blumen, 2018; Ramadas et al., 2016; Shirley & Hearns, 2006). It is a common misconception that primary transports are by default more urgent than secondary transports, although, secondary transports can often be time critical as a result of an insufficient level of care from the referring hospital facility (Shirley & Hearns, 2006).

History of air ambulances

The first reported use of an aircraft for patient transport has been debated for many years. Stories such as the French using hot air balloons to transport injured soldiers from a battlefield in 1870 are now believed to be incorrect, as a result of translation errors (Holleran, 2010; Macnab, 1992; Odendaal, 2017). However, in 1915 during the First World War, a French military captain evacuated a wounded soldier to safety in an unmodified French fighter aircraft. Soon after, aircraft were converted into air ambulances and used in larger scale patient transport (Ewington, 2016; Holleran, 2010; Macnab, 1992; Odendaal, 2017). In 1917, the precursor to the world's first flying doctor service was established, and this air ambulance service became a reality in 1928, transporting the first patient from Cloncurry, Queensland, Australia (Royal Flying Doctor Service, no date). In the 1950s, air ambulance services started in New Zealand, transporting critically ill patients in remote areas to larger hospitals using fixed-wing aircraft. Rescue and air ambulance helicopters began being utilised for patient transports from the late 1980s, as they could land where fixed-wing aircraft could not, and proved to be much faster than road ambulance transports (Ministry of Health, 2008; Swarbrick, 2010).

Risk and safety of air medical transport

There are a number of well-known physiological changes and associated health risks with air travel, that can be an issue for healthy people and are especially challenging for unwell patients. There are four gas laws related to aviation physiology that are important to consider when transporting sick patients. Boyle's law explains that the volume of gas expands and contracts according to atmospheric pressure. When flying at altitude, air within the closed spaces of the body will expand, and special consideration must be taken when transporting patient's with certain conditions. Charles' law explains why room temperature decreases with increased altitude, and that extra caution must be exerted around the transport of patients who are sensitive to thermic changes. Dalton's law explains why traveling at altitude increases the risk of hypoxia, which can be detrimental for already critically unwell patients. Henry's law describes how sudden decompression at altitude may result in dysbaric injuries, such as air embolism or pneumothorax. This then complicates air ambulance transport of patients who are suffering from decompression sickness and need transportation to the hyperbaric centre (Blumen, 2018; Holleran, 2010; Odendaal, 2017). Other stressors of flight include noise, turbulence, motion sickness, disorientation, fatigue, gravitational forces, vibration, fear and dehydration, which can be a challenging environment to provide high levels of clinical care (Blumen, 2018; Ewington, 2016; Holleran, 2010; Odendaal, 2017).

<u>Guidelines and transport standards in New Zealand</u>

Several guidelines and standards of practice apply for air ambulances and the transport of critically ill patients in New Zealand. Ambulance New Zealand (2013) has released their second version of *"Air ambulance/air search and rescue service standard"*, which focuses on the air ambulance operations and activation. In contrast, the *"Ambulance and paramedical services"* by Standards New Zealand (2008) sets the minimum standard for clinical crew skills and requirements, and how the services are organised and provided. Within these standards, the following documents related to intensive care transports and flight nurse's aeromedical training are referred to.

In 2015 the Australasian College for Emergency Medicine, Australian and New Zealand College of Anaesthetists, and College of Intensive Care Medicine of Australia and New Zealand renewed the *"Guidelines for transport of critically ill patients"*. These guidelines acknowledge the associated risks when transporting critically ill patients, and aim to assist medical professionals and hospitals to implement strategies and protocols to reduce these risks and maximise patient safety. Furthermore, these guidelines list transport equipment that should be carried, and outline basic recommendations for clinical monitoring of the critically ill patient being transported (Australasian College for Emergency Medicine et al., 2015). Within the 2016 *"Standards of Practice"* published by College of Air and Surface Transport Nurses (COASTN) (formerly known as New Zealand Flight Nurses Association) it is noted that the air ambulance flight nurses should have aeromedical training and comply with a minimum level of emergency and resuscitation training. These standards aim to promote quality delivery of care to patients and whanau throughout the transport process, ensuring safe and effective transport nursing services. Promotion of optimum working conditions and measures to ensure the safety of all transport nurses are also included in the standards (College of Air and Surface Transport Nurses, 2016).

Healthcare and Air ambulances in New Zealand

New Zealand's hospital system is based on a mix of government care funded by taxation and private health care delivery mainly funded by health insurance. Treatment after injury is funded on a no-blame basis by the Accident Compensation Corporation. Twenty District Health Boards (DHBs) provide government funded health care services to the population within their district. Not all DHBs are able to provide every specialist service, necessitating some inter-district flows. Within this agreement some districts are the 'DHB of service' and provide funded services for other districts, for example, areas that are unable to provide this themselves (Ministry of Health, 2009, 2018d; Nationwide Service Framework Library, 2014).

At the time of this study, there were 18 ambulance/air rescue service providers registered with Ambulance New Zealand (Ambulance New Zealand, 2014). Some of these service providers only transport the patient from the initial scene of illness or injury to a primary medical centre, whereas other services solely carry out inter-hospital transports. According to the National Ambulance Sector Office (NASO) and the Emergency Air Ambulance Services (EAAS), the demand for air ambulance services has been rising, and it is predicted this this trend will continue for years to come. A new model for air ambulance services is also under design (Ministry of Health, 2016, 2018b).

In the Canterbury DHB region, GCH Aviation (formerly known as Garden City Helicopters) and its associated New Zealand Flying Doctor's branch are the air ambulance service providers for the local region where this research study is undertaken. These providers undertake both primary transports and secondary inter-hospital transports. All primary transports are done by helicopter. These are undertaken by the Westpac Rescue Helicopters in conjunction with GCH Aviation, where Intensive Care paramedics are transport crew. However, the objective of this research study is not to explore the above-mentioned mode of primary transports. All secondary inter-hospital transports are coordinated by the CARS team, and are carried out using helicopters, fixed-wing aircraft or by road transport if transport not able to be done by air. For the purpose of this study, only secondary inter-hospital transportation will be discussed, and in this context, the term refers to any patient transport from one medical facility to another medical facility, where the request has been lodged via CARS.

Canterbury District Health Board

The population of the South Island has grown numerically from 1,017,300 from June 2008 to 1,115,800 in December 2017, with the Canterbury region accounting for the largest advancement in the South Island, rising from 522,800 to 612,000 over the same period. The total national population has increased from 4,268,600 to 4,793,900, over the same almost 10 year time period (Statistics New Zealand, 2008, 2018).

Within the Canterbury District Health Board (CDHB), Christchurch Hospital is the largest tertiary, research and teaching hospital in the South Island. It provides a full range of acute, emergency, elective and outpatient services to New Zealand's second largest DHB in area and population (Canterbury District Health Board, 2018). The CDHB has a special partnership agreement with the West Coast DHB, to provide services for their population. The CDHB also provides specialist services including interventional cardiology, vascular and paediatric surgical services to patients from other DHB's through their South Island Alliance (South Island Alliance Programme Office, 2017). Furthermore, Christchurch Hospital is a major trauma centre, regional burns centre and national spinal referral centre, accepting patients from all of the South Island and the lower third of the North Island. This evenly distributes patients between the two national spinal centres and makes the CDHB a major service provider in the South Island (National Spinal Cord Impairment Governance Committee, 2015; Nationwide Service Framework Library, 2014; South Island Regional Major Trauma Network, 2017).

The most recently published statistics for cultural diversity in New Zealand are from the national census of 2013, and also describes the variance within New Zealand regions. The representation of the ethnic groups in the Canterbury region are here compared to the national cultural diversity as a whole, and the following was found: European (86.9% vs. 74.0%), Mãori (8.1% vs. 14.8%), Pacific peoples (2.5% vs. 7.4%), Asian (6.9% vs. 11.8%), Middle Eastern/Latin American/African (0.8% vs. 1.2%), and other ethnicity (2.0% vs. 1.7%) (Statistics New Zealand, 2013).

In 2008, prior to the Canterbury earthquakes, Christchurch Hospital was identified as requiring new and larger hospital facilities, to accommodate the expected growth and changes in Canterbury's population before the year 2020 (Canterbury District Health Board, 2016). The earthquakes cemented the need for a larger hospital facility, and the new Christchurch Hospital Acute Services Building is scheduled to be complete in 2019. An increase in helicopter transports is expected to accompany this development, as the new Acute Services Building will be equipped with a rooftop helipad and will be the South Islands largest hospital building. The increased service capacity includes additional operating theatres, an extended radiology department, an expanded intensive care unit (ICU) and a new emergency department. The helipad has undergone extensive design planning to comply with all regulatory requirements, and the goal is to improve patient care and patient outcomes, by improving patient transport time, flight teams dispatch time, and therefore patient's overall clinical management (Canterbury District Health Board, 2016).

Christchurch Air Retrieval Service

Christchurch Hospital has been involved in air ambulance transports since the 1970s, however, this accelerated following a sentinel event, the 1995 Cave Creek Disaster. This occurred on the South Island's West Coast, where a scenic viewing platform in the Paparoa national park collapsed, resulting in 18 people being severely injured. In total, only four people survived, with serious injuries and 14 died (McKerrow, personal communication, October 18, 2018; New Zealand Flying Doctor Trust, 2018). During this disaster, several medical teams were flown to Greymouth Hospital to assist in stabilising patients and subsequently transported intensive care patients to Christchurch Hospital.

In 2005, the CDHB formally partnered with the New Zealand Flying Doctors Service (NZFDS), resulting in fully equipped aircraft with intensive care doctors and nurses, who provided specialised care while the patient was being transported by air ambulance (McKerrow, personal communication, October 18, 2018; New Zealand Flying Doctor Trust, 2018). Nowadays, CARS represents the medical team based at Christchurch

Hospital, who work in conjunction with the NZFDS and Westpac Rescue Helicopters (operated by GCH Aviation), to provide secondary inter-hospital transport. Other partners include the New Zealand Flying Doctor Trust, Canterbury West Coast Air Rescue Trust, and St. John Ambulance. CARS operate 24 hours a day, seven days a week, and coordinates transport for around 600 - 1000 patients each year. Since Christchurch Hospital is the South Island's largest hospital and tertiary referral centre, the majority of workload comes from patients being transported from other South Island hospital centres to Christchurch Hospital for specialist treatment. However, the service also regularly operates between most hospital centres right throughout New Zealand (Department of Intensive Care Medicine, 2013; McKerrow, personal communication, October 18, 2018).

Types of patient transports/retrievals

Inter-hospital transportation of patients is required for many reasons. The most frequent transports within CARS, involve retrieval of urgent or critical patients from smaller hospital facilities who require a higher level of care, with or without intensive care interventions. Other reasons include relocating or returning patients to their domicile DHB after an admission or specialist treatment, or relocating patients to areas with available bed spaces. The full-time clinical nurse coordinator or a coordinator-trained senior flight nurse undertakes the coordination of patient transport within CARS, while the intensive care specialist on duty at Christchurch Hospital oversees all transports and provides clinical support for the teams.

The medical retrieval team is composed either of an ICU flight nurse or an ICU flight nurse and an ICU registrar. Occasionally, transports require other specialist services and other clinicians may be required such as midwives, paramedics, paediatric, obstetric, surgical, anaesthetic or ICU specialists. A specialist neonatal transport team operates out of the Christchurch Neonatal Intensive Care Unit (NICU) and undertakes any medical care needed for these patients, primarily using road transport, however the CARS coordinator arranges any aircraft usage for air NICU transports.

Aircraft and aviation challenges

New Zealand's unique geography and dispersed population distribution presents many obstacles, both for patients needing to access a higher level of hospital care and the air ambulance services retrieving these patients. With 80% of the South Island classified as "mountainous terrain" and it being the 12th largest island in the world (Blonigen, 2018), the pilots and CARS team face a number of barriers when carefully planning a patient transport. Strong wind, heavy rain and thunderstorms can delay or cancel a transport, so other modes of transport must be considered. The patient's condition and medical presentation is carefully considered, as some conditions require the patient to fly in a cabin pressurised to sea level, ensuring no adverse outcome as a result of travelling by air. Occasionally, some transports cannot be undertaken due to the weather or the complexity of the patient's medical presentation.

The service utilises two fixed-wing aircrafts which are fully equipped for patient transports. Aircraft provided by the NZFDS consist of one aircraft that can accommodate two stretcher patients and up to four crew/patient/relative seats, while the other fixed-wing aircraft can accommodate one stretcher patient and up to four crew/patient/relative seats. The fixed-wing aircraft are capable of reaching speeds of 520 km/h and range up to 2,775 km, they are certified to 35,000 ft, and are both fully pressurised meaning they can keep a sea-level cabin up to 16,000 ft. They are limited to only landing in airfields or airports and only have short runway requirements. Two twin-engine BK117 helicopters are available during the daytime, with one available 24 hrs a day, seven days a week for any helicopter transports that may be needed. These helicopters are provided by the Canterbury Westpac Rescue Helicopter service and can accommodate one stretcher patient and up to three crew seats. The helicopters are not pressurised, but are very versatile, as they can land in many rural locations, and can reach speeds of 280 km/h ranging up to 540 km without needing to refuel (Blonigen, 2018; Canterbury Westpac Rescue Helicopter, 2018; New Zealand Flying Doctor Trust, 2018). Road transports are also possible in the Canterbury and South Canterbury region and are conducted using a St. John's ambulance with the CARS medical team on board. Primarily, these transports are between the CDHB campuses, but are also utilised for urgent trips where weather conditions restrict any type of aircraft use (Department of Intensive Care Medicine, 2013).

Demand for air ambulance services

In the last 10 years, CARS has seen a large increase in patient transports. The service is reported as being busier and has needed to increase the total nursing full-time equivalent hours to accommodate this demand in transport need (McKerrow, 2018, Clinical Nurse Coordinator, Personal communication). The increase in demand has meant that if a transport request cannot be completed due to weather restrictions or the team being unavailable (due to undertaking other jobs), then this could necessitate asking other national service providers, such as Wellington Life Flight, to undertake the patient transport request.

Within the first part of Chapter One, the background for inter-hospital air ambulance services has been presented, and the CARS service has been described. The second part of Chapter One offers a literature review of research studies around inter-hospital air ambulance services, air ambulance service provision and the literature findings.

Related literature search strategy

In order to provide a clear understanding of the context associated with inter-hospital air ambulance transports, a systematic style review of the limited information available in this area has been conducted. A structured approach drawing on the PRISMA guidelines was undertaken (PRISMA, 2018). This has identified that while there is considerable material related to primary air ambulance services, acute accident response transfers and helicopter emergency medical services, there is very little which has focussed on the inter-hospital workload of air transport providers.

Search strategy

The topic focus was limited to literature which looked specifically at inter-hospital air ambulance services. The search was limited to English language only and the date range was from 2000 to 2018. An initial pilot search had identified early on that inclusion of terms restricted to New Zealand was too limiting, as there appeared to be very little published New Zealand data available. The initial intention was to seek primary research studies, either qualitative or quantitative in nature, but recognition of the lack of data following a pilot search saw the scope widened. This expanded to include all peer-reviewed materials, including grey literature published on reputable websites or forums and which had been subject to credible processes (e.g. commissioned reports, Government documents, guidelines, destination policies, and included a review of professional websites relevant to the area).

The search commenced with an identification of the key search terms, which were combinations of the following: air ambulance service, air retrieval service, air medical transport, air medical services, inter-hospital transport, inter-hospital retrieval, aeromedical retrieval. The following databases were searched: Medline (Ovid), Cochrane library (Wiley), CINAHL (EBSCOhost), and PubMed. Search terms were combined using Boolean logic, and limitations were placed to English language text and the availability online. Inclusion criteria are described in the accompanying Table 1.

Table 1

Inclusion and exclusion criteria for literature review

Inclusion criteria	Exclusion criteria
Involved the following: • inter-hospital transport • nurse and/or doctor transport • provided an outline of the service • a description given of the study population	• Single case studies/reports • Focus on transport crew experiences e.g. stress or fatigue • Where the inter-hospital component is part of a larger study, and cannot be extrapolated from this • Military service transportation only • Neonatal transfers

Following the online database search, further work continued as manual searches, exploring reference lists of papers and books, including searching for any additional grey literature on relevant websites of professional organisations and research groups. Specific sites searched included:

- NZ Ministry of Health, National Ambulance Sector Office (Ministry of Health, 2018e)
- NZ Ministry of Health, Emergency Air Ambulance Services (Ministry of Health, 2018c)
- NZ Air Ambulance Service (New Zealand Air Ambulance Service, 2018)

All citations were scanned for relevance to the study focus.

Search results

The search identified 11 studies and articles of relevance to this study. Ten of these were varied in focus, had different air ambulance arrangements, and included a large range of countries: United States of America (Gebremichael et al., 2000; Sand et al., 2010), Australia (Barker, Costello, & Clark, 2013; Barker & Ross, 2014; Delorenzo et al., 2017), Norway (Norum & Elsbak, 2011), Haiti (DeGennaro, Owen, Chandler, & McDaniel, 2016), the Canary Islands in Spain (Lubillo et al., 2000) and the United Kingdom (Dewhurst et al., 2001; Jameson & Lawler, 2000). None of these studies, however, identify a system directly comparable to that of the New Zealand CARS setup, although there are some elements similar to those identified within the CARS structure.

In four of the identified studies, the focus was on a specialty patient group. Two studies were based in the Northern Territory of Australia, one described 200 obstetric air medical retrievals, including demographics, clinical presentation and specialty intervention (Barker et al., 2013). The second study focused on paediatric air medical retrievals in the same geographical area and included 789 over a one year study period, presenting the most prevalent diagnosis, age and specialty intervention (Barker & Ross, 2014). Both of these studies reported much higher patient numbers per annum than those seen within CARS and had a much narrower focus of the patient population group, i.e. paediatric or obstetric patients only. The remaining two studies that focused on a specialty patient group were exclusively looking at critically ill patients either requiring mechanical ventilation or diagnosed with respiratory failure. These studies all looked at the clinical management of the critically ill patient, one study focused on clinical monitored values in a six month study and the other focused on therapeutic interventions and predicted mortality rate, therefore, a comparison with CARS would not be feasible. Furthermore, study numbers varied immensely from 20 per annum to 140 per annum, and the geographical setting of the United

Kingdom and the USA differ significantly to New Zealand (Gebremichael et al., 2000; Jameson & Lawler, 2000).

Another theme which was evident in the identified studies relates to international evacuations. Two studies utilised a similar nurse and doctor service structure to CARS and described similar population characteristics and aspects of patient's clinical presentation. However, both these studies cover global geographical areas and reflect the coverage and workload of insurance or repatriation companies. As such, they cannot directly be compared with New Zealand's population and air transport requirements (Dewhurst et al., 2001; Sand et al., 2010).

Four other studies considered the total air transport provision within their national areas. Where Delorenzo et al. (2017) described 16579 transport missions over a 4.5-year period in Victoria, Australia, Lubillo et al. (2000) described 1054 patient transports over two years, in the Canary Islands, Spain. However, both Delorenzo et al. and Lubillo et al.'s studies include primary and secondary air ambulance services, and due to this, the findings are not directly comparable to the CARS structure. In DeGennaro, Owen, Chandler, and McDaniel's (2016) study of the first year of Haiti's helicopter-based air ambulance service, although a similar transport crew set-up to that of CARS was described, and it was also nationally based, the service only transported 76 patients in their first year. This does not allow for a clear population profile. Similar low patient transport numbers can be seen in Norum and Elsbak's (2011) study of Northern Norway's air ambulance service over an 11 year period. Although this study reports patient demographics and clinical characteristics, together with mission information, the resident population on these islands at the time was only 2,570 inhabitants, and the reported transports are 345 patients within their study period (Norum & Elsbak, 2011). Although small, this study showed male to female ratio of the transported patients was 65% and 34% respectively. This study also showed that a diagnosis of heart and vascular disease together with bone fractures and infections were the most frequent and accounted for half of all transports, while 10% of patients were transported due to a gynaecological or obstetric condition (Norum & Elsbak, 2011).

Only one New Zealand study was identified, that of the Wellington Flight Service (WFS), undertaken by Myers, Psirides, Hathaway, and Larsen in 2012. This descriptive analysis presented a good overview of the WFS, and their inter-hospital transport workload over a five-year period, from 1st November 2005 – 31st October 2010. Similarly to CARS, their service utilises a nurse and doctor crew for patient transport. The authors reported the mission purpose, timings, transport type, severity of illness, clinical service requesting transport and medical crew in attendance. From this, they identified that their flight service completed an average of 2.2 inter-hospital transport missions per day. A total of 7,635 mission requests and 4,046 transport missions were completed over the five-year period. The median mission duration was 4 hours 30 min, and 9% of missions took eight hours or longer. Overall, 70% of transports were by fixed-wing aircraft, 11% road ambulance, 11% helicopter transports and less than 1% for commercial flights. They identified that due to weather changes, mechanical failure or death of the patient before team arrival, 5% of all missions were aborted, and backloads had increased from 6% to 25% over the study period. A doctor accompanied the patient on an average of 34% of all missions (increasing from 28% to 43%), a midwife 4% and the remaining 62% were flight nurse accompanied transports. Retrievals into Wellington Hospital were equal to transfers out of Wellington Hospital over the study period. The highest number of patients were transported for cardiac services, followed by neurosurgery, and ICU transport missions. In relation to the timing of missions, it was found that 69% of missions occurred between 7 am and 4 pm, with 26% beginning after 4 pm, and a further 6% after midnight (Myers et al., 2012). This study presents a number of points for comparison with the CARS service profile and will be considered further in the discussion.

Chapter summary

The purpose of this study is to describe and profile the inter-hospital service features provided by the Christchurch Air Retrieval Service, as there is very limited literature describing inter-hospital patient transport services in New Zealand. Chapter One has defined the core concepts and provided the context necessary to understand both the topic and context of this dissertation. Chapter Two presents the study design and methods that were used in carrying out this research. The study findings are presented in Chapter Three, followed by a discussion identifying the significance of these in Chapter Four and an outline of the conclusions in Chapter Five.

CHAPTER TWO: METHODOLOGY AND METHODS

Introduction

The purpose of this study is to examine the New Zealand CARS air ambulance service. Chapter One presented background information and identified the shortage of literature illustrating full service workload for inter-hospital air ambulance transports. This Chapter presents the methodology and methods used in the study of the CARS' population to generate the overall service profile. To date, there has been no overview generated of the Christchurch-based CARS service which has profiled the patient population, type of transports or service requirements.

Research aim

The aim of this study is to analyse and describe the Christchurch Air Retrieval Services inter-hospital workload, from 1st January 2008 to 31 December 2017. A 10 year period has been chosen as an achievable subset of data for the purpose of this study.

Research objectives

The primary research objective of this study is to develop an epidemiological profile of the Christchurch Air Retrieval Service's patients and specifically describe the inter-hospital transport services provided for this population.

Design

A simple, descriptive, retrospective study design was selected for this research. This study will involve the analysis of retrospective data, originally collected for purposes other than this research, and allows a fast and effective way of studying the research objective.

This is a widely used methodology in healthcare, typically applied to existing databases or used to review medical records (Gearing, Mian, Barber, & Ickowicz, 2006; Vassar & Holzmann, 2013). Due to the nature of this retrospective study the data of interest is already recorded allowing a researcher to examine the data and identify any differences in outcomes between groups of patients according to exposure (Aromataris & Munn, 2017). Utilising a descriptive study design involving retrospective data does not require interpretation or manipulation by the researcher, and the researcher can purely observe and report the characteristics deriving from the existing data.

Study population

The study population of interest was all patients transported by CARS between 1st January 2008 to 31st December 2017. Inclusion criteria was that the patient transport had occurred during this time frame, the transport involved was inter-hospital in nature and involved all ages from full term infants weighing more than 5 kg upwards. Exclusion criteria was any transport of premature babies and babies under 5 kg undertaken by the CDHB specialty neonatal intensive care flight team, along with transports undertaken by the primary transport team on the Westpac Rescue Helicopter.

Data extraction

Data from all CARS patient transports can be found on the original paper transport records held at a CDHB storage warehouse, however, for each transport mission the data is also entered into electronic data records. The record 'clinical team and mission information' is held by the CDHB in the form of an excel spreadsheet, for the purpose of collecting the transport information. This data is entered and accessed daily by the clinical nurse coordinator and the senior flight nurses within CARS, once the transport mission is completed. The electronic data records include information about time and date, the patient’s national health index number (NHI), their age, the sending and receiving hospital, the patient’s DHB of domicile, mission times, information of crew configuration and names, aircraft type, the purpose of the mission and urgency of the patient transport. Given the volume of records being accessed, it was not practical to access the handwritten paper records, the electronic records formed the basis for data extraction.

Demographic data search via the data warehouse

The electronic dataset did not hold information regarding the patient’s sex or ethnicity group, which was determined to be valuable information for describing the epidemiological profile of CARS transported patients. Following ethics and locality approval, the CDHB’s decision support team was requested to retrieve this data in year sets, matched against NHI numbers. This allowed anonymised data to be made available, which provided a year by year block detailing the aggregate sex and ethnicity data, although this was unable to be matched specifically to other data variables.

<u>Permissions and approvals</u>

A number of formal approval processes were undertaken, to ensure a robust study protocol was developed. The initial step was for the research proposal to be approved and peer-reviewed by staff at the Centre for Postgraduate Nursing Studies, University of Otago, Christchurch (Appendix 1). Following this, ethics approval for this study was granted by the University of Otago Human Ethics Committee (Health), Otago, New Zealand, reference number H18/063 (Appendix 2).

Research consultation with Mãori, through the University of Otago, Christchurch, was undertaken and approval granted. Further Mãori consultation was conducted via the CDHB Mãori advisory process, Te Komito Whakarite, and approval was also received from this committee (Appendix 3).

CDHB Locality Authorisation was initially obtained from the CARS clinical director, service manager, and clinical nurse coordinator, followed by the CDHB research office authorisation (Appendix 4).

Data analysis

Once all permissions and approvals were obtained, each years 'clinical team and mission information' was duplicated and identifiable data was removed, complying with ethics and locality regulations. All transports undertaken by the Christchurch NICU team were removed, and the specific variables needed for this research were identified (Table 2). All patient's transports were numbered and ten spreadsheets were created, one for each year. Following this, all patient transports were individually checked for spelling errors, missing or obviously incorrect values (these were corrected when identified), or coded as missing, and all data was coded for analysis. The data was then ready to be analysed using IBM SPSS Statistical, a statistical software programme, 2017, version 25. SPSS allows handling of large variable data formats, where the sum of data variables for this study exceeds 95.000.

Table 2

Data variables

Epidemiological data	**Service provision**	**Clinical characteristics**
Year	Crew	Specialty
Sex	Time team activated	Transport urgency
Ethnicity	Total time of mission in hours	Urgent or elective
Age	Mode of transport	Category
DHB of domicile	Day of week	Accident or medical
Sending hospital	Night flying	
Receiving hospital	Patient backloaded	
	More than one patient	
	Purpose of mission (a)	
	Purpose of mission (b)	

Definition of variables

Epidemiological data

The sex and ethnicity data were retrieved and de-identified by CDHB decision support and summarised into transport year groups. The sex variable was categorised by male, female or unknown. The ethnicity groups were classified by the CDHB based on the Ministry of Health's ethnicity coding system defined as: Asian, European, Mãori, Middle Eastern/Latin American/African, Pacific Peoples, residual categories or other ethnicity (Ministry of Health, 2010). The age of the patient was entered following transport occurrence and refers to the age at the time of transport. As the age of children under two was often described in months, this was converted into numerical values of year(s) with two decimals. The DHB of domicile was only unknown or missing in a total of four transports, however, within the 10-year study period, two official changes had been made to DHB groupings. In 2010, Otago DHB and Southland DHB merged and became the Southern DHB, and this is reflected in the data. In 2015 the Chatham Islands changed from having Hawke's Bay as the DHB of domicile to Canterbury DHB. The variables "DHB of domicile", "sending hospital" and "receiving hospital" refers to the Ministry of Health's regions and hospital registries (Ministry of Health, 2018a, 2018d).

Service provision

The 'total time of transport mission' was calculated from 'time team activated' to 'time team completed' and entered into the spreadsheet, for some years of the transports 'total time of mission' had to be individually calculated. Missions, where two or more patients were transported, had only one 'total mission time' entered, and for some missions where the team was sent on another mission before returning to Christchurch, the second mission would be started at the time of notification. 'Time team activated' refers to when the transport crew members were notified about the transport and started preparing for this mission. The time did not include other arrangements such as the coordinators taking patient details, checking the weather with pilots, arranging bed acceptance at the receiving hospital, booking ambulances or calling in a doctor. ‘Time team completed’ refers to the time the crew handed over patient care at the receiving hospital, completed paperwork, restocked equipment and were able to start another transport mission. The variable ‘crew’ was defined by either ‘flight nurse only’, ‘doctor and flight nurse’, ‘flight nurse and midwife’, ‘flight nurse and paramedic’ or ‘other’.

’Mode of transport’ was categorised as to whether the patient was transported by fixed-wing’ aircraft, ‘helicopter’ or ‘road only’. Infrequently, a transport started by helicopter may be completed by road ambulance due to unforeseen weather changes, but would be categorised as helicopter transport, as this was used on the first leg of the transport. ‘Night flying’ was entered into the spreadsheet, and this capture whether any part of the transfer was undertaken at night time. ‘Day of the week’ refers to: Monday, Tuesday, Wednesday, Thursday, Friday, Saturday or Sunday.

The variable ‘more than one patient’ describes when two or more patients were transported on the same leg of the journey at the same time, and ‘patient backloaded’ was when a patient was additionally transported, although the mission was already assigned to another more urgent transport, i.e. a more opportunistic transport rather than a clinically required one. The ‘purpose of mission a’ and ‘purpose of mission b’ were variables entered at time of transport. ‘Purpose of mission a’ describes whether the patient was brought into CDHB, returned to DHB of domicile, sent from CDHB for treatment, transported between other DHB not involving CDHB, transported due to the earthquake (in 2011) or other. ‘Purpose of mission b’ refers to whether the treatment at the receiving hospital was acutely required or electively required, if the patient was returning to their home area after specialist treatment, due family/social reasons, transported out due to no appropriate beds at CDHB, if the patient’s transport was privately funded, or other.

Clinical characteristics

When the clinical coordinator or senior flight nurses are acting in the flight coordinator role, the transport request is initially evaluated as per ‘transport urgency’ (Table 3).

Table 3

Transport urgency definition

Transport urgency	
P1 Echo	Time critical and most urgent requests, requires the team to leave within 30 minutes
P1	High urgency, requires the team to leave within 60 minutes
P2	Urgent, requires the team to leave within the next 6 hours
P3	Non-urgent, within the next 24 hours

All transports were divided into either a ‘medical’ transport, where the patient’s condition and transport request are due to a medical problem, or ‘accident’ transport, where the patient’s current transport needs result from a recent accident.

The medical speciality who has accepted care of the patient at the receiving hospital was described in the variable ‘speciality’. From the data extraction, over 50 different medical specialities were identified, however, this has been narrowed into 18 categories of ‘medical speciality’ by combining all the different ICU admissions to either adult ICU or paediatric ICU. The CDHB’s specific specialities remained separate e.g. ‘cardiothoracic’, ‘spinal’, ‘hyperbaric’, and other infrequently used specialities such as ophthalmology, maxillofacial or rehabilitation were combined under ‘other’ (Appendix 5). The transport crew attending each transport mission were required to fill out an acuity scoring sheet for each patient, which gives the patient a possible score of 1 to 4 in the ‘category’ variable. The number 1 indicates minimal to no clinical care was needed, and a score of 4 suggests the patient would require intensive care, invasive ventilation or other means of advanced life support. The transport crew attending was also asked to score the patient’s transport as ‘urgent’ or ‘elective’ following initial assessment of the patient.

Missing data

While compiling 10 years of data, it became obvious that there was some data missing, on average 1 - 3% of the overall dataset (Table 4). This missing data was likely due to errors with data entry into the mission information spreadsheet. All the missing data has been specially coded in SPSS as missing and will per category, not be included in the reported data.

Table 1

Missing data

	2008		2009		2010		2011		2012		2013		2014		2015		2016		2017		Total	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Sex	15	(4.3)	7	(1.8)	4	(1.0)	12	(2.9)	5	(1.4)	10	(2.3)	11	(2.4)	19	(4.2)	11	(2.3)	12	(1.8)	106	(2.4)
Ethnicity	15	(4.3)	7	(1.8)	4	(1.0)	12	(2.9)	5	(1.4)	10	(2.3)	11	(2.4)	19	(4.2)	10	(2.1)	12	(1.8)	105	(2.4)
Age	6	(1.7)	4	(1.0)	5	(1.3)	4	(1.0)	4	(1.1)	6	(1.4)	7	(1.5)	6	(1.3)	0	(0.0)	1	(0.2)	43	(1.1)
DHB of domicile	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	2	(0.0)
Sending hospital	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	2	(0.4)	0	(0.0)	2	(0.0)
Receiving hospital	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	2	(0.0)
Total time of mission	7	(2.0)	4	(1.0)	4	(1.0)	8	(1.9)	9	(2.5)	9	(2.1)	7	(1.5)	6	(1.3)	1	(0.2)	8	(1.2)	63	(1.5)
Crew	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Time team activated	1	(0.3)	6	(1.6)	1	(0.3)	1	(0.2)	5	(1.4)	1	(0.2)	4	(0.9)	5	(1.1)	0	(0.0)	2	(0.3)	29	(0.7)
Mode of transport	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	0	(0.0)	0	(0.0)	1	(0.2)	0	(0.0)	2	(0.0)
Night flying	1	(0.3)	1	(0.3)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	1	(0.2)	9	(1.4)	13	(0.2)
Day of week	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	0	(0.0)	2	(0.3)	3	(0.1)
Patient back loaded	0	(0.0)	0	(0.0)	3	(0.8)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	1	(0.2)	3	(0.5)	8	(0.2)
More than one patient	1	(0.3)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	4	(0.6)	6	(0.1)
Purpose of mission (a)	1	(0.3)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	2	(0.4)	0	(0.0)	0	(0.0)	3	(0.1)
Purpose of mission (b)	1	(0.3)	7	(1.8)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	3	(0.7)	1	(0.2)	0	(0.0)	12	(0.3)
Transport urgency	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	0	(0.0)	1	(0.2)	2	(0.0)
Accident or medical	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	1	(0.0)
Specialty	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	1	(0.0)
Category	9	(2.5)	13	(3.4)	8	(2.1)	17	(4.0)	10	(2.8)	2	(0.5)	5	(1.1)	10	(2.2)	6	(1.3)	8	(1.2)	88	(2.1)
Urgent or elective	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	0	(0.0)	2	(0.3)	3	(0.1)

Chapter summary

This chapter has presented the study methodology and outlined the study methods including the overall study aim and design. The processes undertaken regarding both methodological, research permissions and ethical considerations have been described. The study variables are defined and provide the context by which to understand the findings presented in Chapter Three.

CHAPTER THREE: RESULTS

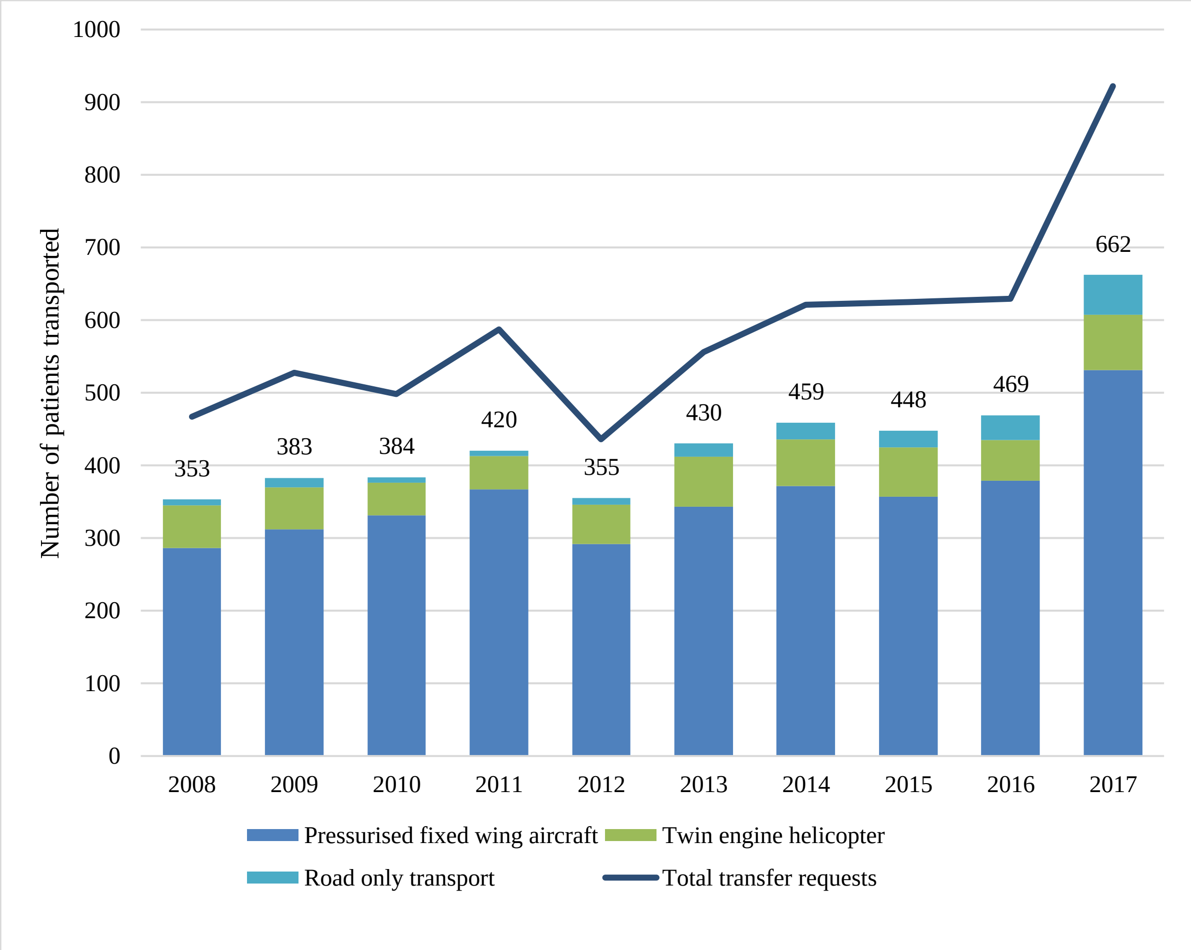
Introduction

Chapter Two presented the methodology and methods applied to study the CARS' population. This chapter outlines the core findings from this study, identifying the elements representative of the CARS identified epidemiological profile and overall service profile. In Chapter Four the data results will be discussed in relation to their importance and meaning.

During the 10-year study period, 1st January 2008 to 31st December 2017, CARS completed 4365 inter-hospital patient transports, despite receiving a total of 5869 transport requests (Figure 1). It is not entirely certain how all 1504 requests not transported were managed, however, some transport requests would have been delayed due to weather, transferred to another service, transported by another means or the patient's clinical status changed. If the clinical status changed, this likely meant they did not require transport due to clinical improvement or deterioration. The overall data total provides an average of 1.2 transports undertaken per day. However, it is noticeable that the rate has increased from the first five years where there was an average of 1.04 transports per year, to the last study year with 1.81 transports per year. The number of transport requests has also seen a similar increase of 467 to 922 over the study period.

Figure 1

Total transport requests and completed missions per year by mode of transport



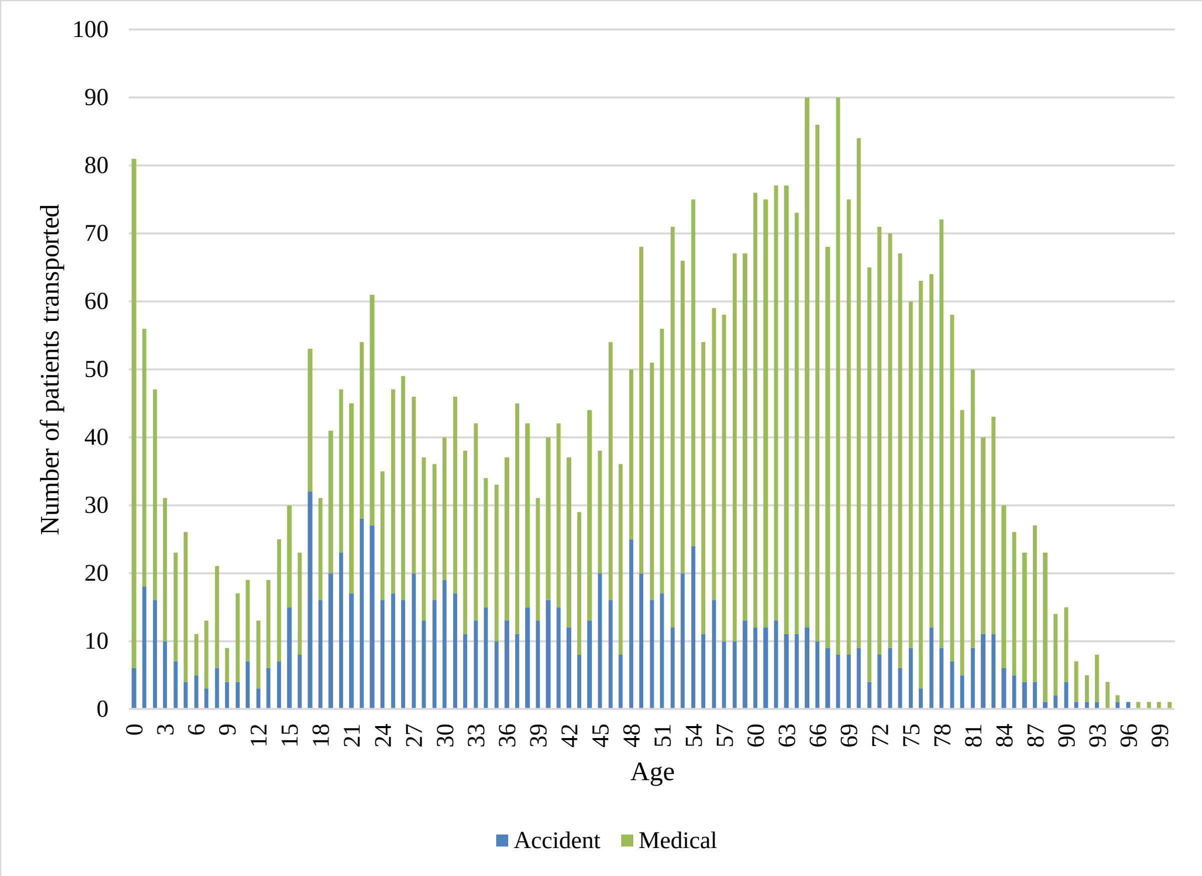
Epidemiological data

Age

The youngest patient transported was 2.5 months old and the oldest 102 years old, with the average age being 49.8 years. Premature babies and babies under 5kg were not transported by the CARS team, but were managed by a specialty neonatal intensive care flight team. However, the number of CARS' transports of children under one year of age was still notably high, and they represent the fifth highest individual age group, only exceeded by ages 65, 66, 68 and 70 (Figure 2).

Figure 2

Age distribution by medical or accident related transport



Sex

Data collection over the 10-year study period showed 58% (n= 2447) were male patients and 42% (n=1803) female, these percentages are consistent throughout the study years. However, as the sex and ethnicity data were retrieved from the CDHB data warehouse, it cannot be compared directly with other epidemiological data variables such as age or DHB of domicile.

Ethnicity

The ethnicity of transported patients was predominantly European (82.6% n=3598), with the second highest ethnic group recorded as identifying as Mãori (9.0% n=390), followed by Asian (2.5% n=111) and Pacific People (1.9% n=81). Middle Eastern/Latin

American/African, Other Ethnicity and Residual Categories all accounted for less than 1% respectively (Table 5).

Table 2

Ethnicity groups by transport years

Year	Asian		European		Mãori		Middle Eastern / Latin American / African		Other Ethnicity		Pacific Peoples		Residual Categories	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
2008	6	(1.7)	293	(83.0)	28	(7.9)					8	(2.3)	3	(0.8)
2009	6	(1.6)	327	(85.8)	27	(7.1)	2	(0.5)			9	(2.4)	3	(0.8)
2010	12	(3.1)	313	(81.9)	43	(11.3)	3	(0.8)			7	(1.8)		
2011	7	(1.7)	355	(84.5)	28	(6.7)	5	(1.2)			8	(1.9)	5	(1.2)
2012	9	(2.5)	300	(84.7)	29	(8.2)	4	(1.1)			7	(2.0)		
2013	20	(4.6)	337	(78.2)	39	(9.0)	5	(1.2)			11	(2.6)	9	(2.1)
2014	7	(1.5)	388	(84.5)	44	(9.6)	1	(0.2)			3	(0.7)	5	(1.1)
2015	16	(3.6)	345	(77.4)	49	(11.0)	2	(0.4)	2	(0.4)	8	(1.8)	5	(1.1)
2016	13	(2.8)	381	(81.2)	44	(9.4)			2	(0.4)	12	(2.6)	6	(1.3)
2017	15	(2.3)	559	(84.6)	59	(8.9)			2	(0.3)	8	(1.2)	6	(0.9)
Total	111	(2.5)	3598	(82.6)	390	(9.0)	22	(0.5)	6	(0.1)	81	(1.9)	42	(1.0)

DHB of Domicile

Over the 10-year period, patients normally residing in all 21 DHB's were represented, however, the top five DHB's of domicile are unsurprisingly the five South Island DHB's. What is surprising however, was that overseas visitors account for a total of 2.5% (n=107) of the CARS transport workload. In 2010, Otago DHB and Southland DHB merged and became the Southern DHB, reducing total number of DHBs to 20, and was the fourth largest DHB of domicile, with 11% (n=608) of the patients transported by CARS. The largest group transported usually domiciled in the West Coast region (35% n=1519), followed by Canterbury (24% n=1064) and then Nelson Marlborough (13% n=582) (Table 6).

Table 3

DHB of domicile, by the highest occurrence

DHB of domicile	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
West Coast	30.0%	32.9%	39.3%	35.8%	34.6%	37.4%	40.3%	40.2%	31.7%	28.4%	34.8%
Canterbury	19.0%	20.6%	21.6%	35.1%	23.7%	26.5%	22.4%	22.3%	26.0%	25.0%	24.4%
Nelson Marlborough	19.0%	19.6%	14.1%	8.8%	13.8%	7.9%	8.5%	6.0%	11.7%	21.9%	13.3%
Otago	5.1%	2.9%	-	-	-	-	-	-	-	-	-
Southland	13.3%	8.9%	-	-	-	-	-	-	-	-	-
Southern DHB	-	-	12.8%	8.9%	9.9%	7.4%	12.4%	9.3%	14.9%	9.9%	11.4%
South Canterbury	6.8%	7.8%	6.0%	5.7%	9.3%	10.0%	8.9%	10.9%	8.3%	7.6%	8.2%
Overseas visitor	2.0%	2.6%	1.6%	1.7%	2.3%	3.5%	2.8%	3.6%	2.6%	2.0%	2.5%
Capital Coast	0.6%	1.3%	1.8%	1.0%	2.3%	1.6%	0.7%	0.2%	0.2%	0.5%	0.9%
Taranaki	0.3%	0.8%	0.3%	1.7%	0.6%	0.7%	0.2%	1.8%	1.1%	1.5%	0.9%
Wanganui	0.3%	0.8%	0.3%	0.2%	0.3%	0.9%	0.4%	0.9%	1.1%	1.1%	0.7%
Mid Central	1.1%	0.3%	0.0%	0.0%	0.3%	1.4%	0.7%	1.1%	0.6%	0.3%	0.6%
Hawkes Bay	0.3%	0.0%	0.0%	0.0%	0.3%	0.9%	1.1%	0.9%	0.4%	0.8%	0.5%
Hutt	0.6%	0.3%	0.3%	0.0%	1.7%	0.9%	0.2%	0.9%	0.4%	0.2%	0.5%
Auckland	0.0%	0.5%	0.8%	0.2%	0.0%	0.2%	0.2%	0.4%	0.0%	0.2%	0.3%
Wairarapa	0.3%	0.3%	1.0%	0.0%	0.0%	0.0%	0.4%	0.4%	0.2%	0.2%	0.3%
Waikato	0.3%	0.3%	0.0%	0.5%	0.0%	0.0%	0.2%	0.2%	0.2%	0.0%	0.2%
Bay of Plenty	0.0%	0.0%	0.0%	0.2%	0.0%	0.2%	0.2%	0.2%	0.0%	0.2%	0.1%
Counties Manakau	0.0%	0.0%	0.0%	0.2%	0.8%	0.2%	0.0%	0.0%	0.0%	0.0%	0.1%
Lakes	0.3%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.2%	0.2%	0.3%	0.1%
Northland	0.3%	0.3%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.2%	0.1%
Waitamata	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.1%
Unknown	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.2%	0.0%	0.0%	0.0%

Sending and receiving hospitals

The sending hospital is directly linked to the DHB of domicile. Changes in the affiliation of an individual hospital to a DHB can result in policy changes which may be evident in practice trends. Prior to 2015, very few patients were sent from the Chatham Islands Hospital, however, when the Chatham Islands Hospital became part of the Canterbury DHB from midyear 2015, there was an understandable increase in transports (Table 7).

Table 4

Sending hospital by the highest occurrence

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Greymouth	29.2%	32.4%	35.2%	35.5%	31.8%	34.3%	38.6%	37.9%	32.9%	27.9%	33.4%
Christchurch Public Hospital	16.4%	14.9%	14.3%	12.4%	9.3%	14.2%	8.3%	7.1%	11.5%	14.7%	12.3%
Timaru	7.6%	8.9%	6.0%	6.0%	9.0%	10.7%	8.7%	11.4%	7.5%	6.3%	8.1%
Nelson	6.8%	5.2%	7.0%	6.0%	7.6%	4.6%	7.0%	2.7%	6.8%	9.5%	6.5%
Ashburton	8.5%	6.0%	5.7%	4.5%	7.3%	6.7%	8.1%	4.9%	5.8%	5.7%	6.2%
Invercargill	9.6%	8.4%	6.8%	4.8%	3.7%	3.5%	4.4%	5.4%	3.4%	4.2%	5.2%
Blenheim	7.1%	7.0%	4.9%	3.1%	5.6%	3.0%	2.0%	2.7%	3.2%	7.4%	4.6%
Dunedin	3.7%	3.1%	2.9%	3.8%	3.4%	2.6%	5.2%	3.6%	6.8%	3.0%	3.8%
Christchurch Women's Hospital	0.8%	2.1%	2.6%	4.3%	2.5%	4.4%	3.1%	3.1%	1.9%	2.9%	2.8%
Wellington	1.7%	2.1%	1.8%	3.8%	3.7%	2.3%	1.7%	1.8%	1.9%	0.9%	2.1%
Chatham Island	0.3%	0.0%	0.0%	0.0%	0.3%	0.9%	0.9%	5.1%	3.6%	3.3%	1.7%
Westport	1.7%	1.6%	1.8%	1.2%	2.8%	1.4%	2.2%	2.9%	1.1%	1.2%	1.7%
St. Georges	0.6%	0.8%	0.3%	0.5%	0.8%	1.4%	1.1%	2.5%	2.1%	2.1%	1.3%
Burwood	0.8%	0.8%	1.3%	0.2%	0.8%	0.2%	1.1%	2.0%	2.1%	2.1%	1.2%
Other	5.2%	7.2%	9.6%	13.9%	11.4%	9.7%	7.7%	6.7%	9.0%	9.2%	8.4%

Table 7 describes the most frequent hospitals that patients are sent from. The ‘Other’ category refers to all the other hospitals sending patients, none of which individually reach over 1% average.

Table 5

Receiving hospital by the highest occurrence

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Christchurch Public Hospital	72.0%	73.9%	73.7%	65.7%	78.6%	71.9%	78.0%	77.7%	77.9%	75.3%	74.6%
Christchurch Women’s Hospital	6.8%	4.7%	3.6%	3.6%	2.5%	4.7%	3.9%	7.1%	2.6%	3.0%	4.2%
Dunedin	1.1%	1.8%	1.6%	6.2%	4.2%	3.5%	5.2%	2.2%	4.5%	4.7%	3.6%
Nelson	1.1%	3.7%	2.6%	1.7%	2.0%	2.3%	0.2%	1.3%	2.3%	4.8%	2.3%
Wellington	0.3%	1.8%	2.1%	3.6%	0.8%	2.8%	2.6%	2.2%	0.9%	1.4%	1.9%
Auckland	1.4%	1.8%	2.9%	1.2%	2.3%	3.3%	0.9%	1.3%	1.7%	1.4%	1.8%
Greymouth	2.3%	1.0%	2.3%	2.1%	2.0%	3.0%	2.4%	1.1%	0.9%	1.5%	1.8%
Blenheim	5.1%	5.0%	2.3%	1.0%	0.3%	0.9%	0.4%	0.2%	0.6%	1.4%	1.6%
Rest home	0.3%		0.5%	9.3%	0.3%	0.2%			1.3%	0.2%	1.2%
Burwood	1.1%	1.6%	0.5%		0.6%	0.5%	0.2%	1.1%	1.5%	2.4%	1.0%
Invercargill	2.5%	1.0%	0.8%	1.9%	0.6%	0.7%	1.1%	0.4%	0.6%	0.8%	1.0%
Starship	0.6%	1.0%	0.8%	1.0%	1.4%	2.6%	0.9%	0.7%	0.9%	0.8%	1.0%
Not transferred	0.6%	0.5%	1.0%	0.2%	0.3%	0.7%	0.2%	0.7%	0.9%	0.5%	0.6%

The primary receiving hospitals are, obviously, Christchurch Hospital and Christchurch Women's Hospital, which account for 78.8% (n=3436) of all patient transports. However, in Table 8 it becomes apparent that in 2011, following the Christchurch earthquakes, there was a higher than average number of transports to Dunedin Hospital, Wellington Hospital and community rest homes.

Failure to transport

The total number of patients who were 'not transported' over the 10-year study period is 24, which only accounts for 0.6% (n=24) of total jobs. This refers to jobs the transport crew would already have started, that is, a job was commenced with the aircraft and the crew were flown to the sending hospital. The patient was then not transported, due to their altered clinical presentation or unplanned aircraft problems restricting patient transport.

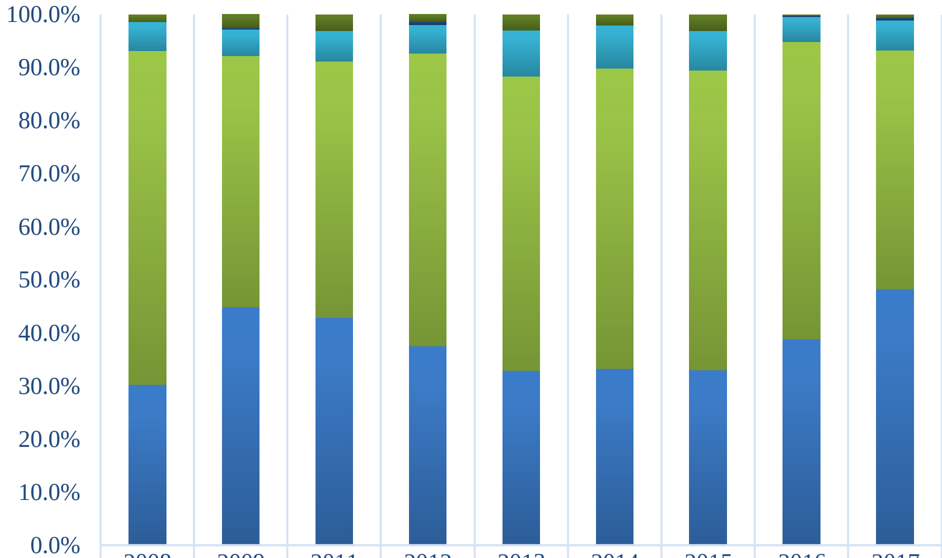
Service provision

Mission time and crew composition

The mean mission time is 5 hours and 34 minutes, with a range from one to 23 hours, and was consistent across the study years, ranging from 5 hours 15 minutes to 5 hours 57 minutes per individual transport year. The most prevalent transport crew composition was 'doctor and flight nurse' present on an average of 53.2% (n=2322) of transport missions, followed by 'flight nurse only' with 38.8% (n=1690). However, the trend over the 10 study years show more frequent use of transports with a 'flight nurse only', and in the year 2017 'flight nurse only' was deployed more frequently than 'doctor and flight nurse'. 'Flight nurse and midwife' was the third most utilised transport crew, and accounted for 6.1% (n=265), indicating the amount of obstetric secondary inter-hospital transports CARS undertakes. ‘Flight nurse and paramedic’ and the ‘other’ crew compositions account for a mere 2% (n=88) of all transports, as seen in Figure 3.

Figure 3

Crew composition by transport years



	2008	2009	2011	2012	2013	2014	2015	2016	2017
Other	1.4%	2.6%	3.1%	1.4%	3.0%	2.0%	3.1%	0.2%	0.6%
Flight nurse and paramedic	0.0%	0.3%	0.0%	0.6%	0.0%	0.0%	0.0%	0.2%	0.5%
Flight nurse and midwife	5.4%	5.0%	5.7%	5.4%	8.6%	8.1%	7.4%	4.7%	5.6%
Doctor and flight nurse	62.9%	47.3%	48.3%	55.2%	55.5%	56.6%	56.5%	56.0%	45.0%
Flight nurse only	30.3%	44.9%	42.9%	37.5%	32.9%	33.3%	33.0%	38.9%	48.3%

Time team activation, mode of transport and night flying

As already illustrated in Figure 1, it can be seen that over 80% (n= 3570) of the transports are by ‘fixed-wing’ aircraft. Viewing the different modes of transport by ‘time activated’ shows that the percentage of transports started after 15:00 hrs are more likely to incorporate ‘helicopter’ or ‘road only’ as transport. This average is related to the high number of fixed-wing transports (Figure 4).

Figure 4

Time team activated by mode of transport

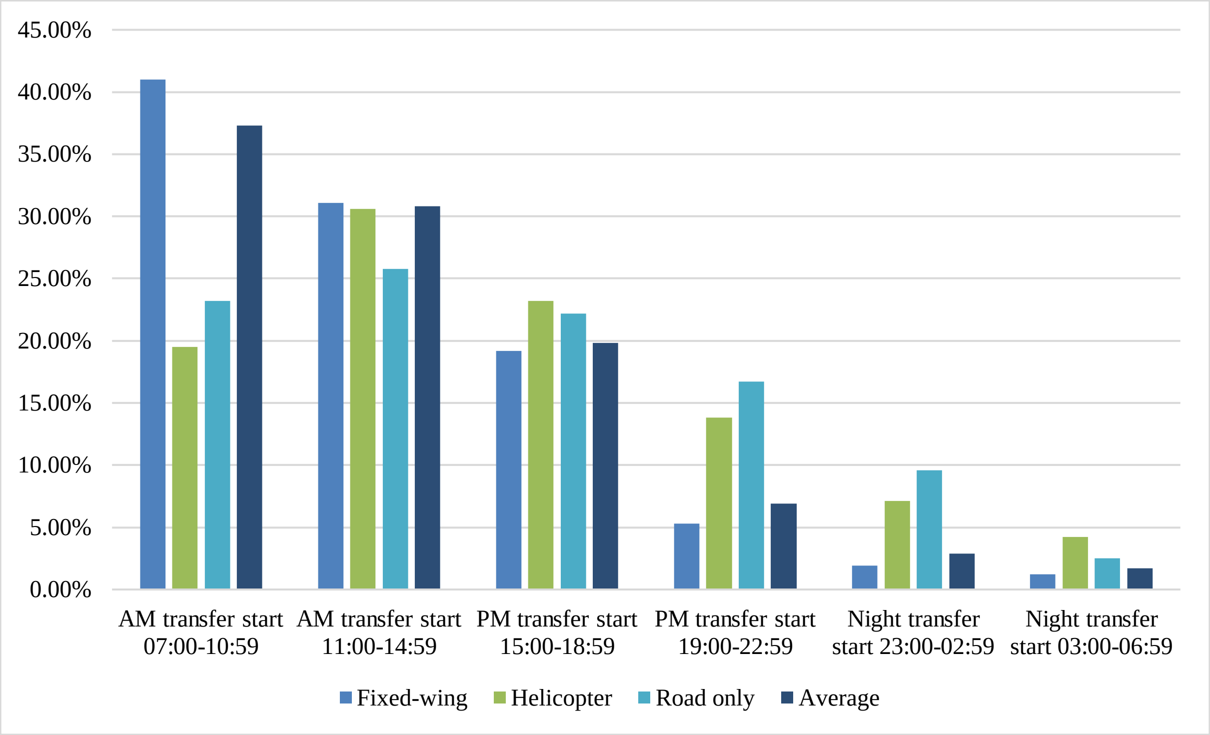


Table 9 also highlights another trend within the different modes of transport. Not only do ‘helicopter’ transports and ‘road only’ transports frequently start later in the day, but these transports are predominately classified as urgent. All transports using ‘helicopter’ or ‘road only’ transport that start after 19:00 hrs are classified as urgent, whereas elective transports did occur in these hours by ‘fixed-wing’ transport. When examining the data, the rise in the elective ‘fixed-wing’ night transports starting between 03:00 – 06:59 hrs, are predominantly related to a 06:00 hrs start flying time to the Chatham Islands. 25% of all transports were classified as having an element of night flying, which correlates with transport start times and the average mission time.

Table 6

Time of day by mode of transport

	AM transfer start 07-11		AM transfer start 11-15		PM transfer start 15-19		PM transfer start 19-23		Night transfer start 23-03		Night transfer start 03-07		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Fixed-wing aircraft														
Urgent	543	(15.2)	588	(16.5)	550	(15.4)	184	(5.2)	64	(1.8)	39	(1.1)	1977	(55.4)
Elective	921	(25.8)	524	(14.7)	134	(3.8)	4	(0.1)	3	(0.1)	3	(0.1)	1593	(44.6)
Total	1464	(41.0)	1112	(31.1)	684	(19.2)	188	(5.3)	67	(1.9)	42	(1.2)	3570	(100.0)
Helicopter														
Urgent	104	(17.6)	173	(29.2)	132	(22.3)	82	(13.9)	42	(7.1)	25	(4.2)	567	(95.8)
Elective	12	(2.0)	9	(1.5)	4	(0.7)	0	(0.0)	0	(0.0)	0	(0.0)	25	(4.2)
Total	116	(19.6)	182	(30.7)	136	(23.0)	82	(13.9)	42	(7.1)	25	(4.2)	592	(100.0)
Road only														
Urgent	25	(12.6)	38	(19.2)	43	(21.7)	33	(16.7)	19	(9.6)	5	(2.5)	163	(82.3)
Elective	21	(10.6)	13	(6.6)	1	(0.5)	0	(0.0)	0	(0.0)	0	(0.0)	35	(17.7)
Total	46	(23.2)	51	(25.8)	44	(22.2)	33	(16.7)	19	(9.6)	5	(2.5)	198	(100.0)
Average														
Urgent	672	(15.4)	799	(18.3)	725	(16.6)	299	(6.9)	125	(2.9)	69	(1.6)	2707	(62.1)
Elective	954	(21.9)	546	(12.5)	139	(3.2)	4	(0.1)	3	(0.1)	3	(0.1)	1653	(37.9)
Total	1626	(37.3)	1345	(30.8)	864	(19.8)	303	(6.9)	128	(2.9)	72	(1.7)	4360	(100.0)

Weekday, backload and more than one patient transports

The most prevalent day of the week to fly is Thursday (16.7%, n=730) and the weekdays are generally slightly busier averaging 14.3 - 16.7%, whereas the weekend average is 11 - 12%. Overall, 7% (n=306) of patient transports were backloaded, however this has varied through the study years, ranging from 2.5% to 12.2% (Figure 5). More than one patient was transported on the same flight for 11.9% (n=520) of the overall transports over the years. This figure has also varied through the years from 6.5% - 17.6% (Figure 6).

Figure 5

Backload

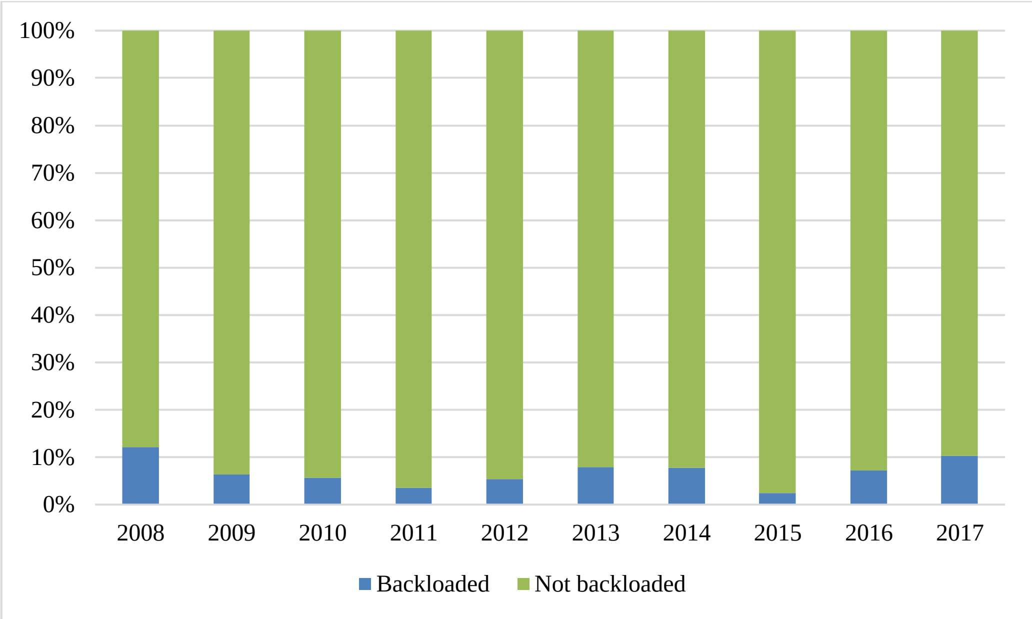
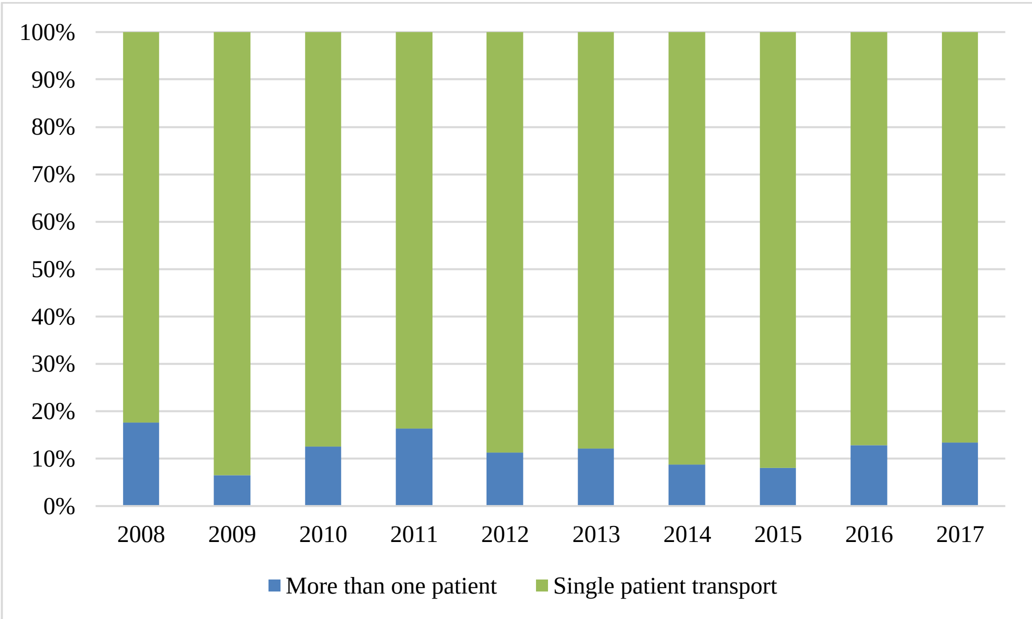


Figure 6

Single vs. more than one patient transport



Purpose of mission a and b

Looking at the purpose of the transport missions, on average 74.4% (n=3247) were to bring the patient to the CDHB, 14.5% (n=634) were to return the patient to their DHB of domicile. Sending patients away from the CDHB for specialist treatment elsewhere accounted for 6.8% (n=298) of transports, 2.6% (n=113) did not involve the CDHB, and 0.7% (n=32) were for other transport purposes. However, noticeably in 2011, 9% (n=38) of that year's transports were due to the Christchurch earthquakes (Table 10).

Table 7

Purpose of mission a

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Bring patient to CDHB hospital	77.6%	74.2%	72.4%	62.1%	74.9%	70.3%	78.2%	82.5%	76.2%	75.1%	74.4%
Send patient from CDHB for treatment	2.8%	4.2%	7.0%	4.8%	6.5%	10.7%	5.0%	15.2%	4.5%	6.6%	6.8%
Return patient to DHB of domicile	17.0%	18.3%	18.0%	20.5%	15.5%	15.3%	11.5%	0.0%	15.3%	15.6%	14.5%
Transfer patient but not involving CDHB	1.7%	2.3%	2.3%	3.3%	2.8%	3.2%	4.6%	1.8%	3.2%	1.1%	2.6%
Other	0.9%	1.0%	0.3%	0.2%	0.3%	0.5%	0.7%	0.4%	0.9%	1.7%	0.7%
Other, due to earthquake	0.0%	0.0%	0.0%	9.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%

Table 11 explains that 67.4% (n=2935) of transports were for patients who required acute treatment and 14.4% (n=625) for those needing elective treatment. Patients that were transported home after specialist treatment accounted for 11.3% (n=493) of transports.

Table 8

Purpose of mission b

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average
Acute treatment required	56.8%	59.0%	62.8%	61.9%	67.6%	74.5%	71.5%	77.3%	73.1%	65.9%	67.4%
Elective treatment required	24.4%	20.7%	17.7%	14.3%	14.9%	7.2%	12.9%	10.8%	9.6%	14.7%	14.4%
Returning to home area after specialist treatment	15.6%	12.8%	13.5%	8.8%	10.4%	11.1%	9.6%	5.6%	11.5%	14.0%	11.3%
Family / social reasons	2.3%	5.1%	2.1%	11.7%	3.9%	3.0%	2.8%	2.7%	3.4%	1.7%	3.7%
No appropriate beds at CDHB	0.3%	2.1%	3.4%	2.9%	3.1%	4.2%	3.3%	2.9%	1.7%	3.3%	2.8%
Private paying patient	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.3%	0.1%
Other	0.6%	0.3%	0.5%	0.5%	0.0%	0.0%	0.0%	0.4%	0.6%	0.2%	0.3%

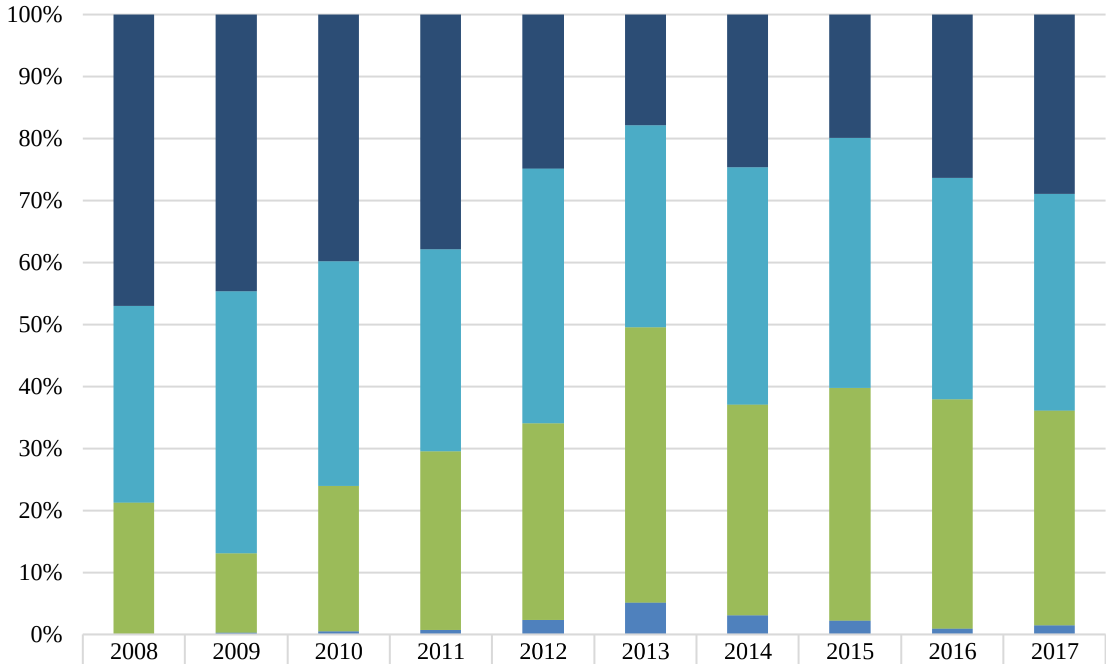
Clinical characteristics

Transport urgency and accident vs medical transport

Over the 10-year study period, the distribution of transport urgency has changed from predominantly P3 to more P1 and P2 transfers. Although P1 Echo requests are infrequent, Figure 7 shows that the majority of patient transports have shifted to be more urgent requests classified as P1 and P2, while a steady trend of less P3 missions can be seen.

Figure 7

Transport urgency per year



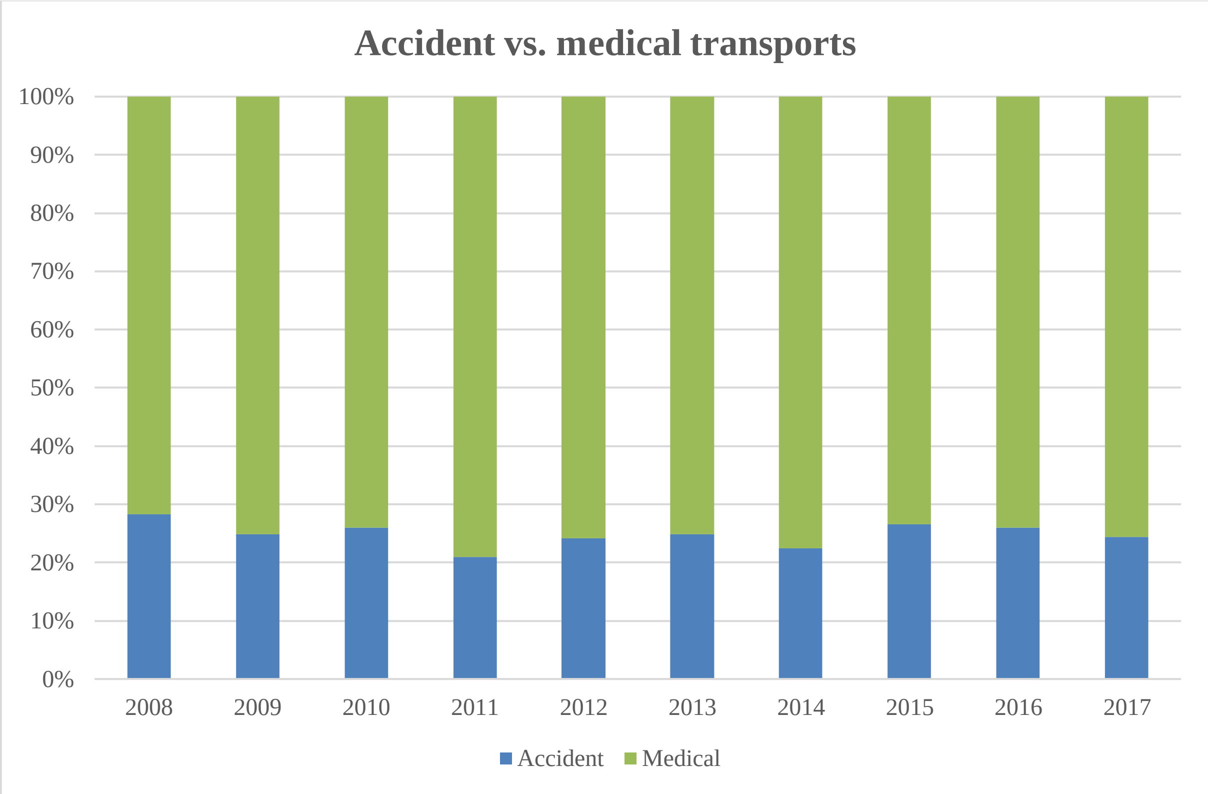
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
P3	47.0%	44.6%	39.8%	37.9%	24.8%	17.9%	24.6%	19.9%	26.4%	28.9%
P2	31.7%	42.3%	36.2%	32.6%	41.1%	32.5%	38.3%	40.3%	35.7%	34.9%
P1	21.2%	12.8%	23.4%	28.8%	31.8%	44.5%	34.0%	37.6%	37.0%	34.6%
P1 Echo	0.0%	0.3%	0.5%	0.7%	2.3%	5.1%	3.1%	2.2%	0.9%	1.5%

P1 Echo P1 P2 P3

A stable trend seen in the data was accident versus medical transport. When looking at individual transport years, 24.8% (n=1081) of transports were accident related, while 75.2% (n=3283) were medically related. There has been little change in these numbers over the study period (Figure 8).

Figure 8

Accident vs. medical transports

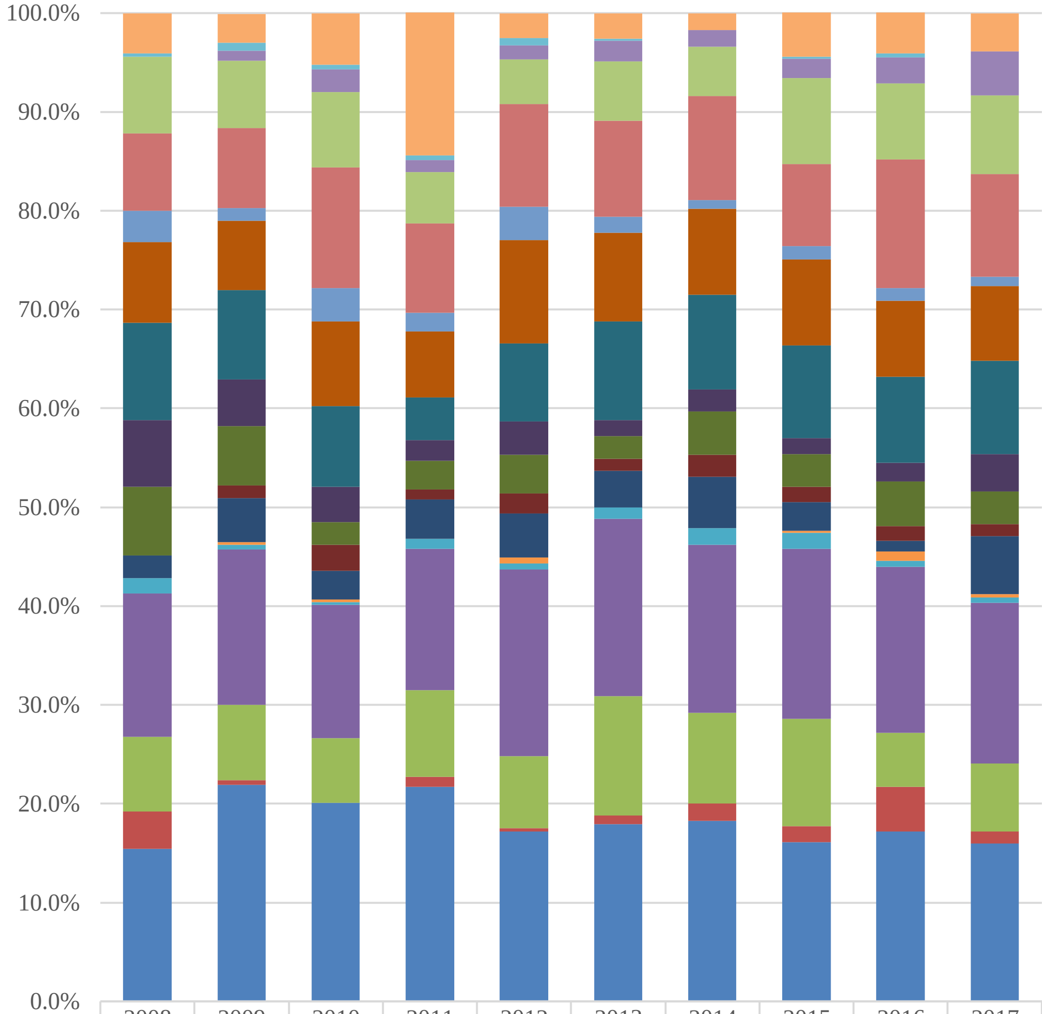


Medical specialty

Within the 10-year study period, over 50 different receiving medical specialities were identified and subsequently combined into 18 main medical speciality categories, as shown in Figure 7. Cardiology (18.1%, n=789) and ICU (16.2%, n=707) transports were the most frequent medical speciality, followed by surgical (10%, n=437), orthopaedic (8.7%, n=378), gynae/obstetric (8.2%, n=360) and paediatric transports (8.2%, n=359). The fact that the CDHB is a national spinal centre is also reflected with 6.8% (n=299) of all transports being for spinal care management.

Figure 9

Medical Specialty



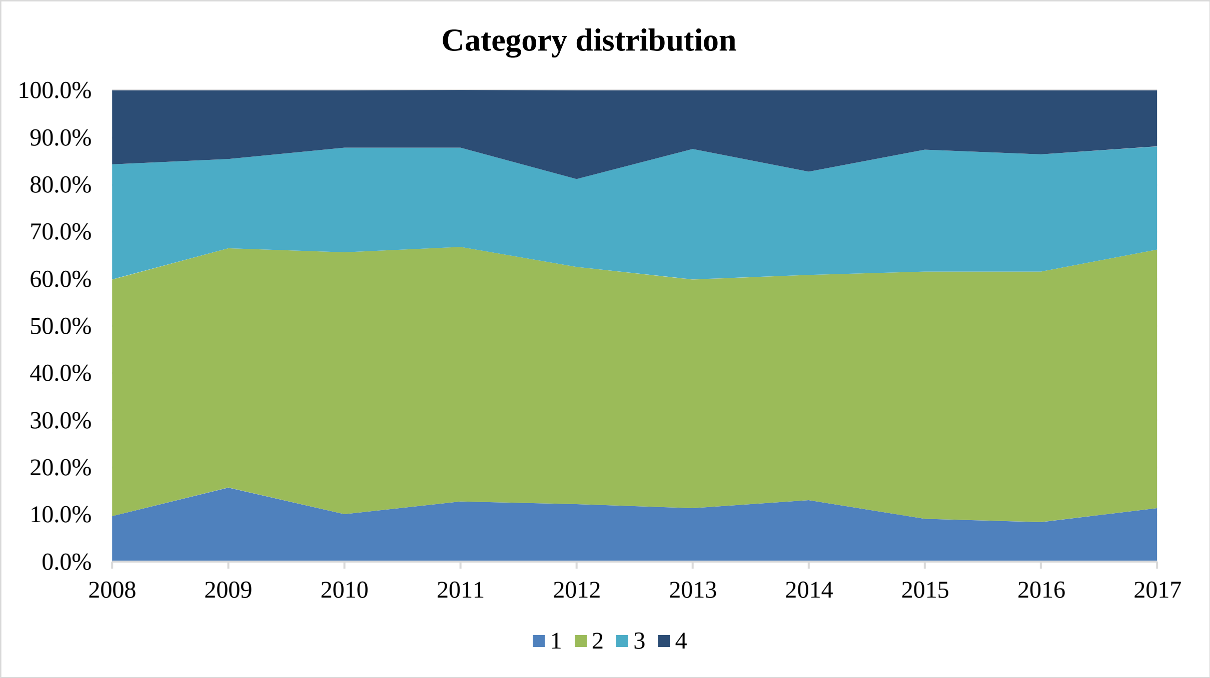
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Other	4.1%	2.9%	5.2%	14.5%	2.5%	2.6%	1.7%	4.5%	4.3%	3.9%
Hyperbaric	0.3%	0.8%	0.5%	0.5%	0.8%	0.2%		0.2%	0.4%	
Vascular		1.0%	2.3%	1.2%	1.4%	2.1%	1.7%	2.0%	2.6%	4.4%
Spinal	7.8%	6.8%	7.6%	5.2%	4.5%	6.0%	5.0%	8.7%	7.7%	8.0%
Surgical	7.8%	8.1%	12.2%	9.0%	10.4%	9.7%	10.5%	8.3%	13.0%	10.4%
Plastics	3.2%	1.3%	3.4%	1.9%	3.4%	1.6%	0.9%	1.3%	1.3%	0.9%
Paediatrics	8.1%	7.0%	8.6%	6.7%	10.4%	9.0%	8.7%	8.7%	7.7%	7.6%
Orthopaedic	9.9%	9.1%	8.1%	4.3%	7.9%	10.0%	9.6%	9.4%	8.7%	9.4%
Oncology	6.7%	4.7%	3.6%	2.1%	3.4%	1.6%	2.2%	1.6%	1.9%	3.8%
Neurosurgical	7.0%	6.0%	2.3%	2.9%	3.9%	2.3%	4.4%	3.3%	4.5%	3.3%
Neurology		1.3%	2.6%	1.0%	2.0%	1.2%	2.2%	1.6%	1.5%	1.2%
Medical	2.3%	4.4%	2.9%	4.0%	4.5%	3.7%	5.2%	2.9%	1.1%	5.9%
Mental health		0.3%	0.3%		0.6%			0.2%	0.9%	0.3%
ICU paediatrics	1.5%	0.5%	0.3%	1.0%	0.6%	1.2%	1.7%	1.6%	0.6%	0.6%
ICU	14.5%	15.7%	13.5%	14.3%	18.9%	17.9%	17.0%	17.2%	16.8%	16.2%
Gynae/obstetrics	7.6%	7.6%	6.5%	8.8%	7.3%	12.1%	9.2%	10.9%	5.5%	6.9%
Cardiothoracic	3.8%	0.5%		1.0%	0.3%	0.9%	1.7%	1.6%	4.5%	1.2%
Cardiology	15.4%	21.9%	20.1%	21.7%	17.2%	17.9%	18.3%	16.1%	17.2%	16.0%

Category and urgent or elective score

Although there has been some significant movement in overall transport numbers over the years, the 'category' scoring appears fairly stable, with over half of the transports (52%, n=2223) receiving the acuity score of 2 in 'category', while other category scores remain stable over the study period (Figure 10).

Figure 10

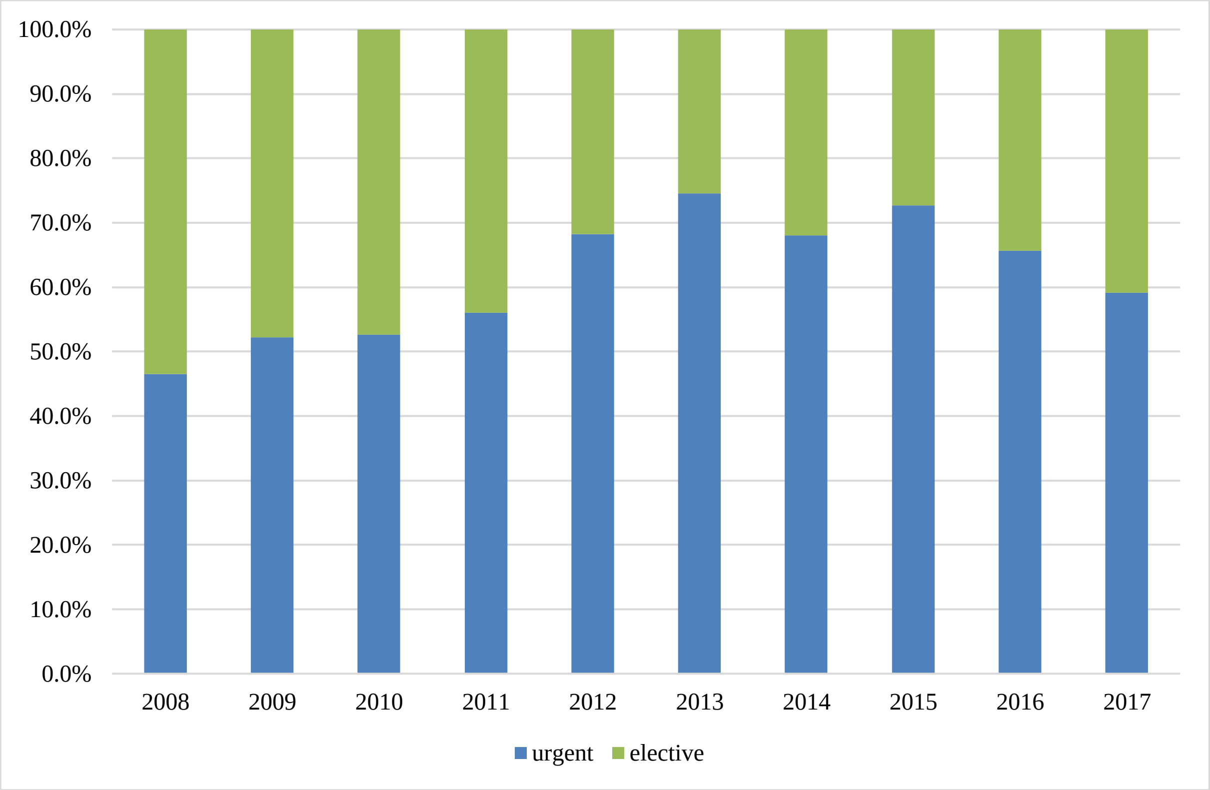
Category distribution



The transport crew's 'urgent' or 'elective' assessment of the patient shows the trend of more urgent transports rising over elective transports from 2012 to 2016. The year 2017 is slightly lower than the previous year's trend, however, this could be reflecting the increased number of backloads undertaken in 2017 (Figure 11).

Figure 11

Urgent or elective scoring



Chapter summary

Details for all the patients transported by CARS in the study period are presented within this chapter's data results in three categories: epidemiological profile, clinical characteristics and service provision. Within each of these categories the findings identified represent the elements that make up the overall generated service profile of CARS. In Chapter Four the significance of these findings and potential impact of the data results are discussed.

CHAPTER FOUR: DISCUSSION

Introduction

Having identified a number of variables associated with the inter-hospital CARS transportation service, and having developed an initial epidemiological and service profile, it is important to consider the implications and significance of these elements. These findings are unique for the CARS service and this chapter presents a discussion of the meaning and potential impact of the findings.

In considering the study design, it is worth noting that because the study period was set at 10 years, this generated a substantial sample size, which allowed a clear population profile to emerge. The study utilised a retrospective dataset in the interests of manageability and timeliness, although it was decided not to access the original paper transport records, but to use the pre-recorded electronic data record set. This limited the study's use of some variables, and also eliminated the opportunity to correct errors or missing data within the electronic dataset. However, the data extracted from the CARS database was found to have a very low rate of missing data, only 1 - 3% of all data was missing. Most missing data was likely a result of errors at the time of initial data entry.

While there are no directly comparable international studies, the New Zealand study of the Wellington Flight Service (Myers et al., 2012) offers an opportunity for some national comparisons and will be discussed following consideration of the CARS data results.

Strengths

The 10-year study period provided a large dataset that has enabled the observation of important trends. The existing dataset used a standardised entry format including sub-categories for most data entry points, enabling more consistent measurement of the variables (Appendix 6). Using an existing dataset has been an advantage for time management, and with only 1 - 3% of missing data, the dataset is near complete which allows for meaningful interpretation.

<u>Discussion of data results</u>

Over the 10-year study period, a number of trends became apparent. The overall number of patient inter-hospital transports was 4365, averaging 1.2 transports per day. There was a noticeable growth in workload over the study period, from the start of the data collection period right to the end, an increase in the number of transports was apparent. Of particular note, 2017 had a large increase in transports and transport requests. This increase is likely influenced by multiple factors, although elements underpinning this may become clearer during the discussion. It is clear that a national increased workload is being recognised in the wider sense, with conversations starting regarding the ongoing sustainability of the EAAS in New Zealand, and the need to review the current model. The NASO, the EAAS and DHBs have stated that "the existing operating model is not sustainable" (Ministry of Health, 2018b, para. 2), and they outline the intent to build a nationally integrated network that covers all of New Zealand. However, while the intention is laudable, there remain issues in terms of jurisdiction and the ability to work effectively to achieve the desired outcomes.

From a local perspective, the increase in workload has concerning implications, in particular relating to resourcing of the service and staffing levels. The number of staff is not the sole concern however, as training and experience also needs to be considered. There must be a clearer process to understand and recognise the profile of flight nurses and associated crew. Nationally, there are moves towards standardising the minimum requirements for flight nurse's education, with the potential introduction of the Flight Crew Passport by the COASTN (College of Air and Surface Transport Nurses, 2018).

Epidemiological data

A core component in understanding the population profile for the CARS service is exploring the demographic features of the patient group who are its service users. The first parameter to consider is that of age. There is a wide age range amongst the transported patients, from 2.5 months to 102 years old. One element that becomes apparent is the large number of transfers for children under one year of age, although this excludes neonatal transports which are undertaken by the specialty neonatal intensive care flight team and were not included in this study. Reviewing the age distribution of patients in relation to medical or accident related transports (Figure 2), suggests that children under one-year old had a high medical to accident related ratio requiring transport. This suggests that while there is a clear need for flight nurses to have an educational focus across the life span, it is also important to recognise that paediatrics is a core element of their practice. This focus is reflected within one of the suggestions for the Flight Crew Passport, part of the COASTN recommendations. Their recommendations are that flight nurses who transport multiple patients groups should complete and maintain advanced resuscitation training for each of those groups, such as adult, paediatric, neonatal or obstetric (College of Air and Surface Transport Nurses, 2018).

Furthermore, by studying Figure 2, patients in the age groups from 1 - 49 years had a much higher than average ratio of accident to medical related transport, and the patients aged 50-102 years were primarily transported for medical reasons. The overall distribution showed that 75.2% of patient transports were medical related compared with 24.8% of accident related transports over the 10-year study period. There is an opportunity to further explore the implications and possible relationships between accident and medical transports with regard to age and other variables such as medical specialty, category and urgent or elective transport. Of interest, it is likely that accident transports occur more rapidly following onset of injury given the differing funding stream and its associated requirements to transport within 24 hours. The study was limited in being unable to compare age to sex or ethnicity. The de-identified sex and ethnicity data sourced from the CDHB data warehouse is separate from other de-identified variables in the dataset.

Comparing the ethnicity data from the study to the known ethnicity data in the Canterbury population or the New Zealand national ethnicity distribution, shows that there is a lower percentage of individuals who identified as Asian within this study. The study identified 2.5% of participants as being of Asian ethnicity, whereas the national distribution is 11.8% and the CDHB population is 6.9%. Both the European and Mãori population distribution were similar to the CDHB and national distribution, being European (86.9% vs 74.0%), and Mãori (8.1% vs 14.8%) respectively, while the remaining ethnic groups in the CARS study findings were slightly lower. However, this data comparison should be treated cautiously for a number of reasons. It is difficult to draw any conclusions from these findings, as the national and Canterbury census-conducted ethnicity data collection allows for identification with multiple ethnic groups, in contrast to the CARS ethnicity data, where a patient was only identified by a single ethnicity. The ethnicity data was also derived from a separate source than other CARS data, and it is unclear whether the ethnicity question was asked or recorded concurrently with the CARS data entry. The importance of recording accurate ethnicity data in relation to health information is well known, as is the recognition that health databases are often inaccurate sources for this information (Bramley & Latimer, 2007; Callister, Didham, Potter, & Blakely, 2007; Swan, Lillis, & Simmons, 2006).

Although comparing the population groups has some limitations, reviewing the ethnic groups by transport years did not reveal any changes over the study years or identify any further reason for the increase in patient transports occurring in the year 2017. The national census report did however show a population increase in the South Island of 17% over the study period, which may contribute to the finding of increased workload.

Compiling the study data related to the DHB of domicile, over 92% (n=4019) of the patients transported had a DHB of domicile on the South Island. By far the largest number of patients were retrieved from Greymouth Hospital (33.4%, n=1519), which was a consistent finding over the years, yet unexpectedly 2.5% (n=107) were identified as overseas visitors and were classified as the fifth highest residential area. The breakdown of DHB of domicile per transport year (Table 5) did however, show an increase in transports from Nelson Marlborough DHB in the two most recent years, 2016 and 2017. This is most likely as a result of a service structure change, where patients from the Nelson Marlborough DHB requiring vascular specialist services are referred to Christchurch Hospital. Although patient retrievals for the years 2008 and 2009 from Nelson Marlborough DHB are also higher than the 10-year study average, when reviewing the sending and receiving hospitals the 2017 study year shows a much larger movement from the Nelson Marlborough DHB, by their main hospitals in Nelson and Blenheim. This demonstrates the service structure change, as the yearly number of patients transported doubled in 2017. The year 2011 was the year of the devastating Christchurch earthquakes, and this is reflected in fewer patient transports to Christchurch Public Hospital, and a noticeably larger intake to Dunedin Hospital and more rest home transports than other study years. The dataset does not explain any further changes or disruptions there might have been related to the earthquakes, or the loss of inpatient beds at the CDHB.

Service provision

The mean mission time of a CARS transport is 5 hours 34 minutes, this time has remained stable over the study years. However, considering the increased number of patients transported, this suggests that in the early study years the CARS team would have been busy an average of 5 hours 22 minutes per day, but by 2017 that number had almost doubled to 10 hours 6 minutes per day. It is reasonable to summarise that this increase in the CARS service provision would have necessitated an increase in transport crew hours and availability. This was, in fact, expanded in the later study years by the reported increase in total flight nursing full-time equivalents. The stressors of flight are not limited only to the patients but also to the transport crew, who would also have experienced this increased workload.

Although the most prevalent crew composition listed was initially the combination of ‘doctor and flight nurse’, over time the number representing this crew composition decreased, and ‘flight nurse only’ transports increased, so that by 2017 ‘flight nurse only’ had surpassed ‘doctor and flight nurse’ as the most common crew composition. Reasons for this may include the associated increase in patients being backloaded in the later years. This should be considered together with the trend towards more highly skilled and expert advanced practice nurses amongst the ICU trained flight nurses, as the transport urgency scoring over the study period has shown more urgent jobs were being undertaken.

Over 80% of the transports were completed by fixed-wing aircraft and this number has remained stable over the study period. There has been a marked increase in road only transports, going from less than 10 per year to 55 in 2017. Less apparent is the increase in helicopter transports. These numbers only slowly increased over the study period, and their percentage did not rise as fast as the two other modes of transport. An interesting finding is that, after 15:00 hrs, fixed-wing transports are significantly less utilised than both road only and helicopter transports (Figure 4). Moreover, not only are helicopter and road only transport more likely to commence later in the day but also start anytime through the night (Table 8), and these transports are far more likely to be urgent in nature. The use of the helicopter for inter-hospital air ambulance transport could also see an increase with the future rooftop helipad on the new Acute Services Building at Christchurch Hospital campus. It would have been interesting to do a separate focus on exploring helicopter transport, however, this was not possible with the time available for this study. As mentioned, the process of backloading of patients was more frequently used in 2017, and also the number of times ‘more than one patient’ was recorded on a single leg of the mission was more frequent in the 2017 study year. This contributes to the higher number of transports undertaken in the 2017 study year.

Clinical characteristics

Transport urgency has increased over the study period, with 70 - 80% of missions needing to be started within six hours by 2017, where previously that number was 50 - 60% in the early study years. This higher urgency demand has inevitably increased the pace of the service, and possibly also validated the need to maintain the transport crews availability.

The large number of medical specialties represented in the data results highlight that Christchurch Hospital is a major trauma centre, and that the CDHB is the DHB of service for the provision of specialist medical services such as cardiology, spinal, paediatric and vascular services. As regional areas and DHBs within New Zealand find it increasingly hard to staff specialty areas and services, the risk of closures and loss of ability to provide all types of services increases. The potential for the larger DHBs to face further increases in workloads is therefore a realistic consideration.

The distribution of the category scoring has remained stable over the study period, where 1 indicates minimal to no clinical care was needed, and a score of 4 suggests the patient would require intensive care, invasive ventilation or other means of advanced life support. The score of 4, where the patient would require intensive interventions, was almost always associated with patients who were transported by both a doctor and flight nurse. However, it is noted that doctor and flight nurse transports were also utilised for many category 2 and 3 patients, as the acuity scoring does not reflect the patient who has a higher potential to deteriorate, or the need to have blood products on standby for transporting the patient with a high-risk bleeding possibility. These high-risk patients were not identifiable in the dataset other than within their transport urgency scoring, but highlight an opening for future prospective analysis of CARS, including subsequent patient outcomes.

Comparison to the Wellington Flight Service

As noted earlier, there was one study undertaken within New Zealand which offered the opportunity for some national comparisons of the data. The WFS study (Myers et al. 2012) is similar, given it is a New Zealand based service, with data generated from retrospective review of a database. The WFS study took place over a five-year period, from November 2005 to October 2010, and was also focused on inter-hospital transports using similar types of crew configuration to those in CARS.

The overall number of transports reported in the Wellington study was 4,046, which initially suggests that this was a much larger flight service. However, the description of the WFS data suggests that their definition of transports is broader than that used by CARS. This included the number of patients transported by a transit care nurse to other hospitals in the Wellington region and those transferred by use of commercial flights. The WFS study also refers to patient transports as being either a retrieval to Wellington Hospital for acute treatment or transport out of Wellington Hospital, and that the proportion of retrievals to transports was equal over the study period. The CARS structure is different as most transports are retrievals only, and ‘transports’ as seen in the WFS, tend to be more opportunistic transports, returning patients as backloading when undertaking a retrieval to the same destination. Despite these differences, the WFS study does provide an opportunity for comparison of similar components to those identified in CARS.

Similarly to CARS, the WFS also reported a higher number of transport requests or contact regarding missions, than actual completed missions. WFS was contacted almost twice as often as they completed a mission. Their average mission length was 4 hours 30 minutes, over an hour less than CARS, however, they more frequently utilised road only transports for local transports. As another point of comparison, 9% of WFS missions took eight hours or longer, whereas CARS had over 12% of missions which were eight hours or longer. This difference is likely related to CARS servicing a larger geographical and mountainous area. Within WFS, 70% of transports were by fixed-wing aircraft, 11% by road ambulance, 11% helicopter transports and less than 1% for commercial flights, compared to CARS with 82% fixed-wing transports, 14% helicopter transports and only 4% road only transports.

The WFS study did not have the same focus on epidemiological data as the CARS study, and the study did not report any sex or ethnicity data. The age range was described, and this suggests a wide range similar to CARS. The WFS study reported an increasing use of ‘doctor and nurse’ transport missions, with an average of 34%, whereas the CARS service has seen a decrease in ‘doctor and flight nurse’ transports, however still averaging a higher 53.2%. WFS described 5% of all missions aborted and an increase in backloading from 6 - 25%, while CARS only described the failure to transport in 0.6% of all transports, and only counted backloading for 2.5 - 12.2% within total transports.

Although the WFS reported their most frequently used medical specialties as: cardiac services, neurosurgery, and ICU transports, the total number of these are only given in relation to retrievals versus transports, or in relation to the grouping of illness severity scoring. Therefore, this data cannot directly be compared to CARS, as CARS used a different illness scoring system, although the most frequent medical specialty was also cardiology. In relation to the timing of missions, WFS found that 69% of missions occurred between 7 am and 4 pm, with 26% beginning after 4 pm, and a further 6% after midnight. Similar percentages can be seen with CARS, with 68% of missions between 7 am and 3 pm, of these, 27% begin after 3 pm and 4% after 11 pm.

Direct comparison of the WFS and CARS data should be treated carefully due to the timing of the studies. The WFS data was examined between 2005 and 2010, where CARS data is more recent analysing the years 2008 to 2017. The WFS and CARS services have many similarities, however, directly comparing the services can be exceedingly difficult. Although both services are within a small national comparable geographical setting, there is a clear difference in transport setups, many different reported variables and ways of reporting transports. The requirements for air ambulance transports can also vary immensely from one region to another. This relates to services provided within the primary retrieving DHB, and also the medical specialties that are available within the outlying DHB, as well as the arrangements regarding the DHB of service.

Limitations

An existing electronic data record set was used and this limited the author's choice in relation to what data and variables were available to compare. Any errors within the electronic data set were not able to be corrected unless these errors were related to straightforward spelling or obvious formatting misprints.

One of the first identified limits within the data analysis was the inability to compare age to sex or ethnicity, since sex and ethnicity data were externally sourced. Retrieving that information from the CDHB data warehouse (as it had not been collected within the CARS mission information dataset), resulted in two separate unlinked datasets that were unable to be combined. Furthermore, comparing the CARS ethnic data with the national or regional population profile was difficult. While the national and CDHB census-conducted ethnicity data collection allows for identification with multiple ethnic groups, the CARS data only reflected a single ethnicity identified per patient. The descriptive methodology did not include the assessment of the effect of random error.

Chapter summary

Within this chapter the CARS study findings have been discussed and the strengths and limitations of the study highlighted. The CARS findings have been compared with the WFS study, although acknowledging there are differences in timing and variables reported. Chapter Five presents a final summary of the overall study findings and conclusions regarding the implications these study findings may have on policy and planning, practice and recommended research opportunities.

CHAPTER FIVE: SUMMARY AND CONCLUSION

Introduction

The main focus of this study has been to describe and analyse the unique, inter-hospital transport workload of CARS over a 10-year study period, and through this to recognise and identify the important role and services that CARS undertakes. Following the literature review it became evident that internationally, there is limited research describing the workload of national, inter-hospital, air ambulance services, let alone any based in New Zealand.

The primary objective of this study was to develop an epidemiological profile of CARS and describe the services provided for this population. In Chapter Three, the CARS data was described within the identified categories: epidemiological data, service provision and clinical characteristics, which was further discussed in Chapter Four.

The main findings identified are the increase in workload over time, with inter-hospital patient transports going from 1.04 patients per day to 1.8 patients per day, with the transport requests seeing a similar increase. The average duration for each transport was 5 hours 34 minutes, but considered in conjunction with the increase in average daily transports, this has seen a steady increase in hours worked. The most frequently used transport crew was the combination of ‘doctor and flight nurse’, similar to findings from the only other national study with a similar service (Myers et al. 2012). What the current study has shown, is that in addition, there is a developing trend towards more ‘flight nurse only’ transports in the more recent years of the study, alongside an increasingly urgent level of service requests.

The most frequently recorded mode of transport was that of fixed-wing aircraft, at 82% (n= 3570), helicopter transports were used on average 14% (n=595) of the time and road transports accounted for a mere 4% (n=198) of the workload. This demonstrated a unique workload pattern when compared to the Wellington study, and suggests that the CARS service has specific requirements and responses driven by its location, population and service needs. Where helicopter and road only transports were used, these were for more urgent requests, and this was part of an overall increase in transport urgency evident over the 10-year study period. The most frequent medical reason for patient transport across the study period remained management of patients requiring cardiology services, at 18.1% (n=789) followed by those needing ICU services at 16.2% (n=707).

Implications

In summarising the core implications of the study findings, it appeared appropriate to group these under the following key headings: policy and planning, practice and research. In this way, the features of significance are presented under the broad categories that influence clinical care, and allow for the development of future recommendations within these sectors. While the study findings are not intended to be directly generalisable, it is felt that there are generic elements that may relate to other services and have relevance across a range of local, national and international contexts.

Policy & Planning

One of the implications to consider for local policy and planning purposes is not only the importance of the continuation of data collection, but the need for improvement in the definitions of the data entry variables. Fully categorising and standardising the data entry should be considered, as this would improve any future data analysis. Predefining medical specialty groups, for example, would clarify the process and potentially contribute to the development of a national data dictionary. This in turn would facilitate comparison of services across DHBs and regional areas, enabling a clearer perspective of how many patients needed transportation for specialty services and assist with future planning.

Incorporating basic demographic data collection that includes ethnicity and sex is essential to determining accurate population profiles. However, it is recognised that this could be difficult to ascertain when transporting the sedated or critically unwell patient. Nevertheless, is recognised that this information is important to gather when assessing health needs of a population and to allow consideration of issues of equity, equality and access to services. It would be very interesting to analyse the population data to see if there are any ethnic groups that are disproportionately represented, in relation to any of the other variables that are able to be collected.

A fully comprehensive datasheet or online database collection including patient outcomes would also assist future researchers to fully characterise the workload of this service. This could assist with examining any potential risks or adverse events that are associated with inter-hospital air ambulance transport. This type of fully comprehensive data collection would also be of interest at a national policy and planning level, and potentially assist in nationally increased workload future planning. The current lack of accurate representation of the population being cared for and the changes occurring over time, limits the ability to forecast future developments, anticipate and plan for resource need, and recognise the potential for new and innovative responses to develop.

Structuring an online, real-time, available platform by which to request patient transports, including the reasons for transport, would allow for a more effective and efficient service. This could enable local services to both share details among themselves, and also share details between other service providers. In this way, two or more different services could seamlessly share transport request information, for example if the local service is busy and a time-critical patient transport request warrants the transport being undertaken by another service. This type of setup could also benefit from more efficient accommodation and planning of patient backloading.

Practice

The study has described CARS as a service that has experienced a large increase in workload and the number of patient transports over the past ten years. Within the last few years of the study, the service has needed to increase their flight nursing full-time equivalent staffing and crew availability to accommodate this increase in patient transports. This study and potential future workload studies would be able to confirm the resources needed for running the CARS service. The large increase in transports in 2017 was seen to be multifactorial, and did not have a specific cause. However, if this trend continues the service could need to re-evaluate if the transport crews current availability is sufficient. Another implication for practice is the increased workload on the service providers, such as fixed-wing, helicopter or ambulance transport availability. Further studying the trends within these, and potentially additional sub-studies, could help enlighten the increased usage of these services over the study years, and hereby assist future planning.

This study has also identified a much larger number of patient requests than actual completed patient transports, and it would be beneficial to enhance documentation around what happened to those requests not undertaken. Was the patient referred onto another air ambulance service, because CARS was already on another job, or did the weather restrict the transport? This data would provide greater clarification around the role of the flight service, the expectations and the service capacity available.

Currently, the urgency reporting around the patients transports is achieved in two steps: one by the clinical coordinator at the time of transport request, and the other by the transport crews initial assessment of the patient. Although both these evaluations are interesting to review, they cannot be directly compared. The coordinators urgency is defined by four categories, three of an urgent character and one elective, whereas the transport crews initial assessment of the patient is either recorded as urgent or elective. It would be feasible to combine these two evaluations so that any potential discrepancies between the two could be examined further. This could potentially be done by adapting the coordinators four categories of urgency scoring to the transport crews paperwork. Furthermore, the transport crew fills out an acuity form that will give the patient a stated acuity category score between 1 and 4. Although an informative tool, it is noted in the data results, that over half of the transport received the category score of 2. This finding could be further explored, and whether the acuity scoring of 2 could, for example, be sub-categorised into 2 or more further sections, easily identifying if the patient was close to a score of 1 or 3. With the current system, this acuity score does not factor in additional aspects such as a patients potential to deteriorate or the need to take blood products on the transport, which could also be addressed if reviewing the acuity score system.

Research

This study has focused on describing and analysing the workload of CARS, a regional air ambulance inter-hospital service. However, further aspects of CARS could certainly be investigated, and a number of recommendations for future research can be made following this initial workload study.

As mentioned, a more in-depth study which included the accurate and point of care collection of sex and ethnicity variables could be beneficial. The data collected would allow for larger insight in the services provided for this specific demographic group. Also, a study of a specific age group, such as children under the 1-year-old age group, could highlight specific trends, medical requirements or seasons for when the specific group was requiring transportation.

The increased workload described in this study highlights the increased work hours of the transport crews, acknowledging that the physiological changes and stressors also apply to transport crew as well as the patient. The potential impact of cumulative effects leads to the need to investigate these factors, including fatigue management experienced by the CARS transport crew.

This study also described the distribution between the different transport modes, and although fixed-wing transports are most prevalent, further research regarding both helicopter and road only transports could explain why these less frequent modes of transport are much more urgent in nature. If conducting this type of study it would be beneficial to have outcome measures, as these patients potentially are more high risk, given more urgent transport was identified at night within this study.

Conclusion

This study has provided the opportunity to develop the first epidemiological profile of the CARS service. This offers a foundation from which further research can continue to explore the impact and significance of this service, its contributions to the region, and perhaps most importantly, to identify the national significance and need for comparable databases and standardised variables. The use of robust, carefully constructed and considered reviews will allow comparison across services and inform not only quality initiatives and patient improvements, but also foster collaborative planning and ultimately a national forum for air transport information.

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APPENDIX 1: Approved Research Proposal

UNIVERSITY OF OTAGO NEW ZEALAND

605684

13 March 2018

Louise Jacobsen
61A Kidson Terrace
Cashmere
Christchurch 8022

Dear Louise

Research Proposal: Master of Health Sciences (Nursing-Clinical)

Thank you for submitting your research proposal. The Research Proposal Review Panel is pleased to **approve** your research proposal and supervisory arrangements as follows:

Title: "Christchurch Air Retrieval Service: Description of inter-hospital transfers over a 10-year period."

Supervisors: Primary Supervisor: Dr Sandra Richardson
Second Supervisor: Dr Phil Hider

When the reviewers discussed your research proposal, the following points were raised for your benefit and consideration (and for discussion with your supervisors):

- This is a relevant and timely study.
- The title should be reconsidered to more accurately capture the scope of the study.
- It is noted that this is a relatively ambitious research proposal, but it is clear that you have consulted widely and appropriately, and have a provisional plan for reducing the scope of the work should you need to.

Memorandum of Understanding for Supervision
We strongly encourage you to develop a formal Memorandum of Understanding with your supervisors outlining the supervisory relationship and responsibilities so that expectations are clear and documented for all parties. A template Memorandum is enclosed for your use. Please feel free to modify it to suit your individual situation.

Centre for Postgraduate Nursing Studies – University of Otago, Christchurch
P O Box 4345, Christchurch 8140, New Zealand
Tel 03 364 3850 • Email nursingstudies.uoc@otago.ac.nz
www.uoc.otago.ac.nz

Ethical approval
You are reminded that your research cannot begin until ethical approval, where appropriate, has been granted. Once granted, a copy of the Ethics Approval must be sent to your Programme Administrator, to be filed along with your research proposal.

I wish you all the best with your studies.

Yours sincerely,

Amanda Clifford
Postgraduate Administrator

cc Sandra Richardson, Phil Hider, Ruth Helms, Linda Munro-Innes

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APPENDIX 2: Ethics approval

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

H18/063

Academic Services
Manager, Academic Committees, Mr Gary Witte

21 May 2018

Dr S Richardson
Centre for Postgraduate Nursing Studies (Chch)
72 Oxford Terrace, Levels 2 and 3
University of Otago, Christchurch

Dear Dr Richardson,

I am writing to let you know that, at its recent meeting, the Ethics Committee considered your proposal entitled "**Christchurch Air Retrieval Service: A retrospective descriptive study**".

As a result of that consideration, the current status of your proposal is:- **Approved**

For your future reference, the Ethics Committee's reference code for this project is:- **H18/063**.

The comments and views expressed by the Ethics Committee concerning your proposal are as follows:-

While approving the application, the Committee would be grateful if you would respond to the following:

Screening health information (question 11.1)

Please note that question 11.1 was incorrectly answered. You have responded 'no' to the question *Will your study involve reviewing or screening health information, for example in order to identify potential participants?*, the response should have indicated 'yes' that you do intend to review health information.

Identifying participants (question 13.3)

The Committee noted that the response of "not applicable" was given to the question 13.3 relating to how participants will be identified. However, the Committee did note, that the study protocol addresses this issue. In future please ensure that this question is also addressed in the application form.

Please provide the Committee with copies of the updated documents, if changes have been necessary.

The standard conditions of approval for all human research projects reviewed and approved by the Committee are the following:

Conduct the research project strictly in accordance with the research proposal submitted and granted ethics approval, including any amendments required to be made to the proposal by the Human Research Ethics Committee.

Inform the Human Research Ethics Committee immediately of anything which may warrant review of ethics approval of the research project, including: serious or unexpected adverse effects on participants; unforeseen events that might affect continued ethical acceptability of the project; and a written report about these matters must be submitted to the Academic Committees Office by no later than the next working day after recognition of an adverse occurrence/event. Please note that in cases of adverse events an incident report should also be made to the Health and Safety Office:

http://www.otago.ac.nz/healthandsafety/index.html

Advise the Committee in writing as soon as practicable if the research project is discontinued.

Make no change to the project as approved in its entirety by the Committee, including any wording in any document approved as part of the project, without prior written approval of the Committee for any change. If you are applying for an amendment to your approved research, please email your request to the Academic Committees Office:

gary.witte@otago.ac.nz

jo.farrondediaz@otago.ac.nz

Approval is for up to three years from the date of this letter. If this project has not been completed within three years from the date of this letter, re-approval or an extension of approval must be requested. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing.

The Human Ethics Committee (Health) asks for a Final Report to be provided upon completion of the study. The Final Report template can be found on the Human Ethics Web Page http://www.otago.ac.nz/council/committees/committees/HumanEthicsCommittees.html

Yours sincerely,

Gary Witte

Mr Gary Witte
Manager, Academic Committees
Tel: 479 8256
Email: gary.witte@otago.ac.nz

c.c. Dr P Seaton Director, Senior Lecturer Centre for Postgraduate Nursing Studies (Chch)

APPENDIX 3: Te Komimito Whakarite approval

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

CHRISTCHURCH

15 May 2018

Dr Sandra Richardson
Centre for Postgraduate Nursing Studies
University of Otago, Christchurch

Mā te rangahau Hauora e tautoko te whakapiki ake te Hauora Māori.
All health research in Aotearoa New Zealand benefits the Hauora (health and wellbeing) of tangata whenua.

Tēna kōe Sandra,

Thank you for taking the time to discuss your research with me on the 14th May 2018. Your research study is titled:

"Christchurch Air Retrieval Service: A Retrospective Descriptive Study".

I note that you are the Principal Investigator for this research and that this study is a collaboration involving the Canterbury Initiative, the Canterbury District Health Board and the University of Otago, Christchurch.

Commentary on Proposed Research Project

Christchurch Air Retrieval Service (CARS) is based at the Christchurch Hospital, and works in conjunction with New Zealand Flying Doctors, Garden City Helicopters, Westpac Rescue Helicopters and St. John Ambulance to provide inter-hospital patient transport. Transportation is predominantly to, or from the Canterbury District Health Board (CDHB) campuses, but also other hospital centres throughout New Zealand. Patient transport may take place in a pressurised fixed wing aircraft, helicopter or even by road, and approximately 400-650 patients are transported each year. However, the CARS has seen a large increase in numbers in the last few years.

Inter-hospital transportation of patients is required for many reasons. These include relocating or returning patients to their domicile district health board after an admission or specialist treatment: relocating to areas with an available bed space; or more frequently, retrieving urgent or critical patients from smaller hospital facilities who require a higher level of care with or without intensive care interventions. The medical retrieval team is composed of an Intensive Care Unit (ICU) flight nurse or an ICU flight nurse and an ICU registrar, with additional input from paediatric, obstetric or other specialist services such as paediatricians, or neonatal teams as required. To date there has been no examination of the service population or profile other than basic or operational reviews.

Ultimately, the aim of this study is to identify and describe the profile of the Christchurch Air Retrieval Service and its patients, and will focus on the following four areas: 1. Development of an epidemiological profile of the Christchurch Air Retrieval Service's patients; 2. Identification of the common presentations within this population and; 3. Description of the population of helicopter transfer users in comparison with those using fixed wing aircraft transfers. This study will be based at the Christchurch Air Retrieval Service, Intensive Care Unit, Christchurch Hospital, Canterbury District Health, Christchurch.

Research and Development Christchurch
University of Otago, Christchurch
PO Box 4345, Christchurch 8140, New Zealand
Tel +64 3 364 0237 • Email research.uoc@otago.ac.nz
otago.ac.nz/christchurch

Māori Health Gain
Canterbury has a statistically lower percentage of population identified as Māori compared to the national percentage, 9.1% and 15.8% respectively. The Māori population in Canterbury comprises 49,680 Māori according to the 2013 census. Patients transported by the Christchurch Air Retrieval service, are not only from Canterbury as around 20-30% of the transported patients are from the West Coast District Health Board. At present, a description of the epidemiologic profile of the Christchurch Air Retrieval Service's patients and workload has not yet been examined however, this study will produce an understanding of the service's utilisation and workload structure that can inform planning for future service and care delivery. It is also anticipated that this study may also be a prelude for examining patient group outcomes for this particular study population, and whether or not patient health outcomes are improved.

Ethnicity
As discussed, the ethnicity of participants is a key variable for understanding the health experiences of different population groups leading to the development of more effective policies and programmes. It is recommended that ethnicity data is collected from each participant in accordance with the Ministry of Health guidelines, which involves the use of the Census 2013 question. Your study should also acknowledge the issues associated with data ethnicity collection.

Consent
This research project does not specifically target Māori participation, although you have indicated that Māori will have a presence in the study population. I understand that you will be seeking consent from the New Zealand Health & Disability Ethics Committee to use individual participant data for this study.

Potential Further Support Resources
Further resources that you might want to access to strengthen your responsiveness to Maori within your research are: 1. HRC's Ngā Pōu Rangahau Hauora Kia Whakapiki Ake Te Hauora Māori 2004-2008, 2. Article by Dr Papaarangi Reid (2017). "Achieving Health Equity in Aotearoa: Strengthening Responsiveness to Māori in Health Research." and 3. The Health Research Strategy to Improve Māori Health and Well Being 2004-2008. For regional data relating to Māori in each District Health Board (DHB) region, the District Health Board (DHB) Māori Health Profiles (2015) published by the Ministry of Health New Zealand will help to create a picture of the health status of a DHB's population at a given time. The other reference that is available is 3. Hauora Māori Standards of Health IV: A Study of the Years 2000-2005 by Bridget Robson and Ricci Harris, Māori Health Research Unit, Wellington School of Medicine, University of Otago, Wellington. The publication Tātau Kahukura: Māori Health Chart Book 2015, Ministry of Health, 2010 (3rd edition) is an update relating to the socio economic determinants of health, health status and service utilisation of the Māori population. Further references are available from the HRC's Guidelines for Researchers on Health Research Involving Māori. All provide Maori specific information on a range of health issues.

Dissemination of Results
The HRC's Guidelines for Researchers on Health Research Involving Māori, is important in terms of how your research results may contribute to Māori health gain. This should occur not only in an academic forum, but also within the community from where data is drawn. In terms of dissemination to Māori, you inform that you have discussed this researh project with Eru Waiti, Māori Health Manager for Ngā Ratonga Hauora Māori at Christchurch Public Hospital. Therefore, at the conclusion of your study, I have recommended that you be guided by Eru to help you identify a local Māori forum e.g. Te Aō Marama (Canterbury District Health Board Māori Health Worker Hui) where your study findings may be presented for dissemination. As such, these avenues may allow an opportunity for the consideration of Māori feedback into any discussion going forward.

Ngā manaakitanga,

Karen Keelan
Kaitohutohu Rangahau Māori/Māori Research Advisor

Canterbury
District Health Board
Te Poari Hauora o Waitaha

Research Office Project ID	18074

Audit Project
Request for Locality Authorisation within CDHB

Instructions:

1. Complete the form. Please provide detailed answers as the CDHB Locality Authorisation will ONLY be provided for that outlined in this application.

2. Print the form and obtain approval/s from Clinical Director and Service Manager from the host department where the audit will be conducted.

3. The following MUST accompany your Locality Authorisation Form:
   a. Ethics Approval Letter or HDEC Out-of-Scope Letter
   b. Source of Funding – where applicable
   ** *Please note – additional documentation or evidence may be requested by the Research Office to assist with processing your application*

4. Send the completed form along with the required documentation to Research Office, Level 5 Christchurch School of Medicine, University of Otago, Christchurch or send via email to cdhb.researchoffice@otago.ac.nz

5. The Research Office will endeavor to process your locality within 5 working days WHEN ALL THE DOCUMENTATION REQUIRED IS RECEIVED.

RESEARCHER TO COMPLETE AND ATTACH ALL REQUIRED DOCUMENTATION

1. Research Team

CDHB Principal Investigator	Louise Jacobsen, Christchurch Air Retrieval Service, Chch hospital	Email:	losen@me.com
CDHB Contact Person:	Louise Jacobsen, Christchurch Air Retrieval Service, Chch hospital	Email:	
Coordinating investigator and Organisation: (if CDHB is not the lead site)	Sandra Richardson, Centre for Postgraduate Nursing, University of Otago	Email:	Sandra.richardson@otago.ac.nz
Contact Person:		Email:	

Other parties involved (e.g. Sponsors, Collaborators, other Sites)

Dr. Phil Hider, Department of Public Health
Dr. David Bowie, CDHB

2. Audit Details

2.1 Research Office Project ID:

RO# 18074

2.2 Audit Title/Protocol Number:

Christchurch Air Retrieval Service: A retrospective descriptive study

2.3 Audit timeline

Start date: 01/01/2008
End date: 31/12/2017

20th May 2018
14th Dec 2018
(Ethics)

2.4 Brief Summary of the Overall Audit

Background:
Christchurch Air Retrieval Service (CARS) is based in Christchurch Hospital, and works in conjunction with New Zealand Flying Doctors, Garden City Helicopters, Westpac Rescue Helicopters and St. John Ambulance to provide inter-hospital patient transport. This is predominantly to or from the Canterbury District Health Board (CDHB) campuses, but also other hospital centres throughout New Zealand. The patient transport may take place in a pressurised fixed wing aircraft, helicopter or even by road, and transports approximately 400-650 patients per year, and has seen a large increase in numbers in the last few years.

Inter-hospital transportation of patients is required for many reasons. These include relocating or returning patients to their domicile DHB after an admission or specialist treatment: relocating to areas with an available bed space; or more frequently, retrieving urgent or critical patients from smaller hospital facilities who require a higher level of care with or without intensive care interventions.

The medical retrieval team is composed of an Intensive Care Unit (ICU) flight nurse or an ICU flight nurse and an ICU registrar, with additional input from paediatric, obstetric or other specialist services such as paediatricians, or neonatal teams as required.
To data there has been no examination of the service population or profile other than basic or operational reviews.

<u>Aim:</u>
The study will identify and describe the profile of the Christchurch Air Retrieval Service and its patients and will focus on these four areas:
1. Development of an epidemiological profile of the Christchurch Air Retrieval Service's patients
2. Identification of the common presentations within this population
3. Description of the population of Helicopter transfer users in comparison with those using fixed wing aircraft transfers.
4. If time allows, look at risk profiles and potential correlations within the population demographics

<u>Design:</u>
A simple, descriptive, retrospective study design was selected for this research, because this will allow the researcher to generate a clear outline of the CARS service, utilising the existing resources. To date there has been no overview generated of the service profiling the patient population, type of transfers or service dynamics.
This study will involve the analysis of retrospective data, originally collected for purposes other than this research. This is a widely used methodology in healthcare, typically applied to existing databases or used in relation to review of medical records.

<u>Main outcome:</u>
Describing the epidemiologic profile of the Christchurch Air Retrieval Service's patients and workload has not yet been examined. This will produce an understanding of the service's utilisation and workload structure that can inform planning for future service and care delivery. This study is also seen as a prelude for examining this patient groups outcome hopefully leading to improved health outcome.

Research Office | Canterbury District Health Board & University of Otago, Christchurch | PO Box 4345, Christchurch Mail Centre, Christchurch 8140, New Zealand Tel +64 3 364 0237 • Email cdhb.researchoffice@otago.ac.nz www.otago.ac.nz/christchurch/research

2.5 Which best describes the type of audit you will be conducting – Please tick

	Systematic evaluation of aspects of health or disability support service delivery by considering measurable indicators of performance and/or quality.
	Quality assurance activities aim to improve health and disability support services by assessing the adequacy of existing practice against a standard.
X	**Programme evaluation** is a type of audit where a whole programme is evaluated, rather than specific interventions.
	Evaluation studies aim to determine the relevance, effectiveness and impact of activities in the light of their objectives. Several types of evaluation are distinguished, including evaluation of the structure, process and outcome of an activity.
	Outcome analyses involve the assessment of health and disability support service quality by reviewing health care information to evaluate outcomes without comparing them against a standard. For example, clinicians may retrospectively examine health care notes and perform descriptive analyses to determine the outcome of medical treatment or course of a particular illness.
	Benchmarking aims to improve practice through the comparison of two or more health and disability support services.
	Public health investigations explore possible risks to public health, are often of an immediate or urgent nature, and are often required by legislation. Examples are investigations into outbreaks or clusters of disease, analyses of vaccine safety and effectiveness, and contact tracing of communicable conditions.
	Public health surveillance involves the monitoring of risks to health by methods that include the systematic collection, analysis and dissemination of information about disease rates.
	Pharmacovigilance (post-marketing surveillance) involves monitoring the adverse effects of pharmaceuticals after their introduction into the general population, by such methods as the spontaneous reporting of adverse events and the monitoring of all adverse events for a restricted group of medicines (prescription event monitoring).
	Resource utilisation reviews evaluate the use of resources in a particular health or disability service activity, for example, by reviewing health records to determine health care inputs such as chest X-rays for patients with a particular diagnosis.

2.6 Describe the methods/ procedures that will occur within CDHB (Note that locality authorisation will only cover the procedures that are detailed here)

Data from the patient transports are stored within the original transport records held at the Christchurch hospital, and for the purpose of assembling the transport information, once the flight mission is completed, the information is entered into a 'Clinical team and mission info' Excel spread sheet stored at and owned by the CDHB, and accessed by the Clinical Nurse Coordinator and the Senior Flight nurses within CARS. The data here entered holds information about time and date, patient NHI, patients age, sending and receiving hospital, and patients DHB of domicile, information of mission times, information of crew configuration, aircraft type, purpose of mission and urgency of patient transfer.

For this study these excel spread sheets will be accessed by the student research investigator Louise Jacobsen at the CARS office and be de-identified by removing the identifiable data before the data audit can continue.

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Research Office Project ID	

4. CDHB Resources Used

4.1 **Access to CDHB Patient Data** – Please specify data source (e.g. HealthOne, Health Connect South, Existing patient registry, Tissue bank samples, Data warehouse, non-electronic Clinical Records)

Only the 'Clinical team and mission info' Excel spread sheet stored at the CDHB will be accessed.

4.2 **CDHB Participants** - Please outline the Recruitment Process and Number

Due to the characteristics of the study design being a retrospective data collection, there is minimal impact to the patients and hospital departments.

5.1 **CDHB Staff** – please outline key CDHB staff and their specific tasks for this audit

	Name	Department	Role in the Audit	Key tasks
1	Louise Jacobsen	Air Retrieval Service, CDHB	Student investigator	• Acces the 'Clinical team and mission info' data • De-identifly the data • Conduct the data analysis
2	Dr Sandra Richardson	Emergency department, CDHB	Coordinating investigator, and primary supervisor	• Oversee the data esembly and data analysis
4	Dr. David Bowie	Air Retrieval Service, CDHB	Expert advisor	• Advice the data analysis
5	John wilkins	Decision Support.		Request etc data key task
6				
7				
8				

5.2 **CDHB Facilities** *(list specific location/s and department/s where the audit will be conducted e.g., Burwood, Orthopaedic Dept.)*

	Location / Department	Methods / Procedures at this Facility
1	Christchurh Air Retrieval Service's office	Acces the 'Clinical team and mission info' data De-identifly the data
2		
3		
4		

5.3 **Other Resources Required** – please specify

Research Office Project ID	

6. **Evidence Required** – THE FOLLOWING SHOULD BE SENT ALONG WITH THE COMPLETED LOCALITY AUTHORISATION FORM:

6.1 **Ethical Approval or 'Out of Scope' Letter**

a. If the project is "outside ethics review" then CI / PI should sign and date

b. If the project has been approved by HDEC, please ensure to request locality on-line via the HDEC website. You will need to type in our email address cdhb.researchoffice@otago.ac.nz

	Reference Number	Date of letter
HDEC :		
HDEC – Out of scope :	✓	27th June 2018
Institutional approval :	University of Otago Human Ethics Committee (Health) H18/063.	21 May 2018 ✓
Not required :	(sign here)	(date)

6.2 **Funding**: Outline any funding sources for this Audit (*e.g. internal departmental funds, scholarships, external funding source, grants*)

No funding

Research Office | Canterbury District Health Board & University of Otago, Christchurch | PO Box 4345, Christchurch Mail Centre, Christchurch 8140, New Zealand Tel +64 3 364 0237 • Email cdhb.researchoffice@otago.ac.nz www.otago.ac.nz/christchurch/research

Research Office Project ID	

RESEARCHER TO ORGANISE APPROVAL FROM RESPECTIVE MANAGERS

CDHB Coordinating Investigator or CDHB Principal Investigator: I hereby confirm that all information contained within this application is true and correct. I will take professional responsibility to conduct this research at CDHB and ensure all consents and approvals are obtained and sighted by the Research Office before research commences. Further, I confirm that conducting this research at CDHB will have no adverse effect of the provision of publicly funded health care at this locality. (Must be CDHB staff)	
Signed: Louise Jacobsen **Name:** LOUISE JACOBSEN	**Date:** 26/6/18

7. Approval From All Areas Where Resources are Accessed

Approvals: I hereby authorise this application to undertake this research within this CDHB Department and guarantee the availability of adequate facilities, equipment, staff and any special support which may be required as detailed in the application. I confirm that it is in accordance with current CDHB policy

Department Name:	**1. Air Retrieval Service**	**2.**	**3.**
Clinical Director - Name	Dr. David Bowie		
Signature	D Bowie		
Date	27/6/2018		
Service Manager - Name	Pamela Gordon		
Signature	P Gord		
Date	29-6-18		
Other Approving Manager Name	Shane McKerrow		
Title	Clinical nurse coordinator		
Signature	Shane McKerrow		
Date	26/6/18		

RESEARCH OFFICE TO FACILITATE APPROVAL FROM CDHB GENERAL MANAGER/S

General Manager sign-off

This research will take place in your hospital, do you approve it?

Hospital 1	*Name:* A. Lintaf	*Signature:*	*Date:* 06/07/18
Hospital 2	*Name:*	*Signature:*	*Date:*

Audit Locality Authorisation Form, Feb 2016 Page 8

Research Office I Canterbury District Health Board & University of Otago, Christchurch I PO Box 4345, Christchurch Mail Centre, Christchurch 8140, New Zealand Tel +64 3 364 0237 • Email cdhb.researchoffice@otago.ac.nz www.otago.ac.nz/christchurch/research

APPENDIX 5: Medical specialties grouping

Dataset identified Specialty	
Cardiology	1
Cardiothoracic	2
ENT	3
Gynae	4
ICU	5
ICU, cardiology	6
ICU, Cardiothoracic	7
ICU, ENT	8
ICU, Gynae	9
ICU, Medical	10
ICU, Neurology	11
ICU, Neurosurgery	12
ICU, obstetric	13
ICU, Oncology	14
ICU, Orthopaedic	15
ICU, paediatric	16
ICU, plastics	17
ICU, Respiratory	18
ICU, Surgical	19
ICU, Spinal	20
ICU, Urology	21
ICU, Vascular	22
ICU, trauma	23
Max Facs	24
Mental Health	25
Medical	26
Neonatal	27
Nephrology	28
Neurology	29
Neurosurgical	30
Obstetric	31
Oncology	32
Orthopaedic	33
Opthalmology	34
Paediatric	35
Paed oncology	36
Paed surgery	37
Plastics	38
Rehab	39
Respiratory	40
Surgical (gastro)	41
Spinal	42
Transplant assessment	43
Urology	44
Hyperbaric	45
Private transfer	46
Haemotology	47
Rest home	48
Hyperbaric	49
transplant assessment	50
rehab	51
other	52

Medical specialty grouping	
1	Cardiology
2	Cardiothoracic
20	Other
3	Gynae/ Obstetrics
4	ICU
4	ICU
4	ICU
4	ICU
4	ICU
4	ICU
4	ICU
4	ICU
4	ICU
4	ICU
4	ICU
5	ICU paediatrics
4	ICU
4	ICU
4	ICU
4	ICU
4	ICU
4	ICU
4	ICU
20	Other
6	Mental Health
7	Medical
20	Other
20	Other
8	Neurology
9	Neurosurgical
3	Gynae/ Obstetrics
10	Oncology
11	Orthopaedic
20	Other
12	Paediatric
12	Paediatric
12	Paediatric
13	Plastics
20	Other
7	Medical
14	Surgical
15	Spinal
20	Other
20	Other
16	Hyperbaric
20	Other
20	Other
20	Other
17	Hyperbaric
20	Other
20	Other
20	Other

APPENDIX 6: Example of standardised dataset with sub-categories

DHB of domicile	Crew	Mode
Auckland	Flight Nurse only	pressurised fixed wing
Bay of Plenty	Doctor and Flight Nurse	non-pressurised fixed wing
Capital & Coast	Flight Nurse and Midwife	twin engine helicopter
Canterbury	Flight Nurse and Paramedic	single engine helicopter
Counties Manakau	Flight Nurse and Advanced Neonatal Nurse Specialist	road only
Hawke’s Bay	Other (enter details in next column)	
Hutt		
Lakes		
Mid Central		
Nelson Marlborough		
Northland		
Otago		
South Canterbury		
Southland		
Tairawhiti		
Taranaki		
Waikato		
Wairarapa		
Waitemata		
Wanganui		
West Coast		
Overseas Visitor		
unknown		

purpose of mission (a)	purpose of mission (b)	Day of Week
bring patient to CDHB hospital	acute treatment required	Monday
send patient from CDHB for treatment	elective treatment required	Tuesday
return patient to DHB of domicile	returning to home area after specialist treatment	Wednesday
transfer pt but not involving CDHB	family / social reasons	Thursday
other	no appropriate beds at CDHB	Friday
other, due earthquake	private paying patient	Saturday
	other	Sunday