Critical Care Strategy Appendix

Auckland District Health Board

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Development of the Strategy

1.1 Overview of Auckland DHB's critical care units

Critical care services at Auckland DHB care for the most acutely unwell and high acuity patients across all specialties. There are four critical care units:

- The Cardiothoracic and Vascular Intensive Care Unit (CVICU) – Adult
- The Department of Critical Care Medicine (DCCM) – Adult
- The Paediatric Intensive Care Unit (PICU)
- The Neonatal Intensive Care Unit (NICU).

An overview of care provided by each unit is provided in Table 1.

Table 1: Overview of Auckland DHB's critical care units

Units	Levels of care	Types of care provided	Other locations this care is provided	Service responsibilities
CVICU	Level 2	High dependency care – single-system support, no ventilation	Middlemore, Waikato, Wellington, Christchurch, Dunedin	► Secondary and tertiary cardiothoracic and vascular critical care for residents of Auckland DHB ► Cardiothoracic and vascular critical care for the Northern Region population ► National services including solid organ transplantation (Heart/Lung) and ECMO.
	Level 3	Intensive care – complex multi-system life support indefinitely, ventilation	Excluding national services and very highly complex cases	
DCCM	Level 2	High dependency care – single-system support, no ventilation	Most hospital sites	► Secondary and tertiary critical care (excluding cardiothoracic and some vascular) for residents of Auckland DHB ► A range of services (excluding cardiothoracic and some vascular) for the Northern Region population, such as trauma, neurosurgery and cancer and blood services ► National services including solid organ transplantation (Liver, Kidney and/or Pancreas).
	Level 3	Intensive care – complex multi-system life support indefinitely, ventilation	Middlemore, Waikato, Wellington, Christchurch, Dunedin Excluding national services and very highly complex cases	
PICU	Level 2	High dependency care – single-system support, no ventilation	Waikato, Wellington and Christchurch, Dunedin (who all also provide short term intensive care)	► Secondary and tertiary critical care for residents of Auckland DHB ► A range of tertiary services provided for the Northern Region population and further afield, such as paediatric surgery (across multiple specialties), trauma, and cancer and blood services ► National services including paediatric and congenital cardiac services, solid organ transplantation and ECMO
	Level 3	Intensive care – complex multi-system life support indefinitely, ventilation	No other centres in New Zealand	

Units	Levels of care	Types of care provided	Other locations this care is provided	Service responsibilities
				► The PICU Retrieval Service, to transport unwell children from elsewhere in New Zealand to Starship.
NICU	Level 1	Infants with minimal complications and gestational age from 35 weeks (i.e., 35 weeks 0 days and above)	Most hospital sites, as part of SCBU or PNW	► Secondary and tertiary critical care for neonates of Auckland DHB ► A range of tertiary services provided for the Northern Region population and further afield, such as for neonatal cardiac conditions, or those with a very low gestational age ► National services including paediatric cardiothoracic / congenital cardiac
	Level 2	SCBU care, infants with moderate complications with gestational age of 32 weeks or above, or mature infants requiring, e.g., continuous positive airway pressure (CPAP)	Whangarei, North Shore, Waitakere, Middlemore, Waikato, Tauranga, Rotorua, Whakatane, Gisborne, Hawke's Bay, Taranaki, Palmerston North, Wanganui, Wairarapa, Wellington, Hutt, Nelson, Grey, Christchurch, Timaru, Dunedin, Southland	
	Level 3	NICU care, critically ill infants from any gestational age, e.g., close to term invasively ventilated	Middlemore, Waikato, Taranaki, Palmerston North, Wellington, Christchurch, Dunedin Excluding national services and very highly complex cases	

Critical care unit roles and configurations

Table 2 summarises the roles and configurations of each unit at Auckland DHB. Other aspects of service provision, including casemix are discussed subsequently.

Table 2: Critical care units and their configuration in Auckland DHB

Units	Directorate	Location at Auckland DHB	Co-located services	Physical beds	Resourced beds (2018)
CVICU	Cardiovascular	ACH Level 4	Level 4 operating rooms (ORs) and post-anaesthetic care unit (PACU), Cardiac and Vascular wards, Cath Lab and Cardiology wards on Level 3	26	16 ICU 6 HDU 22 Total
DCCM	Adult Medicine	ACH Level 8	Level 8 ORs and PACU, Neurology and Neurosurgery wards, General Surgery wards and Maternity delivery on neighbouring floors	24	11 ICU 6 HDU 17 Total

Units	Directorate	Location at Auckland DHB	Co-located services	Physical beds	Resourced beds (2018)
PICU	Child Health	Starship Level 2	Children's emergency department (ED), near to Starship ORs and PACU	22	16 ICU 6 HDU 22 Total
NICU	Child Health	ACH Level 9	Maternity delivery, postnatal wards, Level 8 ORs on floor below	46	40

Adult critical care services (CVICU and DCCM)

CVICU has a significant elective surgical patient workload, while also caring for major acute surgical cases such as cardiac transplants. The Unit also cares for acutely unwell cardiothoracic, vascular and cardiology patients, and any adult patients requiring ECMO. Acute admissions make up ~60% of the Unit's bed-day workload. In contrast, DCCM has a higher acute workload (~88% of the Unit's bed-day workload), providing care for both surgical and medical patients (~36% of admissions were discharged under medical specialties), and for acutely unwell patients arriving through the adult ED.

CVICU has the greatest number of ICU admissions and ventilation hours in New Zealand, and has the largest cardiac surgery throughput in Australasia. When total admissions across both CVICU and DCCM are considered, ACH has one of the largest concentrations of adult critical care service volume in an Australasian hospital.

The physical separation of adult critical care services at ACH is partly due to historical factors, including that CVICU was originally located at Greenlane Clinical Centre. Hospital design decisions made during the redevelopment of ACH in the late 1990s, determined that functional location of operating theatres, wards and ICUs should be based on patient flow. Situating CVICU within the Cardiovascular Directorate, and physically near the cardiology and cardiothoracic wards and operating theatres, was considered to enable more efficient patient pathways.

While both care for critically unwell adult patients, there is relatively little overlap in the patient cohorts cared for by the two units, and they generally function independently of each other.

Paediatric critical care services

PICU provides critical care for paediatric patients across all specialties. There is no other facility in New Zealand that can provide the scope of paediatric care that is delivered by PICU and so it is regularly the provider of last resort. PICU is one of eight standalone paediatric critical care units in Australasia and has one of the highest levels of acuity. For PICU, intubation rates are close to 75%, much higher than the average across Australasian PICUs of 41.2%.[1]

While caring for critically unwell children, there is relatively little overlap with other critical care units at Auckland DHB. Currently, overlaps are limited to ECMO and adult congenital cardiac patients (CVICU), and small volumes of term or near term babies (NICU), mostly with cardiac and other surgical conditions.

[1] ANZICS CORE annual report 2017

Neonatal critical care services

NICU provides most of its care to neonates domiciled in the Northern Region. Under Section 88, significant emphasis is placed on facilitating mothers' choice of the location of birthing. Where higher level neonatal intensive care is required, neonates are transferred to a hospital which can provide the appropriate care - with transfer back to their domicile-neonatal unit when appropriate. Based on health specialty code of discharge, in 2018, 8% of discharges were Level 1 (P41), 55% were Level 2 (P42), 25% were Level 3 (P43), and 7% were Specialist Paediatric Cardiology (M14). The remaining discharges comprised Paediatric Surgery, Paediatric Medicine, Respiratory Medicine and ENT. It is difficult to make direct comparisons to other centres due to differences in coding and rates of repatriation at different levels of neonatal care.

Routine neonatal care may also be provided on the postnatal wards (PNW). For neonates with slightly increased care needs, beyond what is normally provided on the PNW, care may be provided either in the NICU or on the PNW depending on clinical condition, occupancy and resourcing.

The current physical structure of NICU has limited capacity for mothers/parents to room in (four parent rooms), which limits their ability to bond with, and care for, their baby. International best practice care is moving towards keeping the mother-baby dyad together whenever possible.[2]

Critical care services outside of the ICU

Critical care services connect with other hospital services through outreach services, which are often facilitated by the patient at risk (PAR) service. The PAR service reviews patients at risk of deterioration or who are deteriorating. In part this is guided by the use of an early warning score (EWS) and standardised observation chart. When a patient deteriorates a code may be called which signals the need for critical care input. The codes used most often are:

- Red (Pink in Starship) is called for patients who are likely to deteriorate rapidly. These patients may have a high EWS, or any significantly deteriorating vital sign
- Blue which is called for patients who have immediately life threatening critical illness. These patients will have an EWS of 10 or more (Paediatric EWS of 8 or more), or any life threatening vital sign.[3]

In other cases critical care may be asked to review a ward or Level 2 (Emergency care) patient. Most of the outreach calls are managed between DCCM which covers most adult specialities provided at ACH, and PICU which covers Starship. CVICU provides cover for Levels 3 and 4, and act as a second team in the event of concurrent code calls within the hospital.

In addition the ICUs provide a review service for patients under ward care to advise about ongoing care on the ward (including decisions about appropriate levels of care after planned procedures) and/or to consider admission to ICU/HDU.

[2] White RD, et al., 2013. Recommended standards for newborn ICU design, eighth edition.

[3] https://www.hqsc.govt.nz/assets/Deteriorating-Patient/PR/Vital_sign_chart_user_guide_July_2017_.pdf

Relationship between critical care services in the region and nationally

Currently there is ad hoc communication and collaboration between Auckland DHB critical care and other DHBs' critical care services. Nationally there has been some engagement between critical care unit leaders, particularly in regards to workforce size and mix, but this has not been sustained. The exception is NICU which participates in the Newborn Clinical Network.

1.2 Strategy development

Development of the Strategy has been clinically-led, data and evidence-driven, and informed by wider service and capacity planning within the Northern Region and nationally. It has been future focused, considering demand drivers, workforce requirements to sustainably meet patient needs, and evolving models of critical care and technology.

The early stages of the Strategy development consisted of understanding key requirements, defining the scope for strategic planning, and constructing the planning framework. A range of key documents were considered:

- the strategic direction described for Northern Region health services in the Northern Region Long Term Investment Plan (NRLTIP),
- the strategic response to demand pressure signalled through the DHB's Building for the Future Programme Business Case (BFTF),
- the intention of services described in the Auckland DHB Clinical Services Plan (CSP),
- national service specifications particularly national services such as solid organ transplantation and extracorporeal membrane oxygenation (ECMO), and;
- the College of Intensive Care Medicine (CICM) standards for provision of adult and paediatric critical care services, and for neonates the Neonatal Inpatient Tier 2 Service Specification ('Neonatal service specification').

Document review followed by targeted individual interviews with key clinical and non-clinical stakeholders, representing nursing, medical, allied health and management staff for each critical care unit. This informed the development of planning principles to guide the Strategy development. The planning principles were:

1. Improve equity of access to, and outcomes from, critical care for the Auckland DHB resident population, the Northern Region population and the New Zealand population
2. Develop critical care capacity (physical and workforce) that can meet future demand and be used flexibly to ensure that changes in patterns of demand can be appropriately managed
3. Improve patient, whānau and staff wellbeing through promoting person-centred, safe and high quality critical care services and facilities
4. Achieve a sustainable workforce aligned to desired service delivery models and safe staffing standards
5. Continually improve the capability of critical care staff through research, teaching, learning and development
6. Improve the efficiency of critical care services through optimising patient flow along clinical pathways, improving connectedness to the rest of the hospital, and innovations in models of care
7. Develop a flexible model of care for transitional patients that allows them to be appropriately cared for throughout Auckland DHB by their home medical and nursing teams.

These planning principles were considered throughout the development of the Strategy.

1.2.1 Demand modelling

The early focus of the Strategy was to develop a demand and capacity model for critical care services. Analysis of New Zealand data was undertaken to inform model development. This used Auckland DHB information system data over the past 10 years, National Collections data where required, and critical care registry data as collected in Unit databases. International data was considered but dismissed, due to differences in provision of critical care in other jurisdictions.

Demand and capacity projections were developed based on a series of analyses. This included analysis of:
- Key characteristics of critical care patients, including age, ethnicity, domicile and deprivation
- Key drivers of change, including epidemiology, service configuration, length of stay, population growth and ageing
- Occupancy levels over the year, which led to use of the patient census at 10am (selected due to 10am being a high point of hospital occupancy over the year) in line with modelling assumptions used by BFTF.

Baseline demand and capacity projections by critical care unit were calculated for a 15-year period based on the maximum occupancy during financial year 2018. Assumptions driving these projections included demographic changes, and recent trends in average length of stay and clinical intervention rates.

Modified projections were also conducted based on potential changes in patient pathways, regional changes in service delivery models, and changes in the mix of patients cared for by each unit. Assumptions for these modified projections were guided by data, clinical opinion, and local and international trends in demand, service provision and epidemiology based on scans of the academic, research and grey literature.

1.2.2 Workforce modelling

De-identified workforce profile data were analysed to improve understanding of the existing workforce structure and capacity. Where appropriate, variations in workforce structure, capacity and development were substantiated. Workforce Groups (Medical, Nursing, Allied Health and Clinical Support) were established and supported the identification of key challenges. This included considering CICM and neonatal service specification workforce standards, and broadly encompassed workforce capacity, training and research, interaction with existing and possible future models of care.

Medical and Nursing

Analysis included current resourcing by role, recent trends in leave and turnover, and anonymised nursing exit interview data as provided by critical care unit leaders. Comparison of resourcing and workforce structures with other New Zealand critical care units was also undertaken through data collected by Auckland DHB critical care service leaders.

To assess whether current resourcing was appropriate, resourcing requirements were developed from first principles using the CICM standards, neonatal service specification, Australian College of Critical Care Nurses (ACCCN) and the New Zealand College of Critical Care Nurses (NZCCCN) standards, and relevant entitlements and contractual obligations from MECAs (ASMS, RDA/SToNZ and NZNO). This was compared to current resourcing metrics and informed the construction of a set of minimum standards that underpinned Strategy workforce modelling.

Allied Health and Clinical Support Services

Available best practice guidelines and standards for Allied Health and Clinical Support Services involvement in critical care were consulted. These were mainly sourced from the Guidelines for the Provision of Intensive Care Services (GPICS) published by the Faculty of Intensive Care Medicine (FICM) in the UK, published in June 2019, and available peer hospital benchmarks. A scan of literature relating to Allied Health and Clinical Support Services workforce was also conducted. This was followed by separate workshops with Allied Health service leaders and with the Clinical Support Services Directorate leadership team. The workshops helped with understanding current models of care, and those desired by stakeholders.

1.2.3 Strategy development governance and engagement approaches

A large team contributed to the development of the Critical Care Strategy (Figure 10). The Auckland DHB executive sponsor of the strategy was Joanne Gibbs, Director Provider Services, and the clinical lead was Dr John Beca, Director, Starship Child Health – Surgical and SCD, PICU.

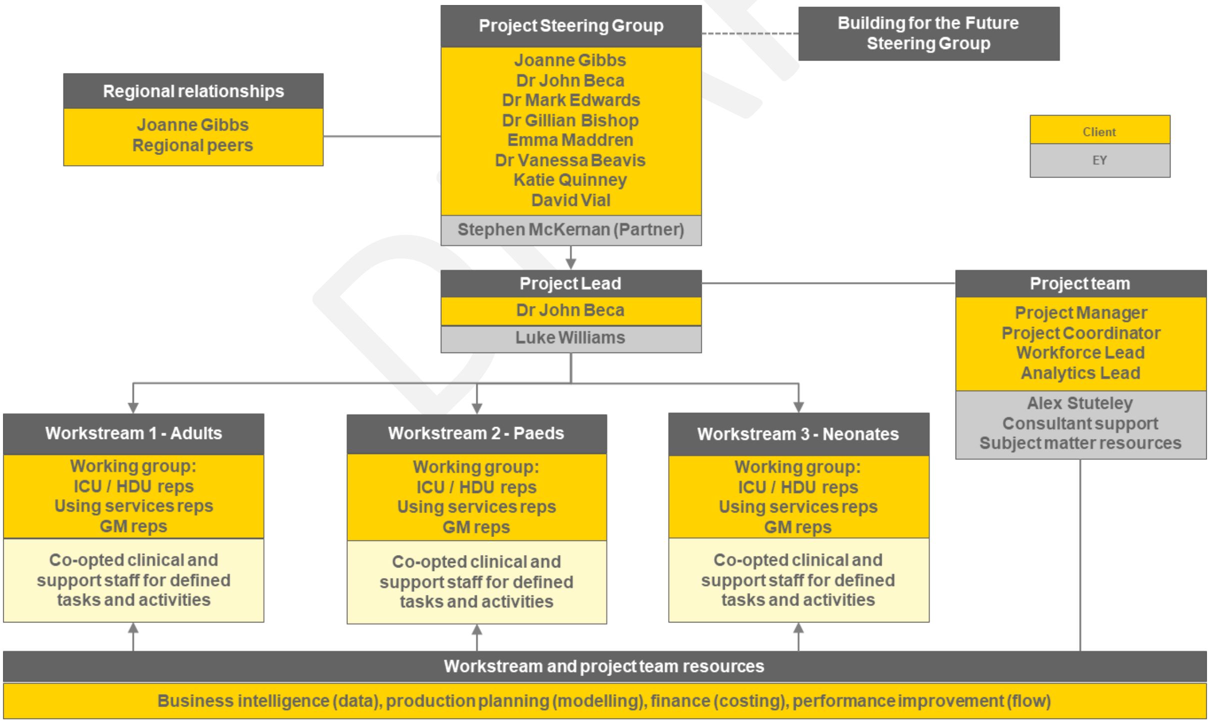


Figure 1: Project structure

An overarching Steering Group was convened every 6-8 weeks, responsible for making decisions on advice provided by workstreams (see below), and leading engagement with the Executive Leadership Team (ELT) and DHB Board.

Three workstreams were established: Adults, Paediatrics and Neonates. Each workstream had a working group guided by agreed Terms of Reference. Working groups met every 2-4 weeks, and were responsible for guiding analysis and priority development for the specific critical care services.

2. Demand modelling

This section provides a profile of critical care services which informed demand modelling.

2.1 Patient characteristics

Figure 2 shows the distribution of bed-days and admission rates by age group to CVICU and DCCM in 2018. Admission rates to both units peak between ages of 65 and 84 years. Bed-days are greater in younger age groups in DCCM than in CVICU. This is mostly related to trauma cases.

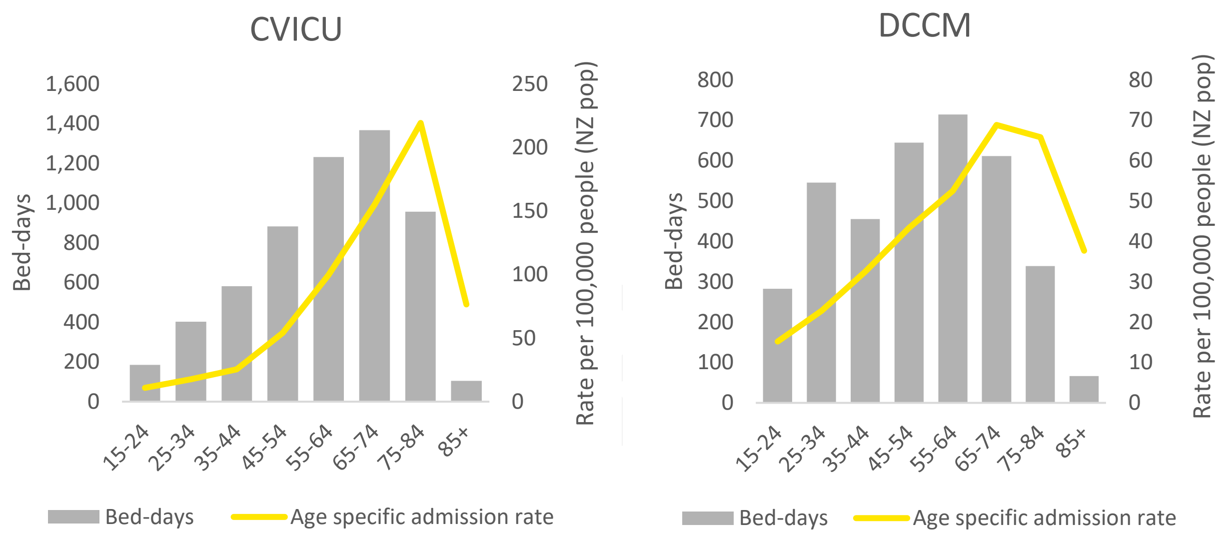


Figure 2: CVICU and DCCM age-specific bed-days and admission rates
Source: ADHB, SNZ, EY analysis

Figure 3 shows the distribution of bed-days and admission rate by age group to PICU in 2018. The admission rate peaks in the 0 to 1 year age group – accounting for ~51% of all bed-days in the Unit.

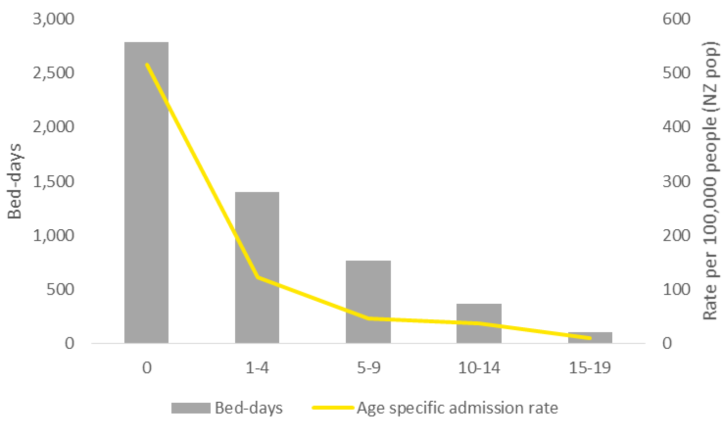


Figure 3: PICU age-specific bed-days and admission rates
Source: ADHB, SNZ, EY analysis

Figure 4 shows the distribution of bed-days and admission rates by gestational age / birthweight for NICU in 2018. Admission rates to NICU peak in the oldest gestational age group, and for birthweight in the normal birthweight range, i.e., 2500-3999g. However, bed-days are greater for younger gestational ages/lower birthweights – showing that lengths of stay are longer for these neonates.

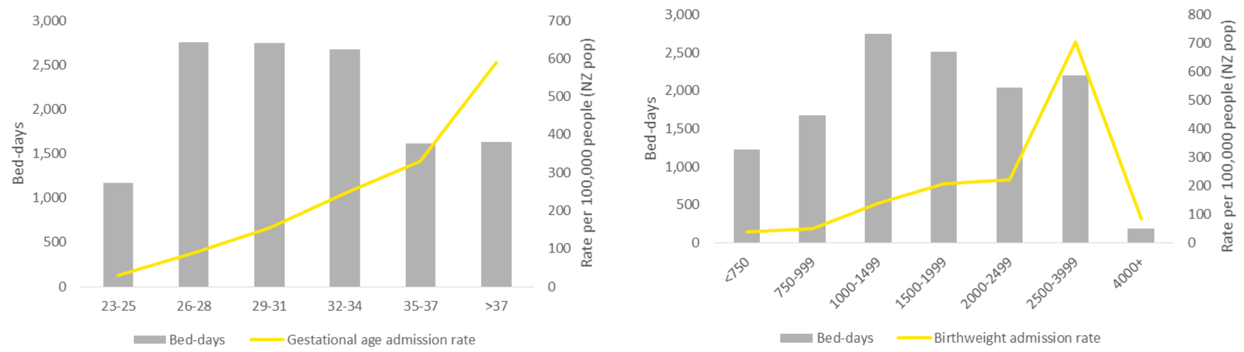


Figure 4: NICU gestational age / birthweight (g) bed-days and admission rates
Source: ADHB, SNZ, EY analysis

Patient ethnicity mix differs between adult, paediatric and neonatal critical care

In CVICU/DCCM and to a lesser extent NICU, the 'Other' prioritised ethnicity[4] makes up the majority of cases (Figure 5). As a share of their population, in PICU, Māori and Pacific children appear to be overrepresented, while in NICU, Asian neonates appear to be overrepresented. The increase in Asian neonates appears to be driven by an increase in the frequency of Chinese and Indian neonates of extremely low (<750g) and those in the normal birthweight range (2500-3999g).

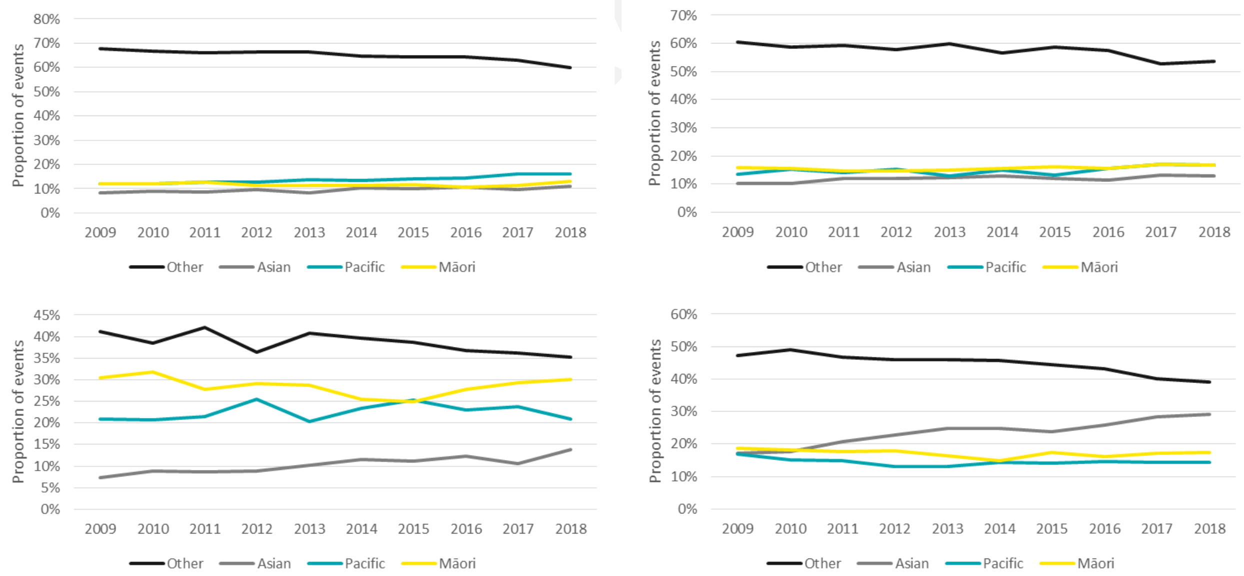


Figure 5: Critical care unit ethnicity distribution over time
Source: ADHB, EY analysis, SNZ Level 2 prioritised ethnicity
From top, left to right: CVICU, DCCM, PICU, NICU

Patients from areas of higher deprivation are overrepresented in critical care

Across all units a higher proportion of patients admitted to critical care are living in, or are born to mothers living in, highly deprived areas, based on the New Zealand Deprivation Index (NZDep13). Over the past few

[4] Prioritised ethnicity is a technique used to ensure that the total number of events is equal to the total population. Each individual is assigned their ethnicity which is highest up the priority list. In descending order the list is: Māori, Pacific, Asian, Other (e.g., European).

years the proportion of admissions from the most deprived areas has increased (Figure 6). This reflects higher burdens of disease (often occurring at older ages) and risk of trauma.

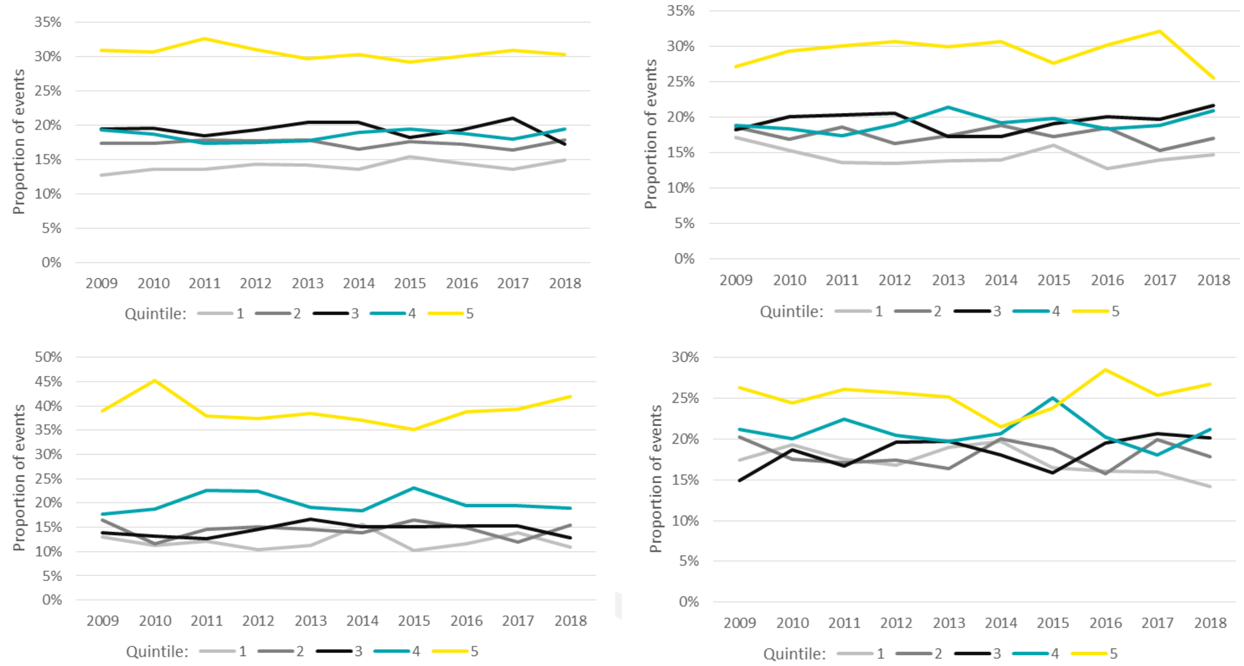
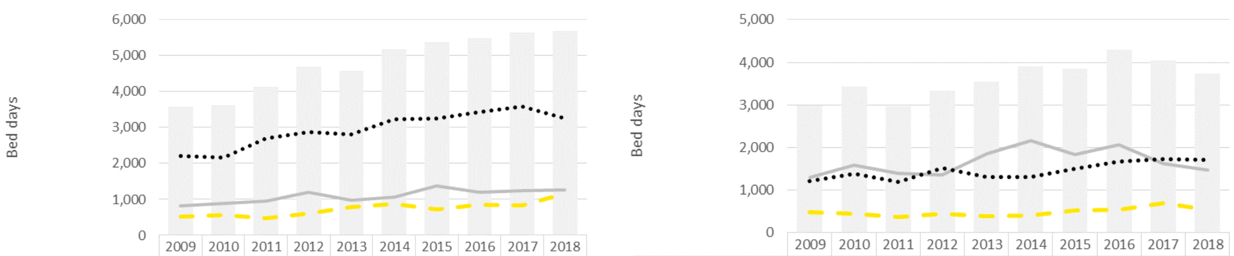


Figure 6: Critical care unit socioeconomic distribution over time
Source: ADHB, EY analysis
From top, left to right: CVICU, DCCM, PICU, NICU

All units have experienced increasing bed-days for residents outside of Auckland DHB, particularly in the past few years

In CVICU, a key component of recent increases in bed-days has been admissions for people from the wider Northern Region and other parts of New Zealand (Figure 7). This has been driven by increases in cardiac transplants, ECMO, and cardiac valve and vascular reconstruction procedures. In DCCM, demand growth has been more modest, and is more evenly distributed across residents of Auckland DHB, the Northern Region and other parts of New Zealand.



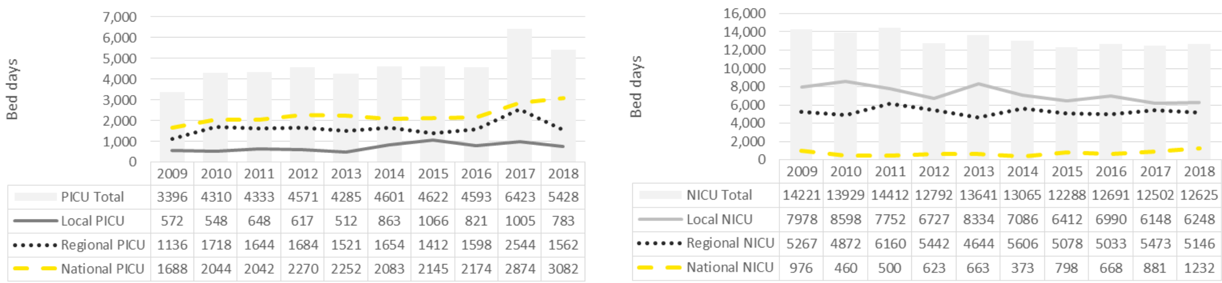
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
CVICU Total	3569	3618	4122	4680	4573	5173	5369	5477	5651	5684
Local CVICU	831	893	949	1190	982	1073	1378	1193	1236	1261
Regional CVICU	2215	2161	2702	2879	2809	3228	3261	3426	3582	3258
National CVICU	523	564	472	612	782	872	730	858	833	1165

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
DCCM Total	2987	3432	2973	3341	3549	3905	3855	4298	4040	3727
Local DCCM	1299	1598	1403	1367	1852	2171	1830	2073	1623	1477
Regional DCCM	1209	1394	1202	1528	1314	1316	1499	1678	1724	1715
National DCCM	479	440	368	445	384	418	526	547	693	536

Figure 7: CVICU and DCCM bed-days by patient domicile
Source: ADHB, EY analysis

In PICU (Figure 8), a large component of the total increase in bed-days has been admissions for patients from the wider Northern Region and New Zealand. The greatest number of bed-days were for patients outside of the Northern Region, demonstrating PICU's national service provision role.

For NICU there has been an overall decrease in total patient bed-days since 2010 for Auckland domiciled neonates, likely due to a declining local population birth rate. However, bed-days for neonates resident outside of the Northern region have been increasing - noting that the fewer bed-days in 2014 and 2016 correspond to periods of workforce challenges for MFM services, resulting in fewer women referred to ACH in those years.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
PICU Total	3396	4310	4333	4571	4285	4601	4622	4593	6423	5428
Local PICU	572	548	648	617	512	863	1066	821	1005	783
Regional PICU	1136	1718	1644	1684	1521	1654	1412	1598	2544	1562
National PICU	1688	2044	2042	2270	2252	2083	2145	2174	2874	3082

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
NICU Total	14221	13929	14412	12792	13641	13065	12288	12691	12502	12625
Local NICU	7978	8598	7752	6727	8334	7086	6412	6990	6148	6248
Regional NICU	5267	4872	6160	5442	4644	5606	5078	5033	5473	5146
National NICU	976	460	500	623	663	373	798	668	881	1232

Figure 8: PICU and NICU bed-days by patient domicile
Source: ADHB, EY analysis

2.2 Service use

This section provides a breakdown of the casemix of critical care services and explores how key service cohorts have changed over time.

Table 3 summarises the top 20 DRGs recorded for patients that had a proportion of their stay at ACH in CVICU in 2018, by population catchment. These DRGs accounted for over 85% of total bed-days in the Unit.

Table 3: CVICU bed-days for top 20 DRGs in 2018
Source: ADHB, EY analysis

DRG	Auckland DHB	Other Northern Region	Other NZ	% non-resident bed-days	Total	% of total bed-days
Tracheostomy W Ventilation >95 hours W Catastrophic CC[5]	243	394	183	70.4%	820	14.4%
Cardiac Valve Proc W CPB Pump W/O Invasive Cardiac Inves W Cat CC	75	471	102	88.3%	649	11.4%
Trach W Vent >95 hours W/O Cat CC or Trach/Vent >95 hours W Cat CC	88	285	47	79.2%	419	7.4%
Lung or Heart/Lung Transplant	73	133	198	81.9%	404	7.1%
Coronary Bypass W/O Invasive Cardiac Inves W Reoperation or W Cat or Sev CC	35	317	14	90.4%	366	6.4%
ECMO W Tracheostomy	20	122	211	94.3%	353	6.2%
Major Chest Procedures W Catastrophic CC	40	160	2	80.2%	202	3.6%
ECMO W/O Tracheostomy	65	39	89	66.3%	193	3.4%

[5] If tracheostomy or ventilation occurs as part of a patient's stay they are assigned a tracheostomy/ventilation DRG, however, the patient's reason for admission is variable.

DRG	Auckland DHB	Other Northern Region	Other NZ	% non-resident bed-days	Total	% of total bed-days
Coronary Bypass W/O Invasive Cardiac Inves W/O Reoperation W/O Cat or Sev CC	26	139	8	85.0%	173	3.0%
Coronary Bypass W Invasive Cardiac Investigation W Reoperation or W Cat CC	85	75	9	49.7%	169	3.0%
Major Reconstruct Vascular Procedures W/O CPB Pump W Catastrophic CC	49	102	16	70.7%	167	2.9%
Major Chest Procedures W/O Catastrophic CC	24	128	2	84.4%	154	2.7%
Cardiac Valve Proc W CPB Pump W/O Invasive Cardiac Inves W/O Cat CC	28	99	13	80.0%	140	2.5%
Heart Transplant	10	19	110	92.8%	139	2.4%
Other Cardiothoracic/Vascular Procedures W CPB Pump W Catastrophic CC	33	75	27	75.6%	135	2.4%
Major Reconstruct Vascular Procedures W/O CPB Pump W/O Catastrophic CC	34	89	1	73.2%	123	2.2%
Cardiac Valve Proc W CPB Pump W Invasive Cardiac Investigation W Cat CC	42	38	3	49.4%	83	1.5%
Coronary Bypass W Invasive Cardiac Investigation W/O Reoperation W/O Cat CC	34	33	4	52.1%	71	1.2%
Ventilation >95 hours W/O Catastrophic CC	2	58	2	96.8%	62	1.1%
Extracranial Vascular Procedures W/O Catastrophic CC	13	39		75.0%	52	0.9%
Total bed-days (all DRGs)	**1,261**	**3,258**	**1,165**	**77.8%**	**5,684**	

Table 4 summarises trends in the types of care provided to patients that had a proportion of their stay at ACH in CVICU between 2010 and 2018. Over time there has been strong growth in services provided on a national basis, and a broadening of the types of care provided in CVICU.

Table 4: CVICU bed-days for top DRG groups
Source: ADHB, EY analysis

Care type	2010	2014	2018	Change 2010 to 2018
Tracheostomy/ventilation	799	1,325	1,308	64%
Cardiac valve procedures	529	900	883	67%
Coronary bypasses	627	822	779	24%
ECMO	264	537	546	107%
Lung or Heart/Lung Transplant	121	198	404	233%
Major chest procedures	256	294	356	39%
Major reconstructive vascular procedures	288	264	290	1%
Other cardiothoracic/vascular procedures	237	165	230	-3%
Heart Transplant	74	136	139	88%
Other	423	532	749	77%
Total bed-days	3,618	5,173	5,684	57%

Table 5 summarises the top 20 DRGs recorded for patients that had a proportion of their stay at ACH in DCCM in 2018, by population catchment. These DRGs accounted for almost 65% of total bed-days in the Unit.

Table 5: DCCM bed-days for top 20 DRGs in 2018
Source: ADHB, EY analysis

DRG	Auckland DHB	Other Northern Region	Other NZ	% non-resident bed-days	Total	% of total bed-days
Tracheostomy W Ventilation >95 hours W Catastrophic CC[6]	213	317	97	66.0%	627	16.8%
Tracheostomy for Multiple Significant Trauma	16	244	66	95.1%	326	8.7%
Trach W Vent >95 hours W/O Cat CC or Trach/Vent >95 hours W Cat CC	100	111	31	58.7%	242	6.5%
Ventilation >95 hours W/O Catastrophic CC	85	81	43	59.3%	209	5.6%
Cranial Procedures W Catastrophic CC	18	106	16	87.1%	140	3.8%
Liver Transplant	8	33	53	92.5%	93	2.5%
Vent & Cran Procs for Mult Sig Trauma, W/O Trach W (Vent >=96hrs or Cat CC)	22	61	4	74.7%	87	2.3%
Cranial Procedures W Severe CC	9	57	12	88.5%	78	2.1%
Respiratory System Disorders W Non-Invasive Ventilation W Catastrophic CC	62	6	7	17.3%	75	2.0%
Major Small and Large Bowel Procedures W Catastrophic CC	44	21	8	39.7%	73	2.0%
Renal Transplant W Pancreas Transplant or W Catastrophic CC	3	39	18	95.0%	60	1.6%
Pancreas, Liver and Shunt Procedures W Catastrophic CC	11	13	35	81.4%	59	1.6%
Renal Transplant W/O Pancreas Transplant W/O Catastrophic CC	15	22	18	72.7%	55	1.5%
Stomach, Oesophageal and Duodenal Procedure W Malignancy or W Catastrophic CC	30	11	5	34.8%	46	1.2%
Septicaemia W Catastrophic CC	23	21	1	48.9%	45	1.2%
Poisoning/Toxic Effects of Drugs and Other Substances W Cat or Sev CC	36	5		12.2%	41	1.1%
Cranial Procedures W/O Catastrophic or Severe CC	5	27	8	87.5%	40	1.1%
Multiple Trauma, Died or Transferred to Another Acute Care Facility <5 Days	6	29		80.6%	36	1.0%
Nervous System Diagnosis W Ventilator Support W/O Catastrophic CC	12	16	4	62.5%	32	0.9%
Rectal Resection W Catastrophic CC	23	2	5	23.3%	30	0.8%
Total bed-days (All DRGs)	**1,477**	**1,715**	**536**	**60.4%**	**3,727**	

Table 6 summarises trends in care types delivered for patients that had a proportion of their stay at ACH in DCCM between 2010 and 2018. This uses Service Related Groups (SRGs) as a proxy for types of care. There has been small growth overall, and a changing mix of the types of care provided in DCCM, in particular with significant growth in neurosurgery and respiratory, and reduction in general surgery and infectious disease (note that a number of national services are subsumed within the 'high-cost' group, e.g., liver transplantation).

[6] If tracheostomy or ventilation occurs as part of a patient's stay they are assigned a tracheostomy/ventilation DRG, however, the patient's reason for admission is variable.

Table 6: DCCM bed-days for SRGs
Source: ADHB, EY analysis

SRG	2010	2014	2018	Change 2010 to 2018
High cost	1,348	2,143	1,476	9%
General surgery	578	412	337	-42%
Trauma	496	141	552	11%
Neurosurgery	177	262	281	58%
Other SRGs	139	185	221	59%
Infectious disease	129	114	101	-21%
Orthopaedics	106	106	96	-9%
Other	122	67	97	-21%
Respiratory	60	77	119	98%
Urology	71	56	59	-16%
Cardiology	38	67	69	79%
Haematology	17	69	62	258%
Digestive system	17	51	67	287%
Vascular surgery	21	21	76	267%
Maternity	22	14	67	200%
Gynaecology	50	38	15	-71%
Plastics	26	42	12	-55%
Total bed-days	3,432	3,905	3,727	9%

Table 7 summarises the top 20 DRGs recorded for patients that had a proportion of their stay at Starship in PICU in 2018, by population catchment. These DRGs accounted for approximately 84% of total bed-days in the Unit.

Table 7: PICU bed-days for top 20 DRGs in 2018
Source: ADHB, EY analysis

DRG	**Auckland DHB**	**Other Northern Region**	**Other NZ**	% non-resident bed-days	**Total**	% of total bed-days
Ventilation >95 hours W/O Catastrophic CC[7]	374	134	316	54.6%	824	15.2%
Trach W Vent >95 hours W/O Cat CC or Trach/Vent >95 hours W Cat CC	29	259	503	96.3%	791	14.6%
ECMO W/O Tracheostomy	25	93	625	96.5%	744	13.7%
Tracheostomy W Ventilation >95 hours W Catastrophic CC		200	309	99.8%	510	9.4%
Neonate, AdmWt >2499 g W Significant OR Procedure W Multi Major Problems	32	69	253	91.2%	353	6.5%
Cardiothoracic/Vascular Procedures for Neonates	52	98	153	82.8%	303	5.6%
Other Cardiothoracic/Vascular Procedures W CPB Pump W Catastrophic CC	8	25	146	95.5%	179	3.3%
Other Cardiothoracic/Vascular Procedures W CPB Pump W Severe or Moderate CC	15	33	89	89.1%	137	2.5%
Respiratory System Disorders W Non-Invasive Ventilation W/O Catastrophic CC	39	30	37	63.2%	106	2.0%
Cardiac Valve Proc W CPB Pump W/O Invasive Cardiac Inves W Cat CC	8	37	60	91.5%	106	2.0%
Respiratory System Diagnosis W Ventilator Support W Catastrophic CC	17	24	63	83.7%	104	1.9%

[7] If tracheostomy or ventilation occurs as part of a patient's stay they are assigned a tracheostomy/ventilation DRG, however, the patient's reason for admission is variable.

DRG	Auckland DHB	Other Northern Region	Other NZ	% non-resident bed-days	Total	% of total bed-days
Neonate, AdmWt >2499 g W Significant OR Procedure W/O Multi Major Problems	33	29	15	57.1%	77	1.4%
Liver Transplant		31	28	100.0%	59	1.1%
Insertion of Neurostimulator Device			48	100.0%	48	0.9%
Allogeneic Bone Marrow Transplant, Age <17	0		44	100.0%	44	0.8%
Heart Transplant		38		100.0%	38	0.7%
Cardiac Valve Proc W CPB Pump W/O Invasive Cardiac Inves W/O Cat CC	2	6	29	94.6%	37	0.7%
Cranial Procedures W Severe CC	6	17	12	80.6%	36	0.7%
Nervous System Diagnosis W Ventilator Support W/O Catastrophic CC	6	15	13	84.8%	33	0.6%
Respiratory System Disorders W Non-Invasive Ventilation W Catastrophic CC	15	17		53.1%	32	0.6%
Total bed-days (all DRGs)	**783**	**1,562**	**3,082**	**85.6%**	**5,428**	

Table 8 summarises trends in the types of care for patients that had a portion of their stay in PICU between 2010 and 2018. There has been strong growth in care types that are nationally provided services. Tracheostomy or ventilation >95 hours was most commonly required for children with respiratory illness and those who required ENT care. ECMO was most commonly required for children with respiratory illness and congenital cardiac conditions.

Table 8: PICU bed-days for top DRG groups

Source: ADHB, EY analysis

Care type	2010	2014	2018	Change 2010 to 2018
Tracheostomy/ventilation	1,408	1,620	2,125	51%
Neonate with surgery or major problem	429	422	507	18%
Cardiothoracic/Vascular Procedures for Neonates	441	557	303	-31%
ECMO	339	132	744	119%
Other cardiothoracic/vascular procedures	422	358	336	-20%
Cardiac valve procedures	168	183	143	-15%
Respiratory system diagnosis with non-invasive ventilation	101	215	138	37%
Respiratory system diagnosis with invasive ventilation	118	125	112	-5%
Liver Transplant	70	93	59	-17%
Heart Transplant	40		38	-4%
Other	775	896	923	19%
Total	4,310	4,601	5,428	26%

As NICU DRGs are mostly based on birthweight and do not specify differences in care type, they are not described in this section.

2.3 Length of stay trends

As a result of changing casemix over time, it is also important to understand the length of stay profile and how it has been changing over time, as future demand will be heavily influenced by length of stay.

Average critical care length of stay by age for CVICU and DCCM is shown in Figure 9, and while length of stay is slightly shorter at older ages, the volume of admissions means that older age groups still account for a significant proportion of bed-days. The peak average length of stay in the 35-44 year age group in CVICU represents mainly transplant and ECMO patients, who while fewer in number tend to have long admissions. As the older population grows over the next 20 years, this will drive bed-day growth alongside general population growth.

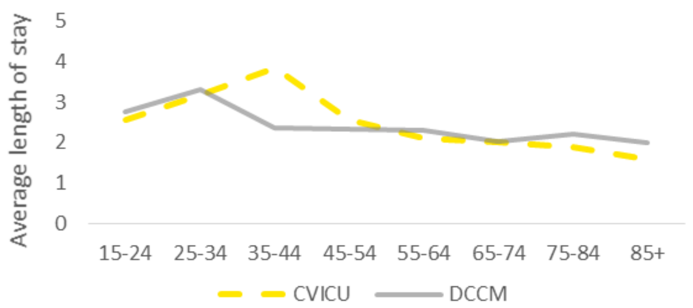


Figure 9: Age-specific average length of stay by Unit
Source: ADHB, EY analysis

Length of stay decreases as age increases for PICU (Figure 10). This implies that on average the needs of younger children are higher.

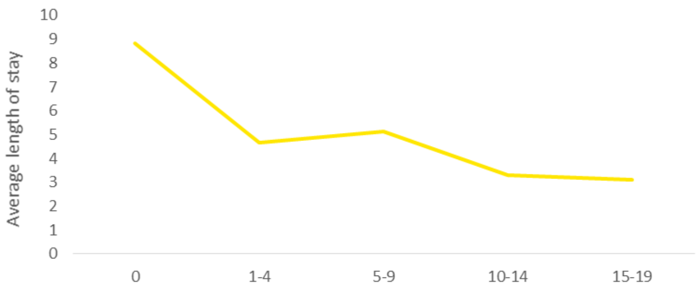


Figure 10: PICU age-specific average length of stay (days)
Source: ADHB, EY analysis

Figure 11 shows the distribution of gestational age/birthweight and average length of stay for NICU in 2018. Average length of stay declines as gestational age or birthweight increases. Similar to PICU, this implies that on average the needs of lower gestational age/birthweight neonates are higher.

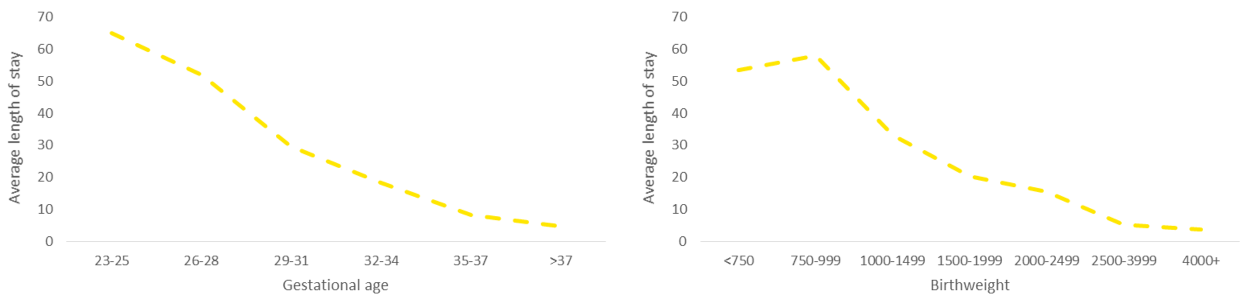


Figure 11: NICU gestational age / birthweight (g) average length of stay
Source: ADHB, EY analysis

Over time patient length of stay has been increasing in all units except for DCCM

Patient average length of stay in CVICU has been increasing since 2009, from ~45 hours to ~52 hours in 2018 (Figure 12). The key driver of increasing length of stay has been patients staying five or more days. Patient cohorts that these longer stays are attributable to include cardiac transplants pre- and post-operatively, ECMO to support either transplantation, pre- or post-cardiac surgery, or for non-cardiac support, and LVADs. Each of these patient cohorts have been increasing in recent years resulting in overall increases in bed-days, given their longer average length of stay.

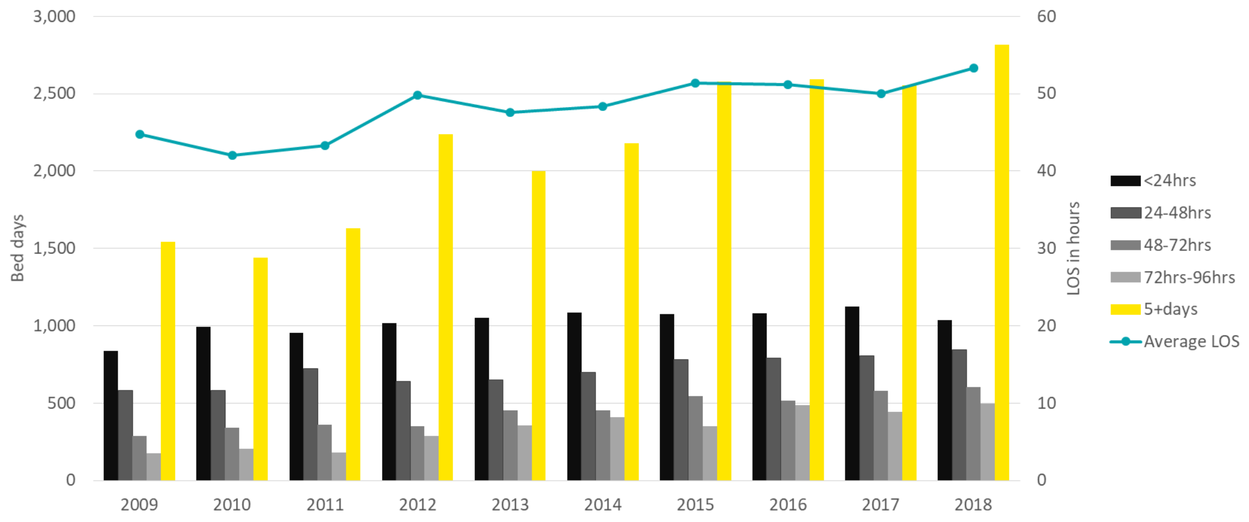


Figure 12: CVICU length of stay and bed-days
Source: ADHB, EY analysis

For DCCM, the average length of stay during an admission has varied between ~55 and ~70 hours since 2009 (Figure 13). This reflects changes in the mix of patients within the Unit, including the mix of ICU and HDU patients. Since 2015, long stay patient bed-days have decreased from a peak of 70 hours to more historic levels around 60 hours.

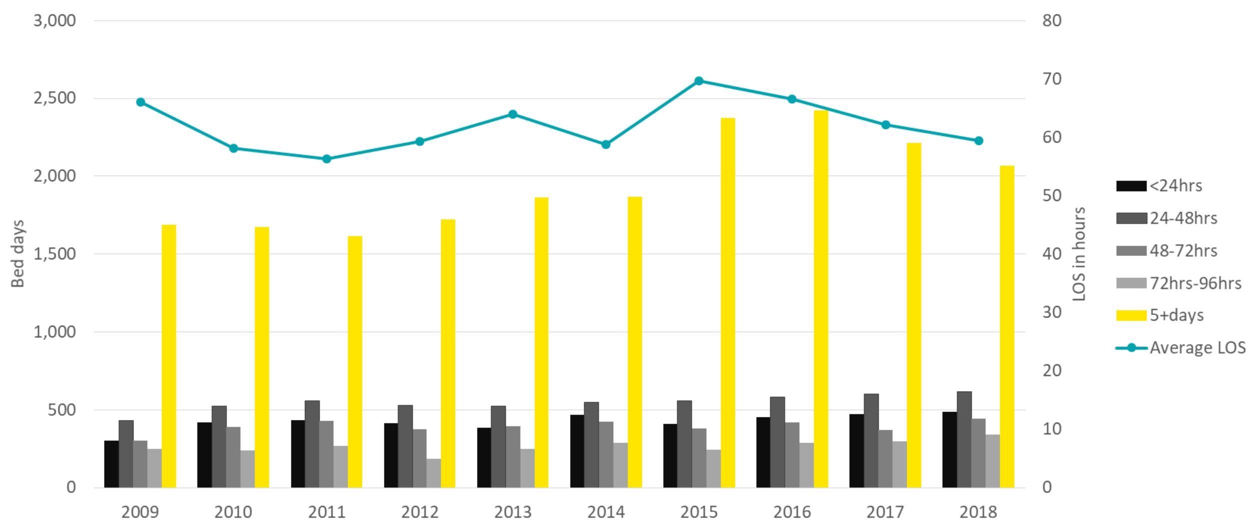


Figure 13: DCCM length of stay and bed-days
Source: ADHB, EY analysis

The average length of stay of patients in PICU has substantially increased - between 2016 and 2017, there was a 44% increase in average length of stay (Figure 14). The average length of stay during an admission as well as the bed-days attributable to long stays (5+ days) has increased significantly over the last two years. This was largely driven by increased numbers of children with complex comorbidities and/or treatments, including long term ventilation, ECMO, and increasingly complex and intensive therapies for cardiac, oncology and neurology patients in particular. This is a very well described international trend and patients requiring long stays in PICU are expected to continue to increase their share of Unit bed-days over the next 5-10 years, further increasing average length of stay.

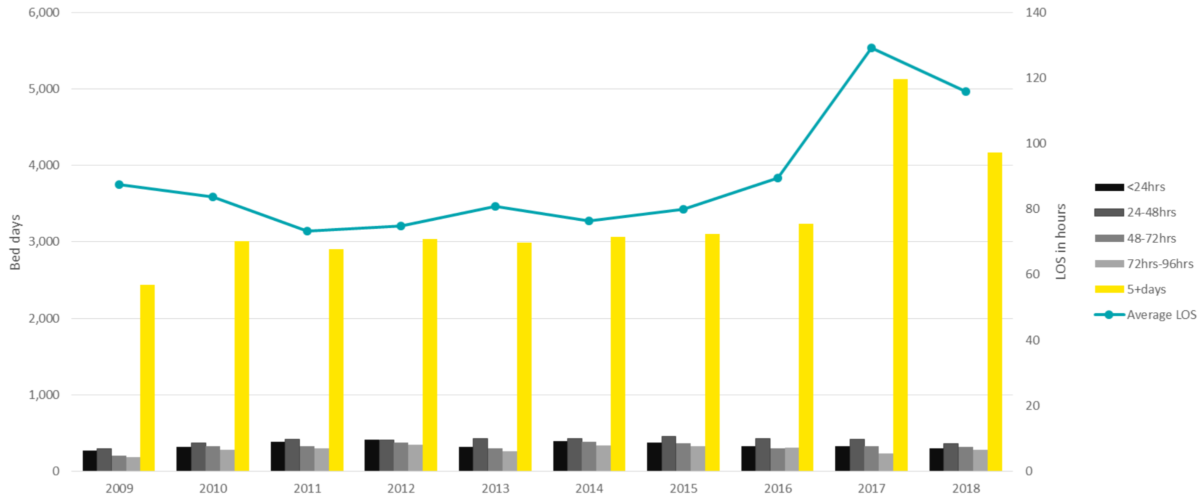


Figure 14: PICU length of stay and bed-days
Source: ADHB, EY analysis

Average length of stay in NICU has fluctuated over the past decade, with an increasing trend from 2015 to a decade high in 2018 (Figure 15). In 2018, average length of stay was 332 hours, an increase of 36 hours since 2015. In 2018, fewer neonates were admitted for less than 96 hours compared to previous years, and fewer for greater than 60 days compared to the previous two years. Most bed-days in 2018 were accumulated by neonates with a length of stay between 30 and 59 days.[8]

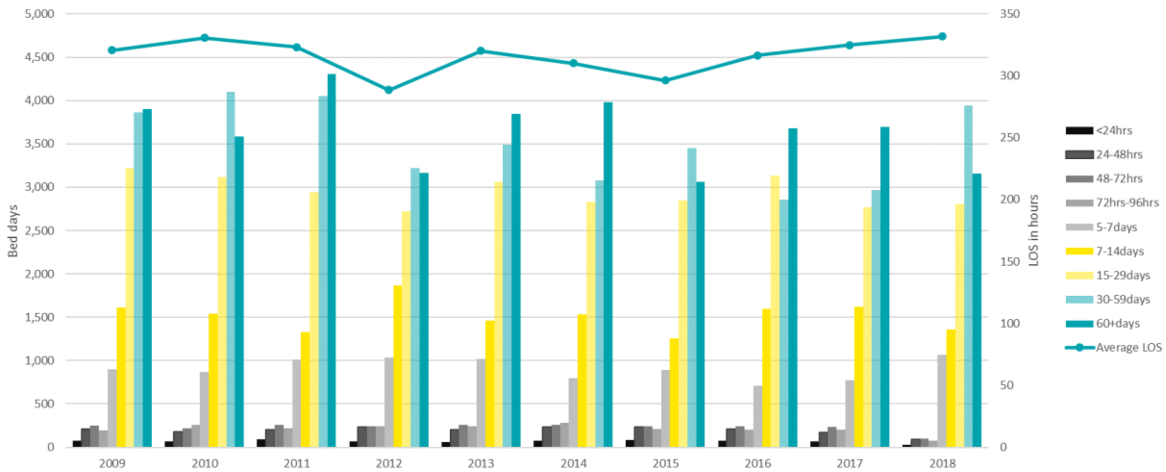


Figure 15: NICU / SCBU length of stay and bed-days
Source: ADHB, EY analysis

[8] Bed-days are calculated at discharge date by year, therefore, for long stay neonates if they are discharged early in the New Year this may not be reflected in the year in which they accumulated most of their bed-days.

2.4 Current capacity

To understand capacity and demand pressure on the units, the number of beds full at a specific time on an individual day was analysed, allowing for exploration of how full a unit is how much of the time (Figure 16).

For CVICU increasing cardiac surgery, continued growth in cardiothoracic transplants, and increasing use of ECMO have all contributed to more patients in the Unit, and longer lengths of stay.

For DCCM, bed occupancy has remained relatively stable since 2010, however, given the acute workload of the Unit, occupancy fluctuates greatly.

For PICU, increasing numbers of long-term ventilation patients and use of ECMO has contributed to a greater number of patients in the Unit, and longer lengths of stay. Although PICU is now resourced to 22 beds, during most of 2018, when PICU was only resourced to 18 beds, there were 90 days where occupancy was greater than resourced capacity.

For NICU in 2018 there were 24 days when the Unit was caring for more neonates than resourced capacity. Note the apparent decrease in occupancy for NICU between 2010 and 2018 is misleading as over this period resourced bed capacity decreased – with the further development of capacity in Waitemata DHB.

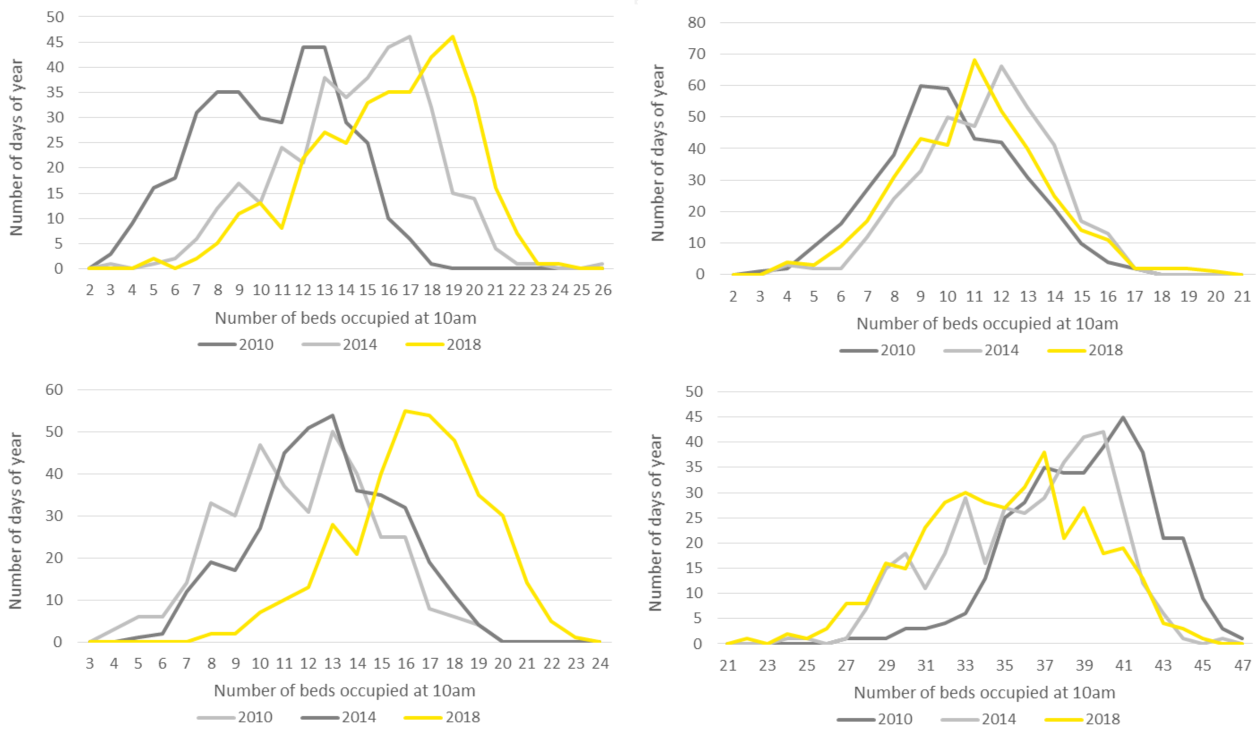


Figure 16: Frequency of beds occupied at 10am over time
Source: ADHB, EY analysis
From top, left to right: CVICU, DCCM, PICU, NICU

For CVICU recent occupancy levels have resulted in significant capacity constraints. For example, in 2018 a total of 98 elective bypass surgeries were cancelled due to the lack of an ICU bed in CVICU. While these cancellations are mostly deferred to subsequent elective lists, they represent unmet need for ICU capacity.

For DCCM, occupancy peaks can result in less than optimal clinical practice – although this is difficult to quantify. Stakeholders noted that occupancy peaks can result in both earlier than planned discharges to the wards or admission delays to the Unit when a bed is not immediately available.

For PICU recent occupancy levels have resulted in significant capacity constraints. This can result in some cardiac surgeries being cancelled. It can also result in 'failures to admit' to PICU. In 2018, there were 73 'failures to admit'. They represent unmet need for critical care capacity since they have had a delay in access to care, and care potentially provided in a sub-optimal location.

For NICU, occupancy peaks have occurred during 2018, and into 2019. Loss of capacity is managed by deferral of deliveries, transfer of stable Level 2 babies to other metro-Auckland DHB and occasionally transfer of pregnant mothers out of the region.

Figure 17 shows average occupancy rates by time of day across the four units in 2018 (yellow bars highlight peak occupancy times).

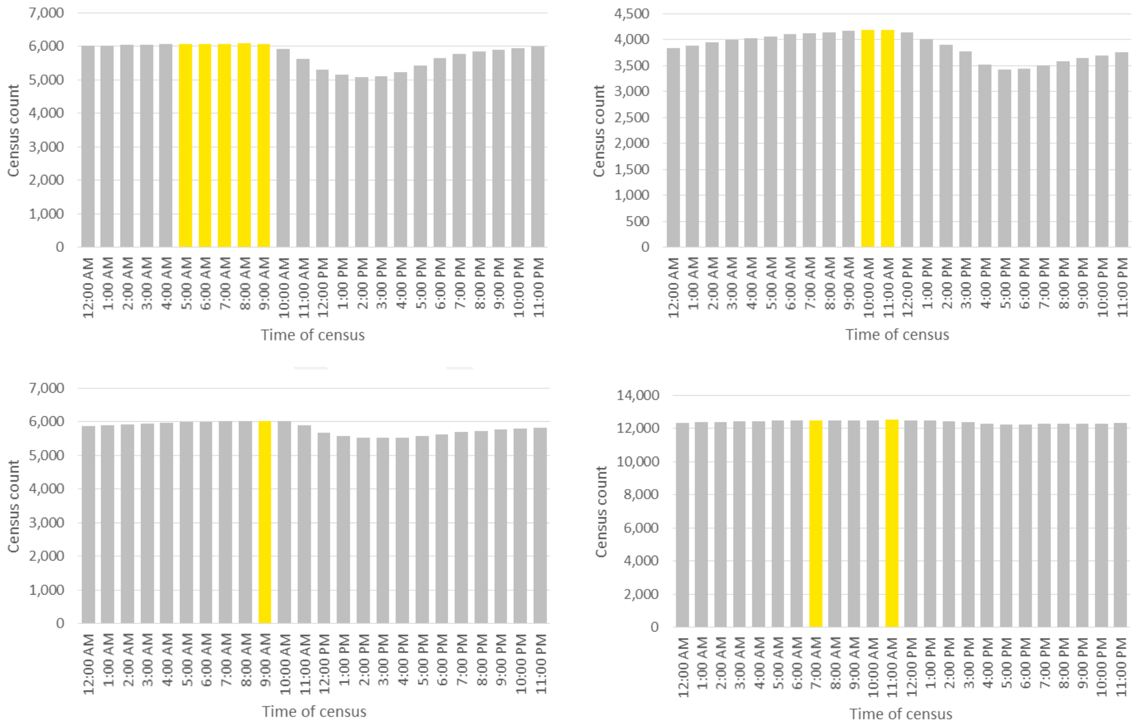


Figure 17: Critical care hourly bed census over 2017/18
Source: ADHB, EY analysis
From top, left to right: CVICU, DCCM, PICU, NICU

For critical care units, it is common to use occupancy metrics to define what level of resourcing is required for the unit (Table 9). There are two ways this may be done. Firstly total actual bed-days are divided by the desired occupancy to show total resourced bed-days (divided by 365 to give beds). In the NRLTIP, using this approach it was signalled that critical care should be planned at 75% occupancy, i.e., resourced beds are occupied 75% of the time on average. Hospital occupancy is commonly higher than this (e.g., 90%). The lower level for ICU is because of the need for acute/emergency capacity and the non-deferrable nature of much of the work.

The other approach, as per Figure 18, uses actual daily occupancy data to derive cumulative occupancy. This approach provides an operational workforce planning view where a percentile to resource can be selected, with an acknowledgement that a percentage of the time additional staff on a shift will be needed, i.e., at the 90th percentile - 10% of the time the ward occupancy will be greater than resourced beds.

The two approaches differ; using average occupancy a lower number means more beds, using cumulative occupancy a higher number is more beds. The two measures reflect workload and correlate but are not the same. The following table provides a range of the cumulative percentiles translated into the occupancy metric (denoted 'Occ %', based on resourced beds at a range of percentiles) using actual data from each of the units. The decision on what level of occupancy should be chosen may vary across units. It needs to account for acute/elective mix, options for decanting if full, and consequences (clinical and financial) of lack of capacity.

Table 9: Cumulative percentiles translated to beds and occupancy based on 2018

Source: ADHB, EY analysis

	CVICU		DCCM		PICU		NICU	
Cumulative percentile	Beds	Occ %	Beds	Occ %	Beds	Occ %	Cots	Occ %
85%	20	81%	14	82%	19	87%	40	86%
90%	21	77%	14	82%	20	82%	41	84%
95%	21	77%	15	76%	21	78%	42	82%
97.5%	21	77%	16	72%	21	78%	42	82%
99%	22	74%	18	64%	22	75%	44	78%

Based on a cumulative distribution approach over the past three years (Figure 18), the proportion of days in the year that the Unit was at that capacity or less can be identified. For example, for CVICU in 2018, there were 17 or less beds occupied at 10am 60% of the time.

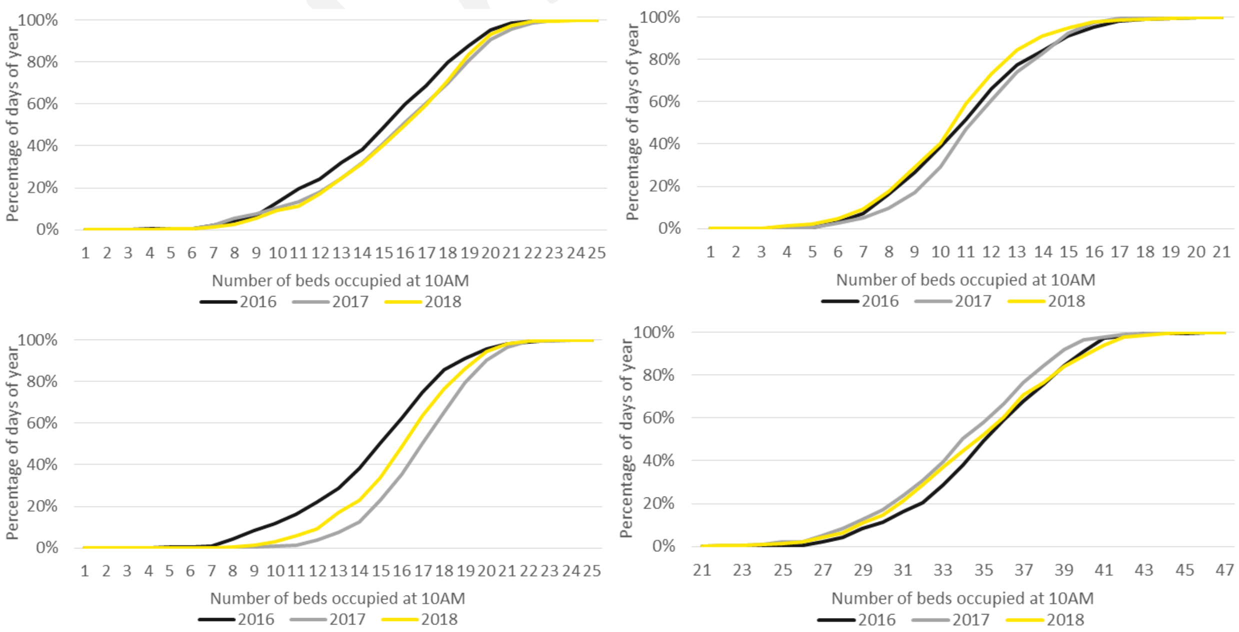


Figure 18: Critical care cumulative frequency of beds occupied at 10AM over last three years

Source: ADHB, EY analysis

From top, left to right: CVICU, DCCM, PICU, NICU

2.5 Demographic changes

Understanding likely future demographic changes is important for considering how demand may change over time.

The adult population is expected to continue to grow and age

Population growth and ageing will be a key driver of demand for CVICU and DCCM care over the next 20 years. Given their roles and responsibilities in regional and national service delivery, both units will be impacted by growth in the Northern Region and national population. Table 10 provides a summary of Auckland DHB, Northern Region and National bed-days for CVICU and DCCM in 2018.

Table 10: Bed-days for adult units by patient domicile
Source: ADHB

	Bed-days		Share of Unit bed-days	
Patient domicile	CVICU	DCCM	CVICU	DCCM
Auckland DHB	1,261	1,477	22%	40%
Other Northern Region DHBs	3,258	1,715	57%	46%
Rest of New Zealand	1,165	536	20%	14%
Total	5,684	3,728		

Over the next 20 years, the adult Auckland DHB population is expected to increase by 32%, the wider Northern Region population by 29%, and other areas of New Zealand by ~15%. Demand for CVICU is expected to increase by 39.7% (+2,300 bed-days) due to population growth, and for DCCM, demand is expected to increase by 28.8% (+1,210 bed-days).[9]

Population ageing will also impact on demand for CVICU and DCCM care. Over the next twenty years, the Auckland DHB 65 years and over population is expected to increase by 86%, the wider Northern Region population by 83%, and other areas of New Zealand by ~63%. It is likely that the 65 years and over population will contribute ~1,900 bed-days to CVICU (~83% of growth due to population) and ~800 bed-days to DCCM (~66% of growth due to population).

The paediatric population is not expected to grow significantly

Currently, the greatest number of bed-days and longest lengths of stay in PICU are attributable to patients from outside the Northern Region. Table 11 provides a summary of bed-days by catchment population for PICU in 2018.

Table 11: Bed-days for paediatric unit by patient domicile in 2018
Source: ADHB

Patient domicile	Bed-days	Share of Unit bed-days	Average length of stay per patient (days)
Auckland DHB	783	14%	5.5
Other Northern Region DHBs	1,562	29%	4.7

[9] Note these projections assume existing per capita admission rates continue in the future.

Patient domicile	Bed-days	Share of Unit bed-days	Average length of stay per patient (days)
Rest of New Zealand	3,082	57%	7.1
Total	5,427		

Over the next 20 years, the Northern Region population aged 0-19 years is expected to grow by 7.8%. In comparison, the child population in the rest of New Zealand is projected to decline by 2%.[10] Since the share of the total New Zealand 0-19 year old population in the Northern Region is ~39%, it means demand growth in the Northern Region will likely offset any reduction in demand from the rest of New Zealand resulting from a smaller child age population.

Projections suggest the total number of births will increase over the next 10 years, although the birth rate will decrease

In the Northern Region, which constitutes close to 90% of the workload in Starship's NICU (Table 12), it is expected that there will be an increase in births from approximately 23,000 in 2018 through to 26,000 by 2027 before a slight drop through the mid-2030s. A similar trend has been projected throughout the rest of New Zealand, with the total number of births projected to change from approximately 60,000 in 2018 to approximately 61,000 in 2038, while reaching a peak of approximately 64,500 in 2027. Given its roles and responsibilities in regional and national service delivery, ACH's NICU will be impacted by the changes in birth patterns. For reference, Table 13 provides a summary of Auckland DHB, Northern Region and National bed-days for NICU in 2018. Longer term birth rates (after 2030) will be impacted by immigration patterns. Higher immigration may mean the birth rate does not increase, assuming immigration of younger working age people to the Northern Region.

Table 12: Bed-days for neonatal unit by patient domicile
Source: ADHB

Patient domicile	Bed-days	Share of Unit bed-days
Auckland DHB	6,248	49.5%
Other Northern Region DHBs	5,146	40.8%
Rest of New Zealand	1,231	9.8%
Total	12,325	

2.5.1 Baseline capacity projections

Demand projections based on expected demographic changes[11] suggest existing bed capacity for adult critical care will be exhausted within the next five years. The greatest demand pressure is on CVICU, with the Unit's physical bed capacity projected to be exceeded by 2021. Bed requirements based on demographic and length of stay demand projections compared with existing physical capacity are shown in Figure 19.[12] In summary the projections suggest that:

[10] Based on Statistics New Zealand DHB Projections for the Ministry of Health (2018 update)

[11] Note these projections assume current per capita admission rates continue in the future.

[12] Due to the size of the adult units and space constraints within existing facilities, co-location of the adult units is not considered feasible. Therefore, capacity projections are shown separately.

- By 2033, CVICU will require an additional 12 physical beds and DCCM an additional 3 physical beds
- CVICU will exceed physical capacity by 2021, while DCCM has sufficient capacity until 2027.

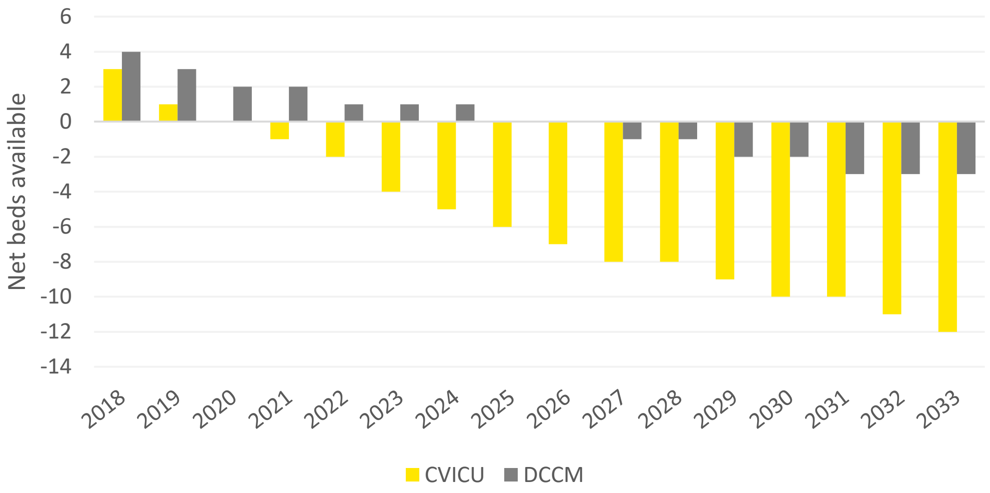


Figure 19: Net beds available by adult critical care unit between 2017/18 - 2032/33
Source: ADHB, EY analysis

Demographic and length of stay demand projections for paediatric critical care suggest that the Unit's existing bed capacity of 22 beds is already exhausted. Population growth will put demand pressure on PICU which will continue to exceed the Unit's physical bed capacity. Bed requirements based on the demographic and length of stay demand projections compared with existing physical capacity are shown in Figure 20. In summary the projections suggest that:

- PICU required an additional 2 physical beds in 2018
- By 2025, PICU will require an additional 13 physical beds.

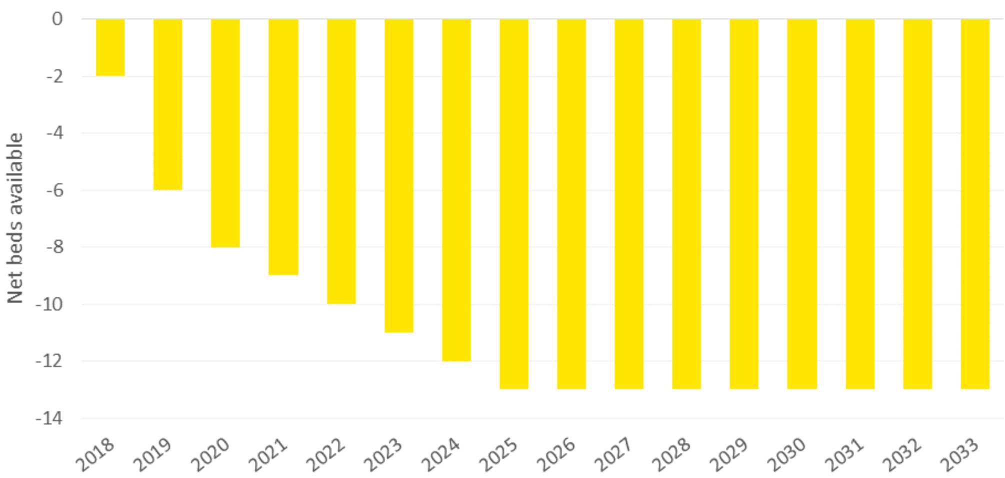


Figure 20: Net beds available in PICU between 2017/18 - 2032/33
Source: ADHB, EY analysis

Demographic and length of stay demand projections for neonatal critical care suggest existing cot capacity may be exhausted by 2020. Cot requirements based on the demographic and length of stay demand projections compared with existing physical capacity are shown in Figure 21. In summary the projections suggest that by 2027, NICU will require an additional 11 physical cots. This may decrease to 9 by 2033 depending on other changes in service configuration.

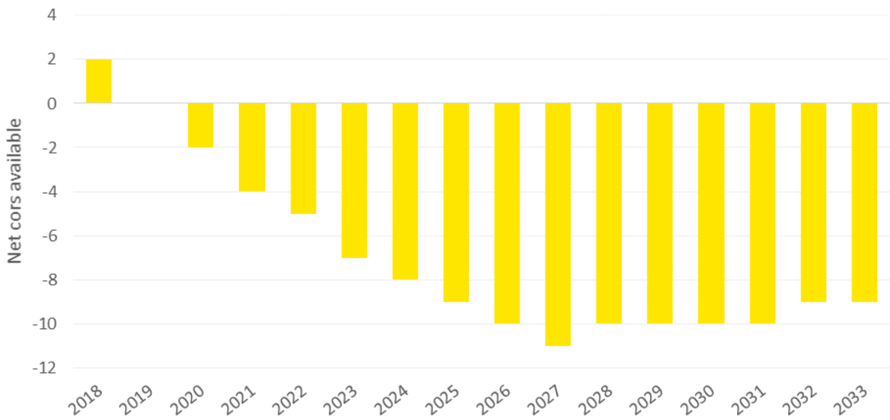


Figure 21: Net cots ('beds') available neonatal critical care unit between 2017/18 - 2032/33[13]
Source: ADHB, EY analysis

2.5.2 Making best use of capacity

Given the significant demand pressure on Auckland DHB's critical care services, the Strategy explored options which can help make best use of capacity. These options are intended to:

- Make best use of bed capacity in the short to medium-term to help manage demand pressure on units, particularly for CVICU and NICU
- Ensure that only patients with clinical conditions that require intensivist input in combination with high acuity nursing are admitted to critical care
- Ensure that when patients are ready to be discharged from critical care, they can be discharged in a timely way to a setting appropriate for their ongoing care.

Admit some patient cohorts to DCCM rather than CVICU

As demand will exceed CVICU's physical capacity earlier than for than DCCM, an option identified was to admit some patients to DCCM who currently go to CVICU. Two such patient cohorts were identified: out-of-hospital cardiac arrests (OOHCA) and vascular patients. Currently these two groups of patients are admitted to CVICU but could be cared for in DCCM if required.

[13] The decrease in bed projections beyond 2026/27 is due to Statistics New Zealand projecting a decline in births. Although changes in births do not necessarily drive demand for neonatal intensive care it is expected that this may decrease demand by 1-2 cots beyond 2026/27.

Admitting vascular patients to DCCM on a consistent basis would be a change from current practice. Current booking practice, particularly pre-operatively for planned cases, and admission criteria for HDU generally and for vascular patients in particular are different between CVICU and DCCM. CVICU intensivists and nurses have also developed skills and experience in providing care for vascular patients. Staff in DCCM may require upskilling.

Based on current and future expected demand for vascular and OOHCA, demand equivalent to about one intensive care bed and two high dependency beds could shift from CVICU to DCCM, and over the next 15 years, one further high dependency bed (for a total of 1 ICU, 3 HDU). This would then free up physical capacity within CVICU. The alternative is to create more physical capacity for CVICU.

Improve patient flow through critical care

There are two key challenges with patient flow through the critical care units:

- exit-block, where a patient is in critical care and ready for discharge, but the receiving ward does not have the capacity to take the patient. Evidence has shown that critical care exit-block is associated with worse patient outcomes and staff and patient experience, and can prolong hospital length of stay and increase cost[14]; and,
- elective scheduling, where services booking critical care beds could do so with more regard to critical care and ward capacity.

Exit-block is a major challenge for hospitals internationally and many jurisdictions are currently trying to enact strategies to ensure timely discharge from critical care, e.g., New South Wales has recently developed an Exit-Block Strategy which details key principles to improve patient flow.[15] Auckland DHB is also facing challenges with exit-block, particularly for DCCM. The impact of exit-block on DCCM's high dependency beds has been estimated at approximately two beds over the year, with discharges to Ward 83 (Neurosurgery) being the most impactful. To make best use of capacity, further work is required to consider, and if appropriate implement, hospital-wide and critical care flow principles.

There is also an opportunity for admission planning and theatre scheduling to take greater account of critical care capacity, as currently exit-block can often be a result of beds in discharge wards being preferentially allocated to elective surgical patients, particularly in DCCM. For CVICU, there is potential to improve elective scheduling, particularly for vascular patients. There is reasonable evidence that managing elective scheduling well can increase effective ICU capacity with no additional physical beds.[16]

Continue to identify alternative or improved patient pathways

Care pathways improvement opportunities include:

- Exploring opportunities for direct transfer to the ward from PACU, as opposed to admission to HDU. Currently some surgical patients are being admitted to HDU as part of their care pathway,

[14] i) Duke, G.J., et. al. Interventions to circumvent intensive care access block.
ii) Tiruvoipati, R., et. al. Intensive care discharge delay is associated with increased hospital length of stay.
iii) de Grood, C., et al. Patient, family and provider experiences with transfers from intensive care unit to hospital ward.

[15] Agency for Clinical Innovation, January 2019 Draft. New South Wales Exit-block Strategy: Guiding Principles to Optimise Intensive Care Capacity

[16] Bekker, R., & Koeleman, P. 2011. Scheduling admissions and reducing variability in bed demand

but do not receive any HDU specific treatment. Along with impacting on critical care demand, patient benefits may also be realised through reduced patient transitions / handovers

- For CVICU, work has been undertaken to develop pathways in which patients could bypass HDU and be discharged directly from PACU to the ward for:
    - some vascular surgery patients, in particular, endovascular aneurysm repair (EVAR), and,
    - thoracic patients, based on revision of criteria for direct discharge within healthier patient groups.
- For DCCM, existing work can be built upon. Future improvements could be made for renal transplant patients. Initial modelling has suggested that such improvements may amount to a transfer of demand to the renal ward equivalent to one high dependency bed
- For PICU, the case-mix needs to be assessed to identify if there are additional cases where some surgical patients are currently receiving HDU care as part of their care pathway, but do not receive any HDU specific treatment.

- In conjunction with direct discharge, the following two opportunities may also support reduced critical care demand:
    - Enhanced Recovery After Surgery (ERAS) pathways, which can contribute to reduced length of stay
    - A formal extended PACU model, with the objective of reducing patient transitions, including those through a critical care unit. Currently PACUs are intended for short-stay for recovery immediately after surgery. However, when the hospital is experiencing peaks in demand, temporary extended PACU-like models may be run. An extended PACU would allow patients to remain in PACU overnight, with discharge occurring before 8am the following morning to maintain patient flow. Infrastructure changes would be fundamental to the success of an extended PACU.

Shared goals of care

In line with the 'Goals of care' national workstream led by the Health, Quality and Safety Commission (HQSC), advance care planning and collaboration on goals of care with patients and their whānau prior to admission to a critical care unit may identify instances where the most appropriate care pathway does not include admission to critical care (where admissions currently occur, with no benefit for patients or whānau). It is unclear what impact this could have on critical care capacity, but is likely to be most impactful for DCCM.

Neonatal transitional care

Neonatal transitional care (NTC) is a model of care which focuses on keeping the mother-baby dyad together and empowering and supporting the mother to care for her own baby whenever this is safely possible. It is a nationally recognised service and has been included in the recent update to the Specialist Neonatal Inpatient Service Specification. NTC has been implemented in many international jurisdictions with positive outcomes, e.g., a UK study identified that NTC could have a role in reducing term admissions to NICU, estimating that two thirds of term admissions for jaundice could be cared for in a NTC without separating mother and baby.[17] Additionally, in New Zealand, NTC models have only recently been established, with Middlemore and Christchurch providing some NTC space, and have been identified as a

[17] Battersby C, Michaelides S, Upton M, Rennie JM. Term admissions to neonatal units in England: a role for transitional care? A retrospective cohort study.

model of care to implement at ACH to improve dyad outcomes and experience. Limiting the separation of mother and baby and allowing parents to care for their infants where clinically appropriate, has been demonstrated to improve weight gain, decrease parent stress, improve breastfeeding rates and reduce length of stay.[18] More work is required between Women's Health, Child Health and Midwifery to determine the optimal model of care in the context of ACH and Starship.

Currently without a NTC, babies are either cared for on the postnatal wards or in NICU, when their acuity would be appropriate for care in a NTC setting. It is estimated that if neonates currently on the postnatal wards were admitted to a NTC they would require ten beds, and if babies were also redirected from NICU then they would require an additional ten beds (20 in total, as a maximal estimate).

Getting baby or dyads closer to home

Supporting babies or dyads to be cared for as close to home as is clinically appropriate is important to reduce burden on whānau and maintain appropriate capacity at ACH and Starship. There is a policy that outlines the process for transfer of neonates from NICU to their home DHB, once their acuity is such that they are appropriate for transport and care for in their local hospital.[19] Implementation of this guideline consistently can be limited due to capacity constraints at domicile DHBs. Furthermore, there are cases where local mothers are required to fly to other centres for birthing due to capacity constraints in Auckland. It is difficult to identify the impact of timely repatriation; however, consistent repatriation as soon as clinically appropriate would reduce demand on Auckland NICU services.

2.6 Future changes in care

This section details key epidemiological trends and potential changes in service configuration which may impact on critical care services. Some of these factors are more certain while others may be considered risks in the form of possible changes to critical care capacity needs.

Future changes in the rate of solid organ transplantation

At Auckland DHB, CVICU provides care for adult patients that have heart and/or lung transplants, DCCM provides care for adult liver and kidney transplant patients, and PICU covers all paediatric transplants (except lung transplants). Over time the number of adult heart, lung, liver, kidney and multi-organ transplants has been increasing.[20] In contrast, for children the number has remained relatively constant at 15-20 transplants per year.

Due to the relatively small volumes, transplantation events are difficult to predict, and total transplant numbers in each year are based on variety of factors. Auckland DHB recently undertook a Transplant Service Capacity Planning project where potential future transplant volumes and their impact on critical care capacity were estimated:

[18] O'Brien, K., et. al. Effectiveness of Family Integrated Care in neonatal intensive care units on infant and parent outcomes: a multicentre, multinational, cluster-randomised controlled trial.

[19] https://www.starship.org.nz/guidelines/regional-cot-management-back-transfer-from-adhb

[20] https://www.health.govt.nz/our-work/hospitals-and-specialist-care/organ-donation-and-transplantation/deceased-organ-donation-and-transplantion-national-strategy

- Heart transplant volumes were projected to increase to 17 transplantations by 2022, a volume that has already been exceeded in calendar years 2017 (24 events) and 2018 (20 events). Lung transplant volumes were projected to increase to 32 by 2022 and were not exceed in 2017 or 2018. It is expected that the increase over the past two years is indicative of a new baseline of transplant volumes, and that uptake of donation after circulatory death for lung transplants will occur in New Zealand. It is expected that an additional two CVICU intensive care beds will be required over the next 15 years for transplant patients
- Liver transplant volumes have not increased between 2016 and 2018, with 54 transplants performed on average per year, however, liver transplant volumes were projected to increase to as many as 79 transplants by 2022. When considering demand projections, it was estimated that liver transplant volumes will still increase over the next 10 years but at a slower rate than predicted, which will require at least an additional DCCM intensive care bed[21]
- For kidney transplants, the intervention rate of transplants is expected increase, requiring an additional high dependency bed in DCCM over the next five years – under the current model of care for these patients.

It is expected that adult critical care will have more growth in transplant care than paediatrics and it is estimated that four additional critical care beds will be required. Given that paediatric transplants account for approximately one in every four or five transplants, it is estimated that one additional paediatric intensive care bed will be required for transplant events over the next 15 years.

Future changes in the rate of LVAD implantation

A left ventricular assist device (LVAD) is an implanted mechanical pump for patients with end-stage heart failure. LVADs can be used as an intermediate intervention prior to heart transplantation or as a destination therapy. LVAD recipients require intensive care and have relatively long lengths of stay – for example, in CVICU between 2014 and 2018, the average length of stay for these patients slightly exceeded 30 days (range 15-50 days).

Currently the use of LVADs is low in New Zealand, at a rate of 0.5 per million implanted annually. The UK is a reasonable benchmark for New Zealand, with a rate of 2.4 per million implemented annually.[22] At the time of the transplantation capacity planning project, the cardiothoracic service indicated that approximately 5-6 LVADs per year was an appropriate level of clinical intervention, based on the population and comparison to international benchmarks. While difficult to predict, it is expected that increasing the number of LVAD procedures will require one additional intensive care bed in CVICU.

Future changes in the ECMO rate

Extracorporeal membrane oxygenation (ECMO) is a complex therapy involving the use of a portable modified heart-lung bypass machine to support patients whose hearts and/or lungs are failing. ECMO is used for three main clinical indications:

- respiratory failure unable to be supported with conventional mechanical ventilation

[21] As per the ACH Transplant Capacity Planning work, estimates are based on assumptions that the increasing rates of fatty liver disease balances that of the decreasing rates of Hepatitis C and so trends in transplant demand remain consistent. This may be viewed as a strong assumption due to potential for shifting Hepatitis C care to primary and community care settings.

[22] https://nhsbtdbe.blob.core.windows.net/umbraco-assets-corp/1310/nhsbt_annual_vad_report_2016.pdf

- cardiac failure such as myocarditis or immediately after cardiac surgery for patients who are unable to maintain their circulation with medical therapy
- following heart or lung transplant if donor organ function is poor.

CVICU and PICU both provide ECMO as a national service. It is a demand driven service, and demand is relatively unpredictable. Patients requiring ECMO have a prolonged intensive care unit length of stay; for CVICU in 2018 the average length of stay was 19 days[23] (range 3-41 days). Demand over the past 12 months has been much greater than expected for adults, with up to five intensive care beds being used for ECMO treatment at any one time. Similarly, for PICU, demand has been increasing (641 bed-days in 2018 compared to 536 in 2017 and 260 in 2016).

Based on demand data from Auckland DHB, on average there were approximately two intensive beds in CVICU and two intensive beds in PICU used for ECMO patients in 2017/18. Projecting current ECMO utilisation forward over the next 15 years suggests that around four intensive care beds in CVICU will be required (additional two beds from the 2018). Due to the increasing burden from complex cardiac surgery for adults, it is estimated that ECMO demand is likely to increase by a further two intensive care beds in CVICU over the next 15 years (six beds in total, and four more than in 2018). For PICU, ECMO utilisation is not expected to increase beyond demographic and length of stay changes, but will need to be closely monitored over the coming years, as its impact on the Unit is significant - given ECMO patients tend to stayer longer on average and require additional bed-side nursing.

More extremely premature neonates are likely to be cared for

As obstetric and neonatal care has progressed, and neonatal outcomes have improved, neonatal care is being provided at younger gestational ages. In New Zealand this is now considered as 23+0 weeks gestation. Neonates born at this age are still at risk of death or disability, and decisions are made in conjunction with whānau on a case by case basis. In the future, there is potential that care may be offered to even younger gestational ages. Some countries such as Sweden are already offering intensive care to neonates born at 22 weeks gestational age.[24] These neonates tend to have longer stays in NICU, often requiring care to beyond 37 weeks corrected gestational age. It is estimated that one additional neonatal intensive care cot is required over the next five years, and another after 10 years, to account for additional extremely premature neonates.

Potential changes in regional, inter-regional and national service configurations

The role of ACH and Starship as New Zealand's most specialised hospitals, as signaled in the NRLTIP, is expected to continue over the next twenty years. It is likely that there will be further consolidation of existing highly specialised services at Auckland DHB, and it will increasingly be a centre for new/emerging specialised clinical practice and new technologies. Some advances have already begun, with proposals for the consolidation of complex vascular surgery across the Northern Region to ACH and for complex cardiac surgery from the Midland Region. If these changes occur then an additional two additional intensive care beds are required at ACH by 2028.

[23] This includes all patients who recieved ECMO for some period of time, including those that were repatiriated and who passed away during admission.

[24] Express Group. Incidence of and risk factors for neonatal morbidity after active perinatal care: extremely preterm infants study in Sweden (EXPRESS). Acta Paediatrica. 2010 Jul;99(7):978-92.

National discussions are also underway with regard to Maternal-Fetal Medicine (MFM) models of care. Currently mothers who would have previously been managed in Hamilton are being managed in Auckland. The MFM network and model of care is likely to be reviewed over the next 15 years, which would have an impact on the numbers of mothers accessing the service at Auckland DHB. Given the current state of discussions, it is assumed that the status quo will continue.

Other changes in care models

Other changes that are likely to affect critical care demand:

- Introduction of a teleICU programme, where patients from other hospitals in the region could be reviewed and / or monitored. This may reduce demand if patients are able to be assessed and are determined to be clinically appropriate to remain in their domiciled hospital
- Changes in technology such as movement towards eICUs or use of artificial intelligence for decision support, e.g., sepsis prediction
- The longer-term impact of the movement towards percutaneous intervention, e.g., transcatheter aortic valve implantation (TAVI) or endovascular aneurysm repair (EVAR), and its impact on demand for other interventions. It is anticipated that these interventions may reduce capacity needs in CVICU through decreased length of stay
- Changes in maternal health such as increasing comorbidities and older maternal age which are associated with increased risk of gestational complications, congenital abnormalities and preterm births could impact on DCCM (mothers) or NICU (babies)
- Changes in child/neonatal health and ability to treat, e.g., change in rates of congenital anomalies / cardiac defects, vaccination rates, other unexpected impacts (e.g., infectious disease)
- Development of in-utero treatments for spina bifida or cardiac anomalies or congenital diaphragmatic hernia changing intervention patterns and thus demand for PICU and NICU.

2.7 Adjusted capacity projections

The following projections present bed projections by component incorporating the demographic and length of stay projection alongside estimates of capacity reduction through making best use of capacity and capacity increases through potential future changes in care. Those estimates which are likely to impact on capacity needs and are within the scope of Auckland DHB and its service delivery are denoted ‘factors’, while those outside of the control of Auckland DHB are denoted ‘risks’. It is difficult to accurately predict the impact of these factors and risks, however, they provide a starting point to understand what the future might look like based on what we know now.

For CVICU, it is expected that over the next 15 years additional factors may lead to the need for an additional 3 beds, with a risk of a further 2 beds being required (Figure 22, Table 13). If the 2032/33 demand adjusted projection (41 beds) proves to be the closest estimate then to remain within the future demographic and length of stay projection footprint of 38 beds, length of stay savings of ~51 bed-days or 0.9% p.a. would be necessary. Similarly, if risks are included (43 beds) then length of stay savings of ~86 bed-days or 1.4% p.a. would be necessary.

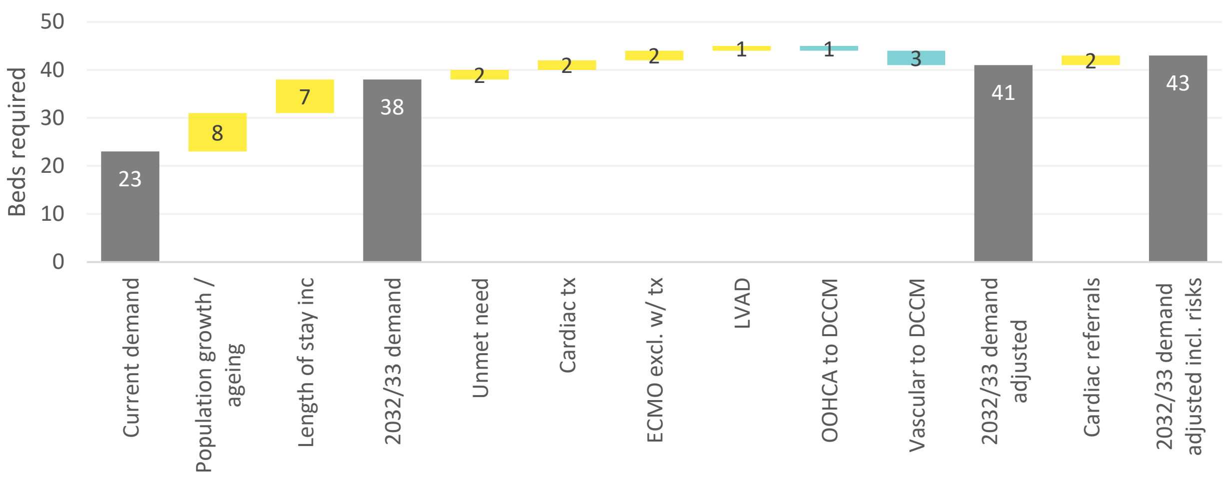


Figure 22: CVICU demand waterfall

Source: ADHB, CVICU/DCCM Unit databases, EY analysis

Table 13: CVICU demand scenarios and risks

Source: ADHB, CVICU/DCCM Unit databases, EY analysis

		2017/18	2022/23	2027/28	2032/33
Baseline projection	Age and flow specific projected beds at 10am max	23	30	34	38
	Baseline demand increases	-	+7	+4	+4
Factors that could increase demand	Unmet need (cancelled bypasses)	+2 ICU	-	-	-
	Transplant	-	+1 ICU	-	+1 ICU
	ECMO (excl. transplant recipients)	-	+1 ICU	-	+1 ICU
	LVADs	-	+1 ICU	-	-
Factors that could offset demand	Vascular to DCCM	-2 HDU	-	-	-1 HDU
	OOHCA to DCCM	-1 ICU	-	-	-
	Vascular pathways†	-	-	-	-
	Thoracic pathways‡	-	-	-	-
Total adjusted		22	32	36	41
Risks that could impact on demand	Changes in cardiac surgery referrals	+1 ICU	-	+1 ICU	-
	Vascular regionalisation	-	-	-	-
Total adjusted incl. risks		23	33	38	43

† stakeholders noted that volumes were likely small, avoiding ~1 day in HDU and ~1 day in Ward 41, three patients through the endovascular aneurysm repair (EVAR) pathway as at November 18

‡ stakeholders noted that volumes were likely small, avoiding ~1 day in HDU, planning on a trial on 10-12 patients which will be evaluated before further decisions are made

For DCCM, it is expected that over the next 15 years additional factors may lead to the need for an additional 3 beds, with no clear additional risks identified (Figure 23, Table 14). If the 2032/33 demand adjusted projection (30 beds) proves to be the closest estimate then to remain within the future demographic and length of stay projection footprint of 27 beds, length of stay savings of ~42 bed-days or 1.0% p.a. would be necessary.

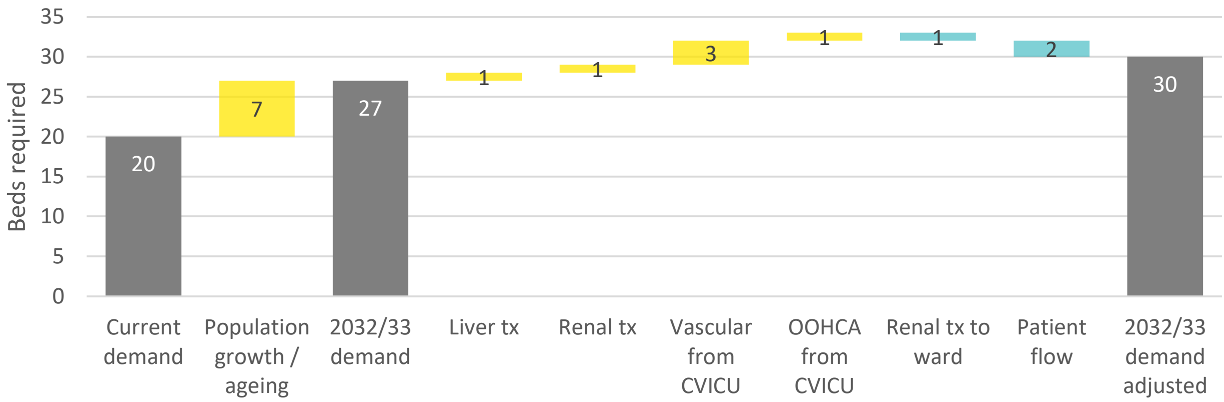


Figure 23: DCCM demand waterfall
Source: ADHB, CVICU/DCCM Unit databases, EY analysis

Table 14: DCCM demand scenarios and risks
Source: ADHB, CVICU/DCCM Unit databases, EY analysis

		2017/18	2022/23	2027/28	2032/33
Baseline projection	Age and flow specific projected beds at 10am max	20	23	25	27
	Baseline demand increases	-	+3	+2	+2
Factors that could increase demand	ED acute flow (transitional care dependent)#	-	-	-	-
	Liver transplant	-	-	+1 ICU	-
	Renal transplant	-	+1 HDU	-	-
	Vascular from CVICU	+2 HDU	-	-	+1 HDU
	OOHCA from CVICU	+1 ICU	-	-	-
Factors that could offset demand	Renal transplant†	-	-	-1 HDU	-
	Patient flow (i.e., less bed block)‡	-2 HDU	-	-	-
Total adjusted		21	25	27	30

attempts to size the cohort from ED with stakeholders has been difficult. The events may not be occurring with a high frequency but when they do occur they have a significant impact

† during stakeholder engagement the renal service noted significant investment would be required to ensure workforce was available and equipped to manage renal transplant patients

‡ there is likely to be increasing demand over time as a result of bed-block, but this may be offset by med / surg bed capacity expansion

For PICU, it is expected that over the next 15 years additional factors may lead to the need for an additional 3 beds, with no clear additional risks identified (Figure 24, Table 15). If the 2032/33 demand adjusted projection (38 beds) proves to be the closest estimate then to remain within the future demographic and length of stay projection footprint of 35 beds, length of stay savings of ~50 bed-days or 0.8% p.a. would be necessary.

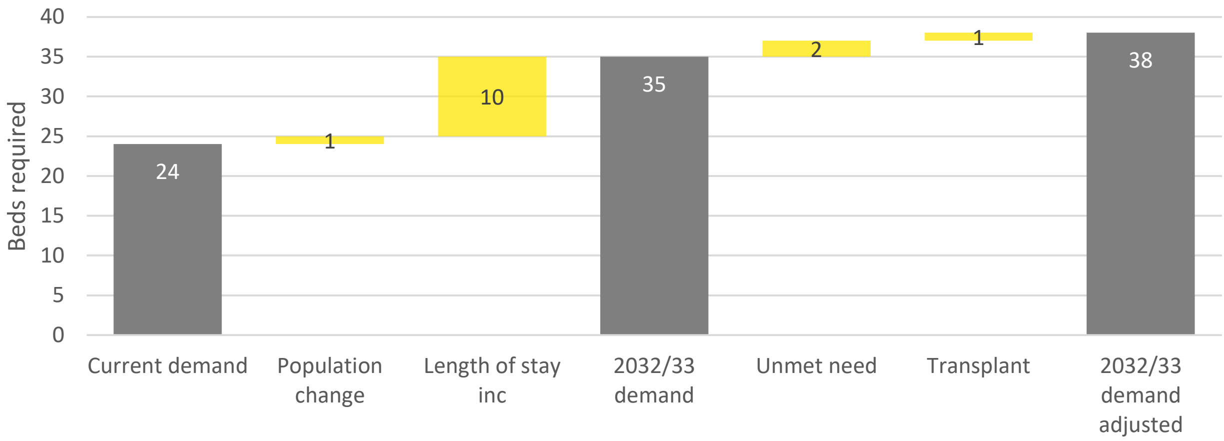


Figure 24: PICU demand waterfall
Source: ADHB, EY analysis

Table 15: PICU demand scenarios and risks
Source: ADHB, EY analysis

		2017/18	2022/23	2027/28	2032/33
Baseline projection	Age and flow specific projected beds at 10am max	24	33	35	35
	Baseline demand increases	-	+9	+2	+0
Factors that could increase demand	Unmet need (failure to admits)	+2 ICU	-	-	-
	Transplant*	-	-	+1 ICU	-
	ECMO (excl. transplant recipients)*	-	-	-	-
Total adjusted		26	35	38	38

* current volumes are subsumed in the baseline projection, these estimates are only for additional growth, i.e., new interventions / growth above population and length of stay increases

For NICU, it is expected that over the next 15 years additional factors may lead to a reduction of 8 cots, with no clear net change based on additional risks identified, however, this is contingent on the establishment of NTC (Figure 25, Table 16). If NTC was established, NICU may be able to remain within its current physical footprint, though this assumes additional resource and capacity available to run NTC. Without NTC, an additional 2 cots may be required due to extremely premature neonates.

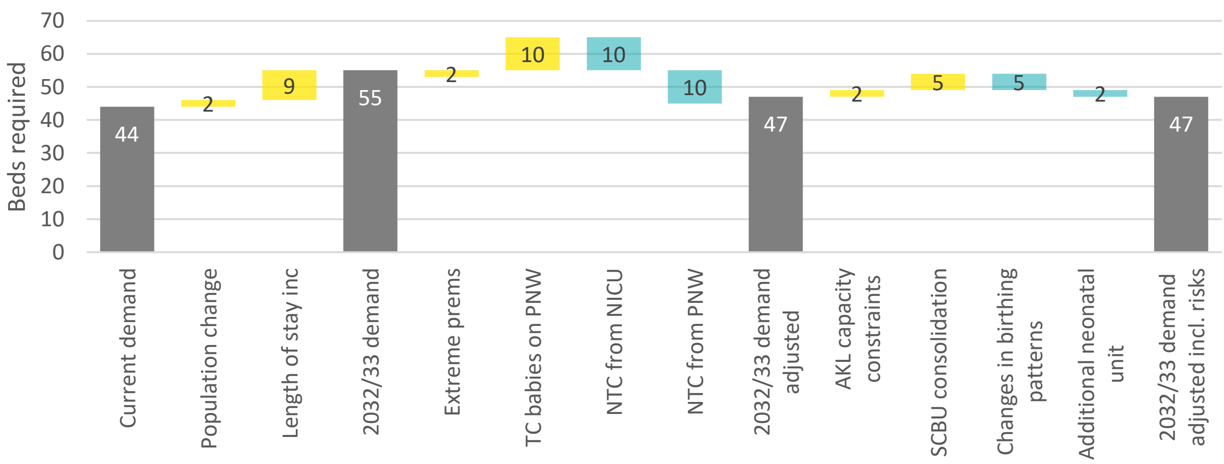


Figure 25: NICU demand waterfall
Source: ADHB, EY analysis

Table 16: NICU demand scenarios and risks
Source: ADHB, EY analysis

		2017/18	2022/23	2027/28	2032/33
Baseline projection	Age and flow specific projected beds at 10AM max	44	53	56	55
	Baseline demand increases	-	+9	+3	-1
Factors that could increase demand	MFM models of care	-	-	-	-
	Increases in extremely premature neonates	-	+1	+1	-
	Transitional care babies on PNW (based on no NTC)	-	+10	-	-
Factors that could offset demand	Neonatal transitional care (ADHB-only assuming all babies from NICU have priority)	-	-10	-	-
	Neonatal transitional care (transitional care babies on PNW)	-	-10	-	-
Total adjusted		44	44	48	47
Risks that could impact on demand	Metro-Auckland capacity constraints	-	+2	-	-
	Consolidation of SCBU configuration	-	+5	-	-
	Paediatric Surgery consolidation	-	-	-	-
	Changes in mothers' birthing decisions	-	-4	-1	-
	Additional Neonatal Unit in Region	-	-2	-	-
Total adjusted incl. risks		44	45	48	47

3. Workforce modelling

Providing care to severely unwell and high acuity patients requires a multi-disciplinary team skilled in intensive care provision. Due to the severity and acuity of the patients cared for in critical care units, staffing levels are different from the rest of the hospital.

The staffing requirements for adult and paediatric critical care units in Australasia are outlined by the College of Intensive Care Medicine of Australia and New Zealand (CICM) Minimum Standards for Intensive Care Units. The CICM standards include information on the medical and nursing workforces, which, for nurses, are supplemented by additional standards published by the New Zealand College of Critical Care Nurses (NZCCCN) and Australian College of Critical Care Nurses (ACCCN).

For neonatal critical care units there are no detailed standards, however, the Specialist Neonatal Inpatient and Community Services Tier Two Service Specification ('Neonatal service specification') provides some information on service expectations.

3.1 Medical workforce

The medical workforce staffing Auckland DHB's critical care units is a mix of Senior Medical Officers (SMOs), Fellows, Registered Medical Officers (RMOs) and Senior House Officers (SHOs). For CVICU, DCCM, and PICU, SMOs hold a Fellowship awarded by the College of Intensive Care Medicine (CICM). Fellows are usually in the final years of their training towards their Intensive Care Medicine fellowship. RMOs can be from a range of training programmes, generally intensive care, anaesthetics, emergency medicine or general medicine / paediatrics. For CVICU, fellows and RMOs may also be from the surgical or cardiology training programmes. SHOs are only present in CVICU and are on a six month rotation as an introduction to intensive care medicine.

The medical workforce staffing for NICU is similar and includes Senior House Officers (SHOs) and Advanced Neonatal Practitioners (ANPs), who participate in the same roster as the RMOs. NICU SMOs hold a Fellowship awarded by the Neonatal and Perinatal Division of the Royal Australasian College of Physicians (RACP). Fellows may be in their final years of their training towards their RACP fellowship in neonatology or paediatrics. RMOs can be from a range of training programmes, generally basic RACP training, obstetrics or paediatrics. SHOs are usually on short rotations, e.g., 3 months, as an introduction to neonatology.

SMOs oversee critical care units, and patient care. They are present every day, and on call after-hours. Appropriately skilled fellows may participate in the after-hours on-call SMO roster. RMOs staff each critical care unit during the day and overnight.

RMOs in each unit also provide outreach to other parts of the hospital (in NICU, SHOs provide outreach). Outreach for DCCM and PICU is a significant amount of work as the units provide care for patients across a wide range of specialties. CVICU has a smaller outreach role, which is generally only within the Cardiac Directorate. NICU also has a smaller role, providing outreach to neonates on postnatal wards.

3.1.1 Medical standards (CVICU, DCCM, PICU)

Adult and paediatric critical care units in Australasia follow the College of Intensive Care Medicine of Australia and New Zealand (CICM) Minimum Standards for Intensive Care Units. The safe recommended number of patients for individual doctors to care for in intensive care is 8-15. To support this, it is recommended that larger intensive care units have a pod structure, with 8-15 patients per pod. Pods may be physically separate spaces in the unit, or patients may be assigned to 'virtual' pods for care purposes. In effect, the pods are functional clinical subunits within the overall critical care unit.

The CICM standards state that there should be a SMO rostered to the unit at all times, and more than one if the unit is in pods (i.e., one SMO per pod of 8-15 beds). This is along with a second appropriate medical practitioner, i.e., at least one SMO and one Fellow/RMO per pod during the day.[25] Overnight the pods can be combined with one SMO on-call, along with a backup. The standards indicate at least four SMO FTE per pod is required for rostering purposes, excluding leadership, training, other responsibilities time.[26]

CICM also provides standards with regard to patient attendances outside of a critical care unit, stating that critical care RMOs should not be rostered for 'rapid response team' shifts for more than 25% of their clinical time - meaning that they should manage patients inside the critical care unit at least 75% of their time.[27] This is to support teaching, learning and supervision.

3.1.2 Medical standards (NICU)

While adult and paediatric critical care units in Australasia should follow CICM standards to care for patients in a pod structure, there is no current similar standards for NICU in the neonatal service specification. Although, the service specification does not discuss pods, it is how NICU currently organise their SMO workforce, and so, in principle NICU should also follow pod standards similar to the other critical care units. [28]

In regard to SMO presence, the service specification states that a neonatal paediatrician should be rostered to the unit at all times.

[25] See: https://www.cicm.org.au/CICM_Media/CICMSite/CICM-Website/Resources/Professional%20Documents/IC-1-Minimum-Standards-for-Intensive-Care-Units_2.pdf

[26] For comparison, the GPICS UK guidelines recommend that the SMO to patient ratio generally does not exceed the range of 1:8 – 1:12, and that the RMO to patient ratio should not exceed 1:8, including overnight. Both RMOs and Advanced Critical Care Practitioners (generally nurses with additional training) may contribute to the RMO roster. The ratios are based on recent evidence on patient SMO ratios and patient outcomes. This evidence demonstrated a 'U-curve', where the optimum ratio was 7.5 patients per SMO in hours, with mortality increasing at lower and higher ratios. The GPICS guideline also suggests that a SMO roster with less than 8 people, due to the number of weekends and nights, is likely to be "too burdensome over a career"

[27] Minimum standards for rapid reponse systems http://cicm.org.au/CICM_Media/CICMSite/CICM-Website/Resources/Professional%20Documents/IC-26-Minimum-Standards-for-Intensive-Care-Unit-Based-Rapid-Response-Systems.pdf

[28] For comparison, the British Association of Perinatal Medicine (BAPM) Framework (Optimal Arrangements for neonatal Intensive Care Units in the UK), specifies that NICUs undertaking more than 2,500 intensive care days a year should consider the presence of at least two consultant led teams during normal daytime hours, increasing to three over 4,000 intensive care days per annum.

3.1.3 Medical MECAs

Alongside the CICM standards and neonatal service specification, there are also terms and conditions in the Multi-Employer Collective Agreements (MECA) for SMOs (ASMS) and RMOs (RDA / SToNZ) that need to be considered. The MECAs are the contracts which outline the agreed workforce terms and conditions between DHBs and the medical workforce (who are parties to a MECA). As part of the contracts, leave and entitlements are detailed (later summarised in Table 17).

For SMOs, the MECA includes that "the parties note that the Council of Medical Colleges of New Zealand endorses that…non-clinical or Section Four activities should make up at least 30% of the total job size", excluding after-hours on call and clinical leadership or service management time.[29]

For RMOs working in critical care, the proportion of night shifts allocated is limited by the MECAs, unless otherwise agreed, to 30% (RDA) or 33% (SToNZ), to protect teaching and learning in a supervised environment.

3.2 Current medical FTE

CVICU

CVICU is currently operating two virtual pods, with two medical teams across two rosters. The Unit has a budgeted establishment of 8.18 SMO FTE (excluding after-hours on-call [AHOC][30]) and currently have a 1.1 SMO FTE vacancy (compared to budgeted establishment).

The Unit's current staffing is 7.3 SMO FTE (including clinical, non-clinical and leadership duty time), 4.0 Fellow FTE and 7.0 RMO FTE. CVICU has 2.0 FTE for Intensivist Fellows, who are initially on the RMO roster, and move to the SMO roster after 6 months. Start times are staggered so that there is one on either roster at any time. The other 2.0 Fellow FTE is for Cardiac Anaesthetic Fellows, who do 6 months in CVICU on the RMO roster, and the other 6 months in anaesthetics. FTE is ringfenced in CVICU for both the Director and Deputy Director, and Supervisor of Training roles and amounts to 0.56 FTE. Currently SMO non-clinical time is estimated at 19.4%. For RMOs, night shifts are currently 30-30.5% of their total shifts. There is also 1.0 SHO FTE.

The CVICU medical team also provide ECMO cover (2 hours for an SMO not first or second on call) in case of an ECMO retrieval. As ECMO volumes rise it is expected a separate roster will be required for retrieval.

DCCM

DCCM is currently operating two virtual pods, with two medical teams across two rosters. The Unit has a budgeted establishment of 10.99 SMO FTE (including AHOC) but currently have a 0.9 SMO FTE vacancy which has been used to fund a Fellow position.

[29] https://www.asms.org.nz/wp-content/uploads/2017/10/2017-2020-DHB-MECA-Signed.pdf

[30] DCCM is the only unit to include AHOC in their SMO FTE, for all other units AHOC is covered under the on-call payment system.

The Unit's current staffing is 10.09 SMO FTE (including clinical, non-clinical and leadership duty time), 2.0 Fellow FTE and 10 RMO FTE. DCCM has 1.0 FTE budgeted for a Fellow, who is on their own roster. FTE is ringfenced in DCCM for both the Director and Deputy Director, and Supervisor of Training roles and amounts to 0.84 FTE. Currently SMO non-clinical time is estimated at 17.7%. For RMOs, night shifts are current 46% of their total shifts.

The DCCM medical team also provides outreach to wards in the hospital, which is a significant load particularly on the RMOs who generally respond, i.e., ward reviews, trauma calls, emergency department resuscitation calls, and attending codes. While highly variable, a DCCM RMO on outreach may spend an average of 6 hours a day 'outside the unit', with SMO support estimated at 1-2 hours per day. To meet this demand, DCCM has instituted a short registrar day shift to primarily respond to these calls – from within current resourcing. Currently DCCM is complying with the CICM standard that 75% of RMO clinical time is spent managing patients within the unit.

PICU

PICU is currently operating two virtual pods, with two medical teams across two rosters. The Unit has a budgeted establishment of 7.2 SMO FTE (excluding AHOC).

The Unit's current staffing is 7.2 SMO FTE (including clinical, non-clinical and leadership duty time), 2.0 Fellow FTE and 12.0 RMO FTE. PICU has 2.0 FTE for Intensivist Fellows, who are initially on the RMO roster. FTE is ringfenced in PICU for the Director at 0.38 FTE, no ringfenced FTE for Deputy Director and 0.13 FTE for Supervisor of Training roles. Current SMO non-clinical time is 18-20%. For RMOs currently, each of night shifts and transport shifts are 30% of their total shifts (60% of all shifts).

The PICU medical team also provides outreach to wards in the hospital, which can be a significant load particularly on the RMOs who generally respond, i.e., ward reviews, trauma calls, emergency department resuscitation calls, transporting patients to scans within the hospital, and attending codes. On top of outreach, the PICU medical team provide a transport service which can impact even further on the RMO workforce. Approximately 250-300 retrievals are undertaken by PICU a year. If a transport call occurs and there are outreach needs within Starship, there are times where only one RMO is covering PICU.

NICU

NICU is currently operating three virtual pods, with three medical teams across three rosters. The Unit has a budgeted establishment of 6.0 SMO FTE (excluding AHOC).

The Unit's current staffing is 6.0 SMO FTE (including clinical, non-clinical and leadership duty time), 2.0 Fellow FTE, 11.0 RMO FTE, and 1.0 SHO FTE. FTE is ringfenced in NICU for both the Director, and Supervisor of Training roles at a total of 0.4 FTE. Currently SMO non-clinical time is estimated at 30%. They are supported by 9.0 Registered Nurses (under Expanded Scope of Practice), NP interns and NP FTE.

Because of the wide range of NICU requirements, from ward level care to high intensity ICU, the standard ICU modelling below has limitations in its application and further work is required to tailor the model.

3.2.1 SMO workforce metrics

In terms of SMO workforce age, each of the units have a reasonable distribution across age groups. The CVICU workforce is somewhat younger than other units, while the others may face more succession planning challenges in future (Figure 26). Turnover is also very low, with most SMO staff attrition due to retirement, which only occurs every few years.

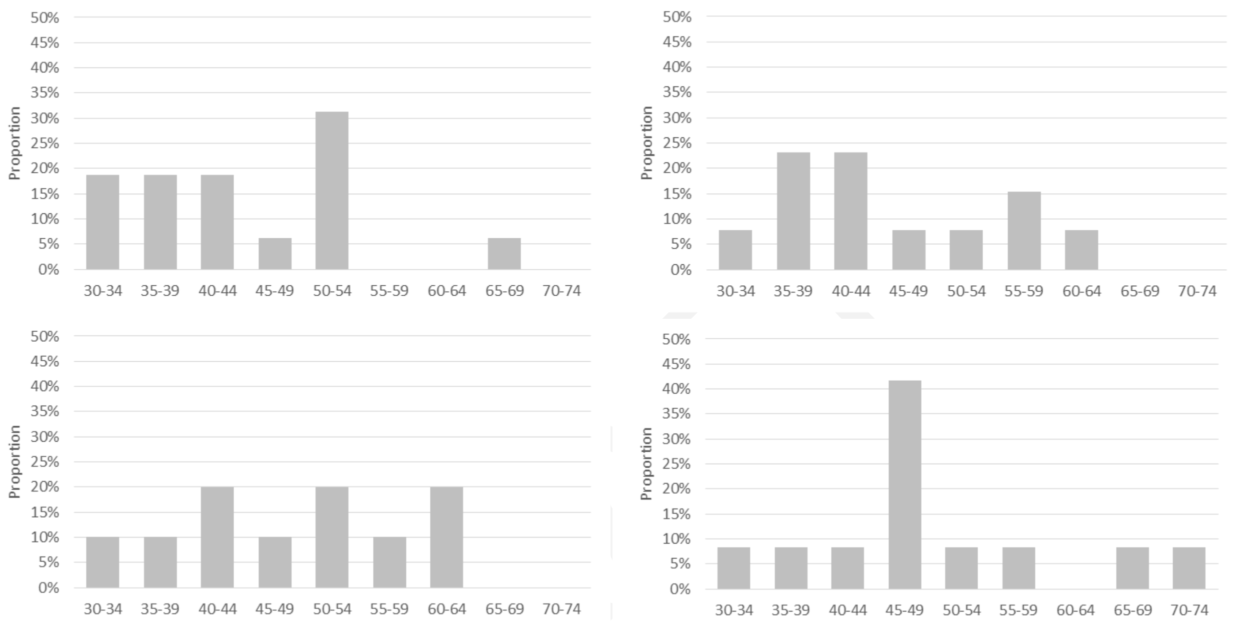


Figure 26: Critical care SMO workforce age
Source: ADHB
From top, left to right: CVICU, DCCM, PICU, NICU

Analysis of leave by SMOs is not provided, due to small numbers, however, generally with current roster requirements SMOs do not take their full annual or study leave allocations. Minimal sick leave is taken, however, when taken it can be for a prolonged period.

3.3 Principles for medical workforce planning

To determine medical staffing of the critical care units based on CICM standards and MECAs, principles based on pod configurations and the medical staffing appropriate for this configuration, were developed. The principles were that for each pod:

- The planning principle is 10 patients per pod on average (once the average reaches 12 then an additional pod would be considered for opening depending on patient mix, likelihood of ongoing higher patient numbers, and other options for managing demand)
- One SMO per pod during the day
- One Fellow and one RMO per pod during the day, with DCCM requiring one extra RMO, and PICU two extra RMOS, during the day for out of unit attendances (e.g., outreach, transport)
- Two SMOs on-call during the evening and weekend (first and second on-call)
- Two RMOs overnight in each unit
- Accepting that due to challenges in recruiting Fellows, especially in DCCM, that frequently the Fellow roster would not be fully staffed all the time.

The exact sizing of Fellows, RMOs and SHOs is not explored here, due to these workforces' dependency on recruitment (for Fellows), and decisions made by the vocational training committee (VTC, for RMOs and SHOs).

3.3.1 SMO sizing

Based on the principles above, modelling of SMO FTE was undertaken. Briefly, the modelling involved calculation of:

- Leave days including annual, onerous, CME, CME travel, TOIL (for public holidays and CME), professional meetings, and other unplanned leave such as sabbatical (three months every seven years), sick, and bereavement (Table 17)
- Ordinary in-unit clinical hours based on a two-pod model, i.e., excluding AHOC
- Non-clinical time calculated at 25% of the job size based on total hours excluding AHOC
- FTE required on a 40 hour per FTE contract.

To then reach the final FTE, adjustments were made for the FTE loading given to the Clinical Director, the Deputy Clinical Director and the Supervisor of Training.

Table 17: SMO leave assumptions
Source: ADHB

Leave type	Amount (weeks)
Annual leave	6
Onerous duties	1
CME/travel	3
Statutory days (discounted as not everyone works)	2
Other unplanned	1

The following table (Table 18) provides the SMO sizing based on a two-pod model incorporating the workforce planning principles and leave assumptions. It is important to note that this is a template including core functions. There may be variations by unit in these core functions and some will have additional functions, for example:

- Additional back-up activities, i.e., ward calls / outreach / PAR / ECMO cover / transport or retrieval
- Additional SMOs on ward rounds
- Additional clinical meetings, i.e., MDTs, transplant assessments.

Based on the sizing (Table 18), approximately 4.2 SMO FTE (excluding unit leadership duties) would be required per pod in a two-pod model. This is in line with CICM standards minimum level of resourcing.[31] It is important to note that as the units, particularly CVICU and PICU, grow to have more than 24 patients most of the time, there will need to be consideration of adding a third pod and review of the most appropriate medical model to run the unit.

Compared to current budgeted FTE, running this model requires an additional:

- 0.81 SMO FTE for CVICU
- 1.79 SMO FTE for PICU
- 1.24 SMO FTE for DCCM

[31] The CICM standards also state that medical staffing should be sufficient to manage the patient mix, duties outside of the critical care unit and administration, teaching, research and audit activities on top of the minimum staffing of 4.0 SMO FTE.

Table 18: SMO FTE (excluding AHOC) sizing for a two-pod configuration

Source: ADHB

Role	Occurrences per week	Hours	Hours per week	Leave cover	FTE required	FTE required including Non-Clinical
Duty intensivist 1	5	9	45	1.3	1.46	1.97
Backup intensivist	5	9	45	1.3	1.46	1.97
Duty intensivist 2	5	9	45	1.3	1.46	1.97
Routine clinical meetings	3	7.5	22.5	1	0.56	0.76
Other clinical meetings	3	5	15	1	0.38	0.51
Post-night handover and clinical work	5	4.5	22.5	1.3	0.73	0.99
Weekday Friday handover and clinical work	1	4.5	4.5	1.3	0.15	0.20
Total clinical excluding AHOC			199.5		6.2	8.36
Non-Clinical			66.5	1.3	2.16	
Total + Non-Clinical			266		8.36	8.36
SCD			15		0.38	0.38
Deputy SCD			5		0.13	0.13
Supervisor of training			5		0.13	0.13
Total excluding AHOC			291		8.99	8.99

DCCM has previously used a similar process for modelling FTE. This used rostered on-duty hours to derive non-clinical time but does not include “other” clinical time beyond those rostered on. This model includes AHOC. If this is excluded the FTE is approximately 8.76, so very similar to the template above. Compared to budgeted FTE for DCCM, running this model would require an additional 1.24 SMO FTE.

Table 19: DCCM SMO FTE (including AHOC) sizing for a two-pod configuration

Source: ADHB

Components	Description	Hours required per week
Ordinary clinical hours		
Intensivist Pod 1 (day)	On for 9 hours each weekday	45
Intensivist Pod 2 (day)		45
Backup Intensivist (day)		45
Handover Intensivist (day)	Intensivist on for 6 hours of the weekday following overnight duty	30
Ordinary clinical hours subtotal		165
After-hours		
On-duty (weekday)	Approximately 7 hours per weekday of in-unit clinical time	35
On-duty (handover)	Approximately 5 hours per weekend day of handover	10
On-duty (weekend day)	Approximately 13 hours per weekend day of in-unit clinical time	26
On-duty subtotal		71
On-call	Total after-hours less on-duty. The sizing exercise identified 111 hours as the after-hours total. This includes on-call time affected by clinical work	40
Totals and non-clinical		
Total clinical hours excluding AHOC	Total of ordinary clinical hours and after-hours on-duty	236
Non-clinical time	This is applied at 25% of total job size to total hours excluding after-hours on-call	79
Total hours of work	Total of clinical (ordinary clinical, after-hours on-duty, on-call) and non-clinical time	355

Components	Description	FTE required
Clinical FTE	Total hours as above inflated for leave based on Table 18 and divided by 40 hours per FTE	11.4
Leadership duties FTE	Director, Deputy Director and Supervisor of Training FTE	0.83
Total FTE	Sum of clinical FTE and leadership duties FTE	12.23

3.4 Nursing workforce

The largest component of the workforce in critical care units is nursing. To work as a nurse in critical care requires specific skills, and new recruits generally have a significant period of education and supernumerary time.

The senior nursing staff are generally comprised of a Nursing Unit Manager (NUM), and Clinical Charge Nurses (CCNs) / Charge Nurse Coordinators (CNCs) / Charge Nurses (CNs). In terms of running the units, in CVICU, CNCs are responsible for overseeing the care of each pod of patients on a shift, while in DCCM/PICU/NICU it is CCNs who do shift coordination and are responsible for a team of RNs.

For bed-side nursing, registered nurses (RNs) provide care to one or two patients on a shift basis.[32] The number of patients that each nurse cares for is dependent on care-level (i.e., ICU/HDU), patient-mix and acuity.

In addition to senior and bed-side nurses, there are ‘runners’, who are not assigned a patient load but assist the bed-side nurses and move around the unit as required. Nurse specialists (NS) provide care for the most complex and long stay patients (and their whānau) while also carrying out quality improvement activities. Nurse educators (NE) and research nurses (predominantly externally funded at Auckland DHB) support education and research in each unit. Each unit has some other support roles such as for equipment management and Donation Link. There are also clinical coaches, a relatively new position, which has been developed to assist more junior staff as required and support the education requirements of the unit.

3.4.1 Nursing standards (CVICU, DCCM, PICU)

CICM standards state that there should be a nurse in charge of the unit with a post-registration qualification in intensive care. This is along with a supernumerary team leader in charge of each pod per shift who is a designated senior nurse[33], also with a post-registration qualification in intensive care. In terms of bed-side nursing, ICU patients are recommended to be cared for with a ratio of one nurse to one patient (1:1), and HDU patients at a ratio of 1:2. There are some exceptions to this, such as nursing for patients receiving ECMO, who may require a ratio of up to 2:1. CICM standards also state that more than 50% of the unit’s nursing staff should have a post-registration qualification in intensive care (optimally 75%), and there should be at least one nurse educator for every 50 nurses on the roster.[34]

[32] For NICU, the number of neonates cared for each shift is more flexible, i.e., 1-4 per shift.

[33] See Section 3.1.1 for further information regarding pods.

[34] For reference, the UK’s Guidelines for Provision of Intensive Care Services (GPICS), provide standards of one CCN for every 10 beds (rather than on a pod basis), one nurse educator for every 75 nurses, and only a minimum standard of 50% for post-registration qualification.

Broadly, the New Zealand College of Critical Care Nurses (NZCCCN) standards follow the CICM standards, and are in line with Australian College of Critical Care Nurses (ACCCN) standards. However, they also provide more specific guidance on the need for additional nursing service requirements, including outreach, research, quality improvement, rapid response teams, patient retrieval and transport, telemetry, education, and dedicated equipment nurses or technicians. The NZCCCN standards also stipulate that the ratio of runners should be one per 8 ICU patients, or per 16 HDU patients, and for units with less than 50% qualified staff, the standards indicate that additional runners and education staff are required.

3.4.2 Nursing standards (NICU)

The neonatal service specification states that for a Level 3 unit there should be a nurse in charge of the unit. It also states that a Level 3 unit should have neonatal nurse practitioners or clinical nurse specialists, and that all nurses are trained in neonatal intensive care, however, it does not state a level of post-registration qualification that should be maintained.

Bed-side nursing ratios in NICU range from 1:1 to 1:4 depending on a neonate's needs with:

- intensive care neonates requiring 1:1 nursing until they are more stable where they may decrease to 1:2
- high dependency care neonates requiring 1:2 (or 1:3 nursing for more stable infants)
- special care neonates requiring 1:4 nursing.

Further to these roles, the neonatal service specification also states to support discharges from NICU, a discharge facilitator or nurse with expert knowledge is required.

3.4.3 Nursing MECA

The New Zealand Nursing Organisation (NZNO) and Public Service Association (PSA) MECAs are the contracts which outline the agreed workforce terms and conditions between DHBs and the nursing workforce (who are parties to the MECA). As part of the contract, leave and entitlements are detailed (later summarised in Table 21). Due to the complexity of shift leave, the MECA conditions are provided.

For nursing shift leave, the MECA states that, "employees who work rotating shift patterns or those who work qualifying shifts shall be entitled, on completion of 12 months employment on shift work, to up to an additional 5 days annual leave," where qualifying shifts are defined as a shift which involves at least two hours of work performed outside of 8am-5pm exclusive of overtime. As the nursing staff of the critical care units generally work 12-hour shifts, most nurses receive the full entitlement. To reach the full entitlement (121 or more qualifying shifts worked), nurses have to work at least seven shifts every three weeks on average.

For professional development, the MECA states that nurses should receive 32 hours per year for full-time employees, and if at Proficient level in the Professional Development and Recognition Programme (PDRP), receive an additional day per year; and if Expert / Accomplished level in PDRP then two additional days.

Nurses who are also NZNO delegates, or workplace representatives, receive paid time off to attend NZNO-related meetings.

3.5 Current nursing FTE

Nursing FTE per unit are provided in Table 20, the numbers are current as of May 2019 unless otherwise stated.[35] Additional roles are activities that the nursing workforce completes within the total FTE allocation.

Table 20: Nursing workforce

Source: ADHB

Role	CVICU	DCCM	PICU	NICU
Senior nurse FTE	NUM 1.0 – across Wards 42, 41 and CVICU[36] ANUM 1.0 CN 3.0 CNC 5.4	NUM 1.0 CNC 1.0 CCN 6.0	NUM 1.0 CNC 0.5 CCN 7.0	NUM 1.0 CCN 6.0
Nurse specialist / research	CNS 2.0 Technical NS 1.0 Research 3.5[37]	Research 3.8	Research 2.6 Transport CNS 0.5 Long-term care CNS 1.0 Technical NS 1.0	Family liaison 2.0 Lactation 0.8 Homecare 2.0
Nurse educators	NE 1.0 Clinical coach 1.8	NE 2.0 Clinical coach 1.8	NE 2.5 Clinical coach 1.8	NE 1.6
Registered nurses	RN 112.5	RN 86.6	RN 119.5	RN 91.0
Additional roles	NZNO reps, health and safety, equipment management, rostering, data entry	NZNO reps, health and safety, materials management, rostering, data entry	NZNO reps, health and safety, mandatory staff training	NZNO reps, health and safety, equipment management, rostering, data entry
Indicative FTE workload for additional roles	2.3 RN 1.0 CNC	1.7 RN 0.8 CCN	3.0 RN	0.64 RN 1.0 CNC

3.5.1 Nursing metrics

The nursing workforce is younger in CVICU than DCCM (Figure 27), with over half the Unit's workforce aged under 35 years. Nearly a fifth of DCCM's nursing workforce is aged 50 years and over.

Across both adult units it is estimated that staff currently take 70% of their allocated sick leave, 82% of staff annual leave, and 75% of study leave. RN turnover in CVICU is 21.0% and DCCM is 13.5% (over calendar year 2018). CVICU's relatively high turnover rate likely reflects the younger cohort of nurses who leave their positions for international experience or to start families.

At June 2019, approximately 21% of the CVICU nursing workforce and 42% of the DCCM workforce held a post-registration qualification in critical care (compared to CICM standards of at least 50%).

[35] Please note that nursing staffing FTE and headcount (and other metrics, such as turnover) fluctuate as resignations / recruitment / change in FTE for individual staff occurs.

[36] Ward 42 is Cardiothoracic, Ward 41 is Vascular.

[37] Consists of 0.7 FTE for a nurse research fellow, 0.7 FTE for a clinical specialty nurse and 1.9 FTE for RNs - note that research FTE varies depending on clinical trials being undertaken as funding is based on research activities.

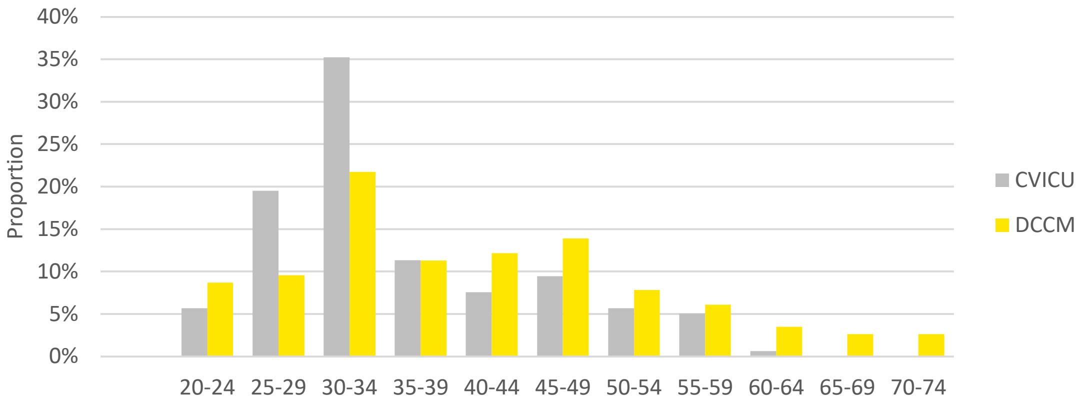


Figure 27: CVICU and DCCM nursing workforce age
Source: ADHB

PICU's nursing workforce is also quite young on average, however, approximately 16% of nurses are aged 50 or older – so there is potential that some of this cohort may transition to reduced hours or retirement over the next 15 years (Figure 28).

It is estimated that nursing staff currently take 67% of their allocated sick leave. Approximately 113% of staff annual leave is taken, and 104% of study leave. RN turnover is 13% (over calendar year 2018).

At June 2019, approximately 62% of the PICU workforce held a post-registration qualification in critical care.

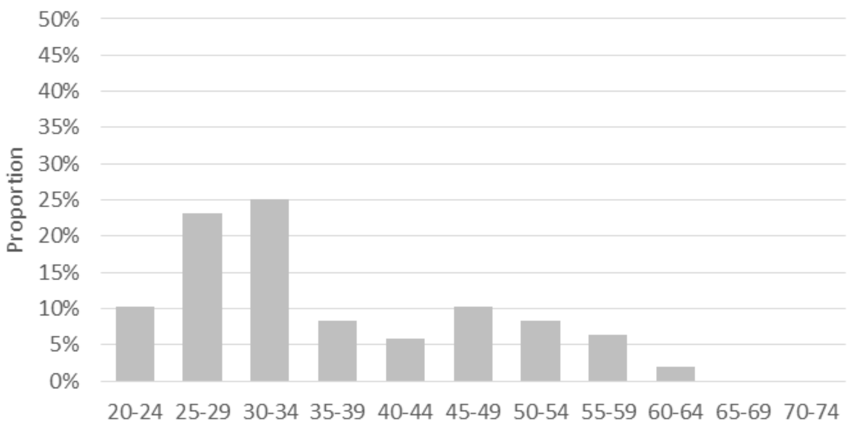


Figure 28: PICU nursing workforce age
Source: ADHB

NICU's nursing workforce has a relatively high proportion of nurses aged over 50 so over the next 15 years there is likely to be a number of nurses who will retire or reduce their hours (Figure 29).

It is estimated that NICU nursing staff currently take 70% of their allocated sick leave. Approximately 83% of staff annual leave is taken, and 50% of study leave. RN turnover in NICU is 13% (over calendar year 2018).

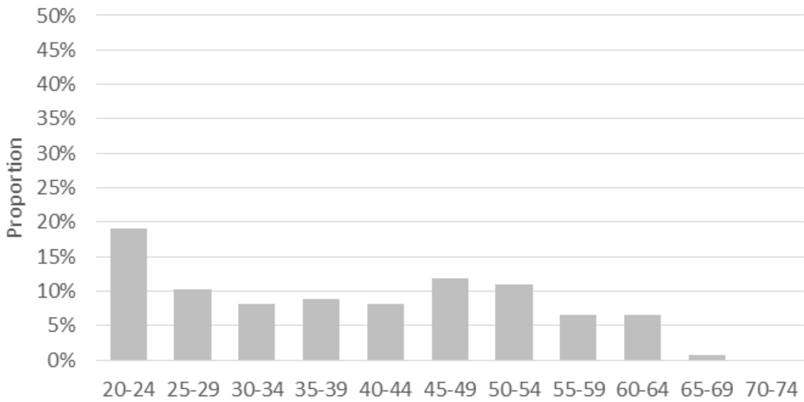


Figure 29: NICU nursing workforce age
Source: ADHB

3.6 Principles for nursing workforce planning

Historically, Auckland DHB has used a ratio of 5.3 Registered Nursing (RN) FTE per ICU bed as a basis for staffing. This ratio was based on CICM, NZCCCN and ACCCN standards, MECA terms and conditions, and analysis of nursing time availability after leave and other provisions as at the time the ratio was estimated.

Given changes in the MECA since the historic 5.3 RN FTE ratio was established, an update of the bed-side nursing ratio was undertaken alongside modelling of the total RN workforce for each unit. Senior nursing involved in the day-to-day running of the unit and education staff were also considered.

Workforce planning principles for nursing included:
- Units meeting the CICM and NZCCCN standards, and for NICU meeting the neonatal service specifications and where appropriate aligned with CICM and NZCCCN standards
- Units meeting all MECA requirements, including annual leave and study leave allocations.

The purpose of these principles was to identify any potential change required in the bed-side nursing ratio, alongside consideration of other nursing roles in critical care units. It is important to note that there are some nursing roles that are specific to each Unit as they fill a defined, individual need, e.g., Clinical Nurse Specialists.

3.6.1 Nursing sizing

Based on the principles above, modelling of bed-side nursing, clinical charge nurse, and nurse educator FTE was undertaken, considering all duties and leave. Briefly, the modelling involved the input of a wide range of assumptions through MECA conditions and data collected by NUMs including:
- Leave days including annual, sick, study days, public holidays, shift leave, long service leave, and other unplanned discretionary leave
- The impact of turnover and additional release from clinical time (i.e., data entry) on FTE
- The FTE required to resource one intensive care bed
- The FTE required for runners to cover resourced beds
- Nurse educator FTE based on estimated nursing headcount
- The CCN FTE based on estimated number of pods and leave assumptions as per RN FTE.

Metrics for the model

Based on the MECA, Table 21 provides the modelling assumptions used. For metrics dependent on contracted FTE and shift length, values are calculated based on a full-time RN working 12-hour shifts. The 'Percentage taken' field provides the modelling assumption for each metric, i.e., modelling assumes 100% of annual leave can be taken. Additional release time is excluded from the model due to differences in each Units' responsibilities.

Table 21: Model metrics based on MECA
Source: NZNO MECA

Metric	Description / condition	Hours per year	Percentage taken	Total hours
Annual leave	160 hours per year	160	100%	160
Sick leave	10 days per year	120	70%	84
Discretionary leave	10 days per year based on employer discretion	120	1%	1.2
Public holidays	Up to 11 days depending on usual rostered shifts and full-time status	132	100%	132
Study leave	32 hours per year, additional day/s based on PDRP level	32	100%	32
Shift leave	Up to 5 additional days based on number of qualifying shifts (>121 shifts per year)	60	100%	60
Long service leave	40 hours after every 5-year period (on average 8 hours per year, assuming the nurse reaches 5-years of service). Assumed that half of the workforce complete 5-years continuous service	4	100%	4
Total				473.2

RN FTE per bed estimate

Over each year there are 2,080 working hours possible (40 hours per week over 52 weeks per FTE), however, once adjusted for leave there are 1,606.8 hours of work possible, which can be translated into 133.9 shifts (12-hours per shift). To staff a bed with nurses at a 1:1 ratio over an entire year requires 730 shifts to be staffed (365 days, 2 shifts per day). Therefore, with the average nurse working 133.9 shifts on average, the RN FTE per bed is 5.45 FTE (730 divided by 133.9).

Impact of variation in study leave, turnover and release from clinical time

As the impact of study leave, turnover and release from clinical time is different by unit, further modelling was undertaken to estimate the impact on nursing FTE per bed based on:

- Increases in the amount of study leave based on PDRP level
- The percentage of staff turnover
- Current additional roles (as per Table 20).

If the average PDRP level across the unit is proficient, then an additional 0.027 FTE should be added to the ratio, for a total of 5.477 FTE per bed. If it was expert / accomplished then an additional 0.055 FTE should be added, for a total of 5.505 FTE per bed.

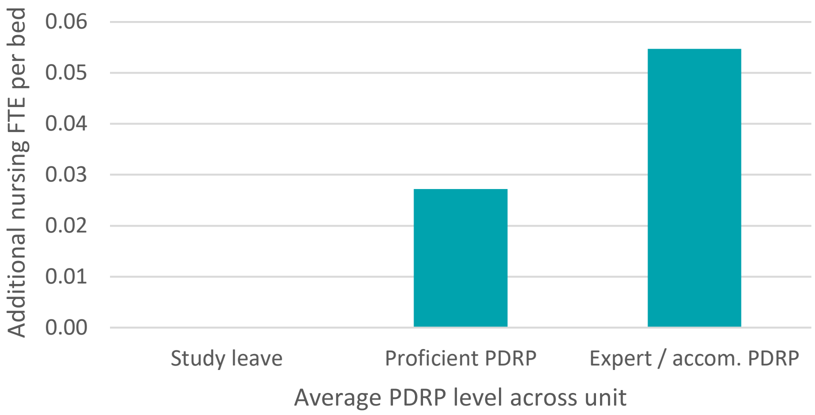


Figure 30: Impact of study leave on FTE per bed
Source: ADHB, EY analysis

The impact of turnover can be significant for the units, as each new staff member is supernumerary for a period of time after they join. This varies across the units from between 6 weeks for a nurse with some prior critical care experience to 12 weeks for a nurse with no prior critical care experience. If the supernumerary time is factored into the working hours available, then it has a significant impact on the bed-side nursing ratio. At 13% turnover (similar to DCCM, PICU and NICU current turnover), approximately 0.1 FTE per bed should be added to the bed-side ratio, for a total of 5.55 FTE per bed, and for CVICU at 21%, closer to an additional 0.16 FTE per bed.

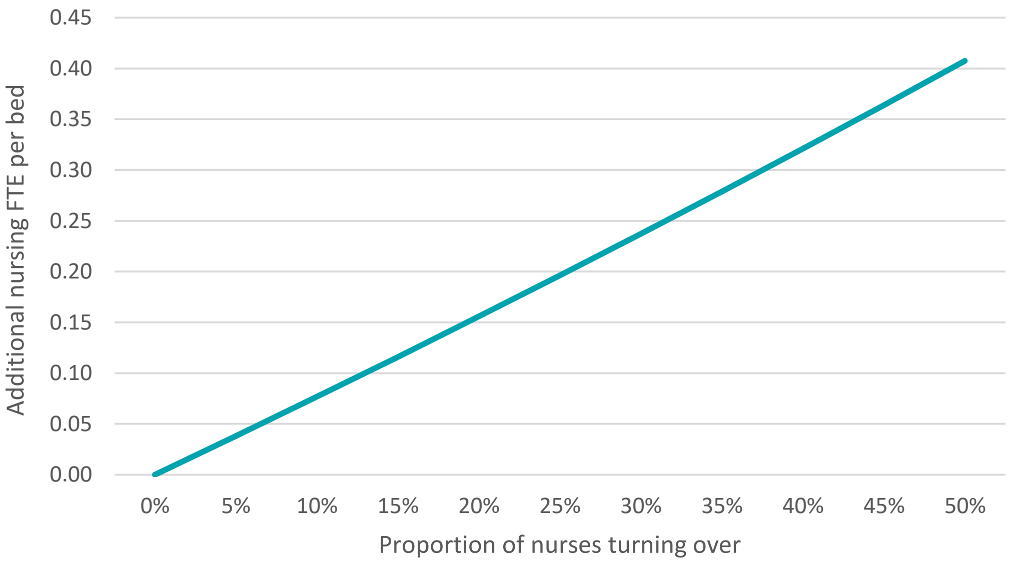


Figure 31: Impact of turnover on FTE per bed
Source: ADHB, EY analysis

Number of runners

As per the NZCCCN standards, there should be a runner for every 8 ICU patients or every 16 patients, and if the level of education in the unit is considered low then additional runners are required. Based on these standards, each unit should have three runners per shift. Using 5.45 FTE for a nurse 24/7, this will be 16.35 FTE. Additional runner capacity is required in PICU to also cover retrievals. It is expected that the runner standard will also apply to NICU.

Required nurse educator FTE

As per the CICM and NZCCCN standards, NE FTE should be calculated as 1 NE FTE per 50 nurses (head count). Across the units, the average contracted RN FTE is approximately 0.8, therefore, NE FTE should be calculated as the total RN FTE divided by 0.8 and then divided by 50. For example, CVICU currently has 112.51 RN FTE, if divided by 0.8 it gives 141 (estimated head count rounded up), and then divided by 50 gives 2.82 NE FTE. It is expected that the NE standard will also apply to NICU.

Across each of the adult and paediatric units, clinical coaches (currently 1.8 FTE from the RN pool for each unit) are crucial to retaining and developing unit skill-mix. It is expected that this FTE will be ringfenced within education FTE alongside nurse educators. Clinical coaches play an important role in supporting and mentoring junior nurses.

Shift coordination FTE

Based on a two-pod model this requires 10.90 FTE. It is important to note that this is very dependent on the number of pods that are run overnight and it is expected that initially a single-pod will be run overnight, i.e., if there are two shift coordinators during the day and one overnight, then 8.18 FTE is required. It is expected that NICU would also follow the latter model. Shift coordination is also done by senior nurses (CCN, CN, etc). The 8.18 FTE for shift coordinators is reduced by the clinical time shift coordination done by these senior nurses. This will vary somewhat by unit but is typically 5-6 FTE.

Calculation of total unit FTE

To arrive at a resourcing estimate based on the aforementioned principles, they were applied to current resourced beds across the critical care units. This estimate applies to core unit functions that all ICUs require to manage clinical patient workload. There are additional non-clinical roles and functions that require additional time and also vary with each ICU.

Table 22: Total estimated core unit FTE using current resourced beds

Source: NZNO MECA, EY analysis

Metric	CVICU	DCCM	PICU	NICU
Resourced ICU beds	16	11	16	14*
Resourced HDU beds	6	6	6	-
Bed-side RN FTE	103.55	76.3	103.55	76.3
Runners	3	3	3	3
Runner FTE	16.35	16.35	16.35	16.35
Total RN FTE	119.9	92.65	119.9	92.65
NE FTE	3.00	2.32	3.00	2.32
Clinical coach FTE	1.8	1.8	1.8	-
Shift coordination FTE‡	8.18	8.18	8.18	8.18†

* NICU cots were estimated as 16 Level 3 cots resourced at 1:2 nursing and 24 Level 2 cots resourced at 1:4 nursing - equivalent to 14 at 1:1 nursing.
‡ note that the required shift coordination FTE will need to be considered in the context of the total clinical FTE of other senior nurses (e.g., CCNs)
† if a transitional care nursery is established then there will need to be consideration of shift coordination and thus CCN FTE. It was indicated that one additional CNC FTE may be required, for a total of 9.18 CCN FTE across NICU and transitional care.

As per Table 20, RN and CCN time is required for additional roles within each unit. These roles vary with each unit but include such roles as NZNO reps, health and safety, equipment management, rostering, data entry, materials management, ECMO lead, retrieval lead.

3.6.2 Registered nursing projections

To then project the workforce required, it is assumed that FTE relating to release from clinical time is ringfenced and that the 5.45 FTE per bed is the basis projection (Figures 32 to 35). 5.45 FTE per bed was selected as it is a clear representation of the workforce requirement at a minimum (see Table 21). Where necessary, additional factors should be accounted for with an appropriate FTE increment.

The following projections provide an indication of how the nursing workforce may need to grow to meet demand over the next 15 years, including the impact of current turnover rates attenuated to 10% (the Auckland DHB target) by 2022/23. This projection also assumes that the current ICU/HDU (NICU/SCBU for NICU) mix continues into future and increases in beds based on the demand projections translate into step increases in RN FTE.

For CVICU, it is estimated that the nursing workforce will grow to ~191 FTE - an additional ~78 FTE from current resourcing by 2032/33. Of the additional ~78 FTE, ~42 FTE is to meet demand from population growth, and ~36 FTE is to meet demand from changes in lengths of stay.

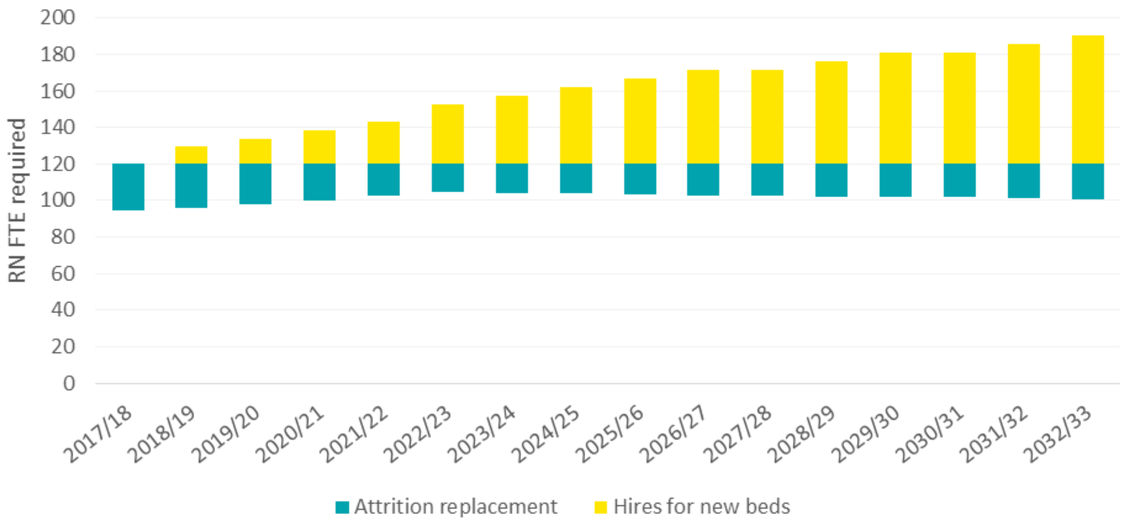


Figure 32: CVICU RN FTE required over time
Source: ADHB, EY analysis

For DCCM, it is estimated that the nursing workforce will grow to ~124 FTE - an additional ~37 FTE from current resourcing by 2032/33. All of the additional ~37 FTE is to meet demand from population change.

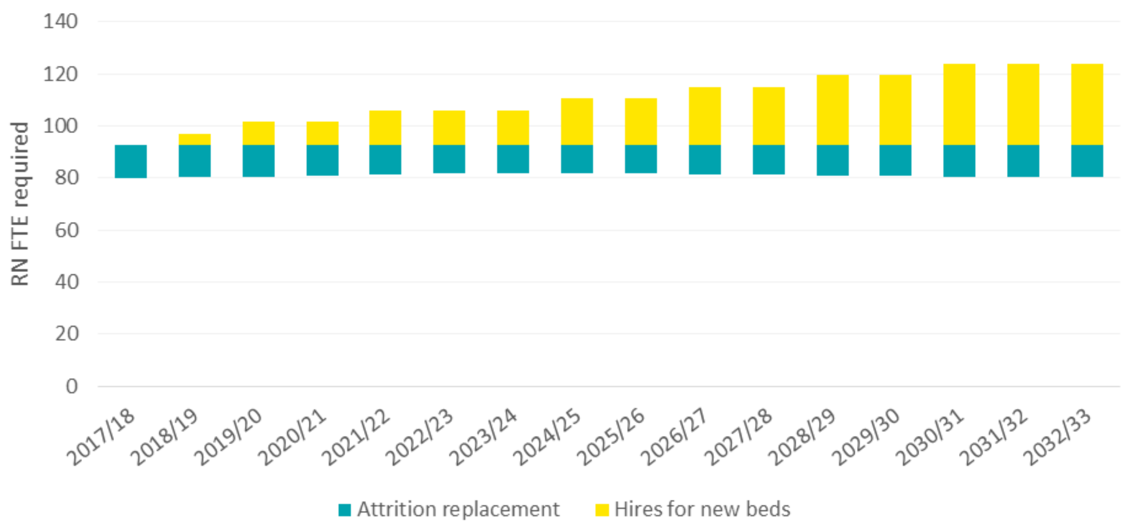


Figure 33: DCCM RN FTE required over time
Source: ADHB, EY analysis

For PICU, it is estimated that the nursing workforce will grow to ~172 FTE - an additional ~52 FTE from current resourcing by 2032/33. Of the additional ~52 FTE, ~5 FTE is to meet demand from population change, and ~47 FTE is to meet demand from changes in lengths of stay.

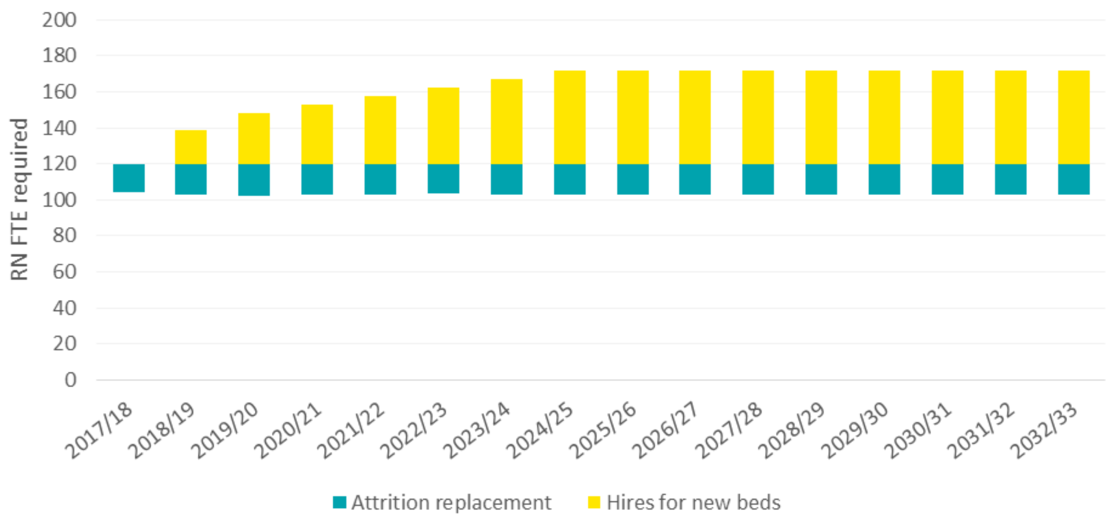


Figure 34 PICU RN FTE required over time
Source: ADHB, EY analysis

For NICU, it is estimated that the nursing workforce will grow to ~113 FTE - an additional ~22 FTE from current resourcing. Of the additional ~22 FTE, ~4 FTE is to meet demand from population change, and ~18 FTE is to meet demand from changes in lengths of stay.

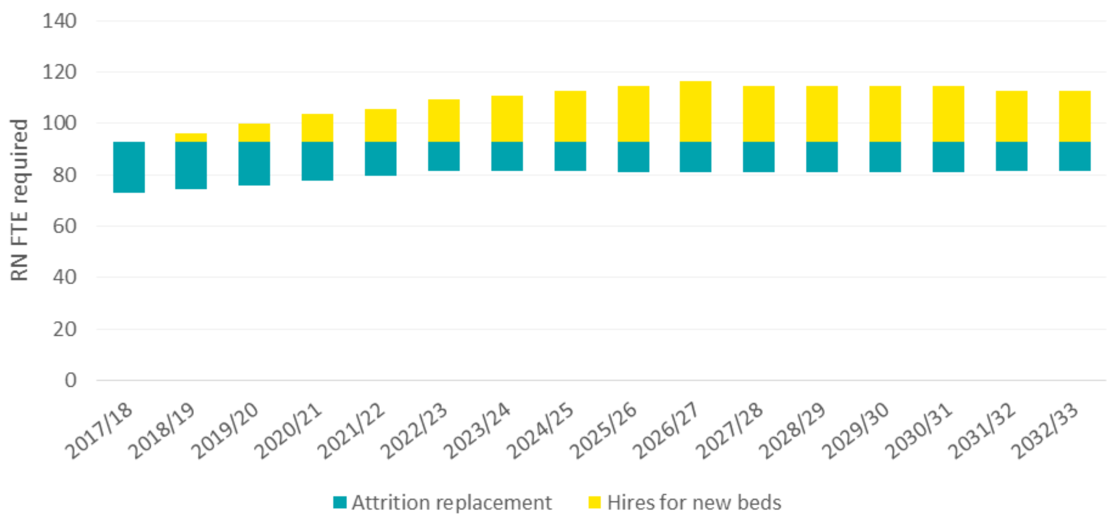


Figure 35: NICU RN FTE required over time
Source: ADHB, EY analysis

3.7 Allied Health

During their stay in critical care, patients may require input from a range of allied health services. For example, psychological support, neurodevelopmental reviews, imaging, labs, and dietician input. For some allied health services FTE is ringfenced for critical care, while others provide services on a referral basis. To provide services in critical care, a minimum skill level is required, with allied health staff usually being senior, experienced practitioners.

The allied health workforce provides specialist input in a wide range of patient care needs in critical care units. The key allied health workforce disciplines which operate in critical care units are:

- Physiotherapy
- Speech and Language Therapy (SLT)
- Occupational therapy (OT)
- Social work
- Psychology
- Dietician
- Hospital play therapists.

Current allied health service standards

The College of Intensive Care Medicine of Australia and New Zealand (CICM) standards provide some guidance on allied health service levels (like what is stated in the neonatal service specification). For a Level 3 intensive care unit the following is noted:

- 24-hour access to pharmacy, pathology, operating theatres and tertiary level imaging services immediately available on site
- access to allied health professionals including a dietician, occupational therapist and speech pathologist as required. There must be access to other medical specialists, other allied health practitioners (e.g., physiotherapist, social worker, Kaiatawhai (Māori liaison officer)) on request 24 hours, and access to technical support staff (biochemical engineers and scientific officers) as required

- Appropriate clerical and secretarial support. It is expected there will be one ward clerk per pod (8-15 beds), including a weekend presence and at least one FTE secretarial support per eight intensive care specialists
- One equipment officer per ICU.

Best practice treatment of critical care patients requires many care skills and knowledge that are provided by allied health, for example respiratory physiotherapy when a patient is intubated, or to enable early mobilisation. Allied health staff also improve patient care by providing support and education to other staff in the unit, as they are specialists in their own fields, for example, staff education on safe feeding of patients with impaired swallowing. Ensuring appropriate allied health input in care planning and delivery for patients in critical care is important in the progression of a patient's health during their admission. Allied health input assists with optimising patient length of stay, and patient outcomes following hospitalisation (e.g., mobility).

The CICM standards provide broad guidance on the involvement of allied health in the delivery of care for patients in critical care units. UK guidelines provide more specific guidance about allied health best practice and service levels in critical care. The Faculty of Intensive Care Medicine (FICM) Guidelines for the Provision of Intensive Care Services (GPICS) V2 were released in June 2019. These guidelines include Standards (the 'musts') and Recommendations (the 'shoulds'). The guidelines relevant to allied health staffing levels, as opposed to what services should be provided, are overviewed below. It should be noted that each of the suggested ratios need to be interpreted and applied based on the requirements of a given unit, including patient acuity and roles and duties of other workforces. Additionally, historically data collection and research regarding allied health service levels in critical care has been limited, restricting the evidence available to consider. Note that social work is not represented in the FICM guidelines.

Physiotherapy

The FICM guidelines state the following standards for physiotherapy in critical care units:

- Respiratory physiotherapy must be available to patients 24 hours a day / 7 days a week
- Patients receiving rehabilitation must be offered therapy by the multi-disciplinary team across a 7 day week.

They further recommend a ratio one FTE[38] physiotherapist to four ICU Level 3 beds. They note that multiple factors impact on an appropriate ratio for a unit.

Speech and Language Therapy

The FICM guidelines state that as a standard access to a SLT in a critical care unit should be available five days a week in working hours. They further recommend:

- A ratio 0.1 SLT FTE per critical care bed, and a greater level may be required for a greater than five day service - depending on patient acuity / case-mix
- Ideally SLT should be available seven days a week.

Occupational therapy

The FICM guidelines state the following standards for OT in critical care units:

- Access to OT five days a week in working hours

[38] Note the guidelines use the term Whole Time Equivalent (WTE) employee.

- Patients receiving rehabilitation must be offered therapy by the multi-disciplinary team across a 7 day week.

They further recommend:
- Basing staffing ratios on unit case-mix and acuity
- Moving towards a seven day a week service.

Psychology

The FICM guidelines state that as a standard, all patients in a critical care unit should be screened daily for delirium, and risks for becoming delirious. They further recommend:
- Psychologist support being available for patients, their relatives, and staff
- Large critical care units should have access to one psychologist FTE, smaller units to a psychologist with dedicated time for intensive care.

Dietetics

The FICM guidelines state that as a standard access to a dietitian in a critical care unit should be available five days a week in working hours. They further recommend:
- A ratio 0.05-0.1 FTE per critical care bed, necessary to meet the capabilities expected of advanced clinical practice (development of protocols and guidelines, teaching, audit, research, staff development)
- Consideration of extended scope of practice roles (e.g., inserting feeding tubes).

3.7.1 Allied Health resourcing and opportunities

The role, responsibilities and resourcing of allied health in critical care units at Auckland DHB has evolved over time, often in reaction to demand pressures, and the availability of resources. This has resulted in variation in the involvement of allied health between units, and coverage gaps from leading practice care models.

Table 24 provides a summary of allied health resourcing across the DHB's critical care units. Allied health services deploy staff based on a triage / prioritisation system, therefore resourced / estimated actual FTE for the units is presented where available – but may not be representative of resourcing use on a given day. It is important to note, that collection of data about demand and resource use is very limited, and that the FTE numbers are based on a mix of TrendCare and estimated time spent in each unit.

Compared to the standards, critical care allied health resourcing is on average lower. Significant differences include:
- Low physiotherapy FTE when standards suggest 1 FTE per four ICU beds, particularly for PICU
- Low SLT FTE when standards suggest 0.1 FTE per critical care bed, particularly for DCCM
- Low dietetics FTE when standards suggest 0.05-0.1 FTE per critical care bed across all units.

Table 23: Critical care allied health resourcing (FTE)
Source: ADHB

Role	DCCM 2019 (17 beds)	CVICU + Ward 42 2019 (57 beds)[39]	PICU 2019 (22 beds)	NICU 2019 (40 cots)
Physio	1.00	2.00	0.5	0.1 (estimated at 0.2)
OT	0.08	0.20	0.1	0.1 (estimated at 0.2)
SLT	0.12	1.27	1.0	0.2
Dietetics	0.25	0.40	0.6	0.4
Social work	0.50	1.00	1.0	1.4

Through engagement with allied health services improvement opportunities identified include:

- Take a planned and structured approach to allied health model of care design and resourcing:
  - Determining optimal models of care and then determining the workforce required to deliver on the model
  - May be based on patient pathways or whole-of-unit needs.
- Improve data collection for service improvement and development:
  - Develop robust data collection systems
  - Use data to demonstrate value of allied health services and support evidence based changes in care model resourcing.
- Identify optimal service configurations:
  - Seek opportunities to re-configure how shifts are structured, equipment is managed and technology is used, and consider potential use of profession-specific assistants.
- Support training for staff:
  - Support staff to sub-specialise, e.g., neuro-physiotherapy
  - Assist staff to attend overseas training to bring learnings and models back to the DHB.

3.8 Clinical Support Services

Clinical support services encompass a wide range of services and form a key component of patient care provision. In relation to critical care provision, clinical support services considered in the Strategy include Pharmacy, Laboratory Services, Radiology and Clinical Engineering[40]. Clinical support services may provide services on request, i.e., ad hoc based on need, or be routinely present in units, e.g., pharmacy, some cases of radiology. Working in critical care requires a high level of skill, and generally more experienced and senior staff members service the critical care units.

Within current CICM standards the information provided about the expected level of clinical support services is limited. The standards state that there should be 24-hour access to pharmacy, pathology, and tertiary level imaging services immediately available on site, with access to technical support staff, including biomedical engineers and scientific officers, as required. Regarding ICU design, the CICM standards include that a workshop and laboratory should be included, including the provision of point of care tests (a blood gas machine which allows stat measurement of blood gases, simple electrolytes, haemoglobin and facility to measure blood glucose).

[39] Allied Health support in the Cardiovascular Directorate currently has FTE split across CVICU and Ward 42 (Cardiothoracic).

[40] At Auckland DHB, clinical engineering is responsible for the maintenance of most medical equipment, excluding some radiology machines. Information technology (IT) support to the units and associated services is also considered.

There is some international guidance regarding clinical support services and critical care, mainly relating to pharmacist to patient ratios. For example, the Society of Hospital Pharmacists of Australia's Standard of Practice for Clinical Pharmacy Services[41] outline that staffing levels are driven by the range of services required, complexity of care, and hospital throughput. Based on the number of patients per day, they recommend for critical care units 1 FTE pharmacist per 10 patients (including weekdays and weekends).[42]

The UK FICM GPICS[43] state that there must be a designated intensive care pharmacist for every critical care unit, and that they attend the daily multi-disciplinary ward rounds. The GPICS pharmacy standards also include a ratio of 0.1 FTE for every level 3 bed, and every two level 2 beds for a five day a week service, which should be seven days a week by 2020. They also recommend an extra 20% minimum of resource to maintain service during leave or other commitments.

The FICM GPICS also provide guidance regarding other clinical support services, including daily input from microbiology and seven-day availability of radiology. The guidelines recommend that all point of care laboratory devices, to assist clinical decision making, should be subject to appropriate quality assurance mechanisms. The guidelines also recommend that urgent clinical chemistry and haematology advice is available within 60 minutes by an appropriate specialist, and a radiologist is always immediately contactable.

3.8.1 Clinical Support Service resourcing and opportunities

Current clinical support service provision is ad hoc and prioritised based on clinical need, though there are some cases of designated FTE, e.g., pharmacy into DCCM, and rounding of some critical care units by radiology. For clinical engineering, a ratio of approximately 1 technician to 750 pieces of equipment is maintained across the hospital. They also aim to provide as much assistance in-house as possible given the high cost of proprietary maintenance and repair.

As technology continues to advance and the utility of bed-side diagnostics increases, e.g., ultrasonography and point of care tests, increased support from these support services, and more broadly from clinical engineering and IT, will be crucial. The following opportunities were identified by clinical support services within the context of critical care:

Radiology

- Review resourcing for radiology services appropriately:
  - Identify step changes in workforce requirements rather than increments
  - Monitor revolutionary changes (in clinical models of care, particularly critical care models) and ensure implications are appropriately highlighted and resourced, e.g., a change in critical care from a fluoroscopy test to ultrasound, so that changes in resourcing can reflect clinical practice
  - For any development of a pathway, data should be collected, and radiology should be consulted with in the development process so that the FTE required to deliver the service is identified and resourced.

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[41] https://www.shpa.org.au/resources/standards-of-practice-for-clinical-pharmacy-services

[42] https://www.shpa.org.au/sites/default/files/uploaded-content/website-content/SOP/sop_clinical_pharmacy_s32-s34_chapter9.pdf

[43] https://www.ficm.ac.uk/sites/default/files/gpics-v2.pdf

- Consider access to radiology services closer to the critical care units. This could include future co-location of CT scanners with critical care.

Pharmacy

- Review resourcing for pharmacy services (i.e., meeting local or international ratios) and integrate into the multi-disciplinary team
- Implement best practice informatics, in particular e-prescribing and administration, which should be interconnected and integrated with care delivery
- Consider appropriate standardisation between the adult critical care units, to facilitate efficiency and resilience of staffing, e.g., for cross-cover.

Laboratory services

- Review resourcing for laboratory services and adjust as required (i.e., meeting care needs, delivering training consistently, and maintaining quality assurance)
- Develop access to high quality point of care testing for critical care units
- Identify space and ability to train workforce and meet accreditation requirements consistently.

Clinical engineering / IT

- Standardise equipment across the organisation where possible to decrease the cost of maintaining equipment through rest-of-life
- Improve wireless network capability across the organisation
- Build identification of physical space needs into the process of procurement of equipment, i.e., equipment which produces a lot of heat should identify air conditioning needs to manage this.

4. Care for higher acuity patients

Hospital inpatient services are challenged in managing patients of higher acuity

ACH and Starship inpatient services manage a wide spectrum of patient needs. In most instances the appropriate care pathway for patients at ACH and Starship is documented and clear including for patients who should be admitted to critical care. However, there is a group of patients where there is ambiguity about the most appropriate setting of care. These patients tend to have greater care requirements than the 'average' inpatient, and require additional and timely medical and nursing input.

The DHB recognises that better defining appropriate care pathways for this group of patients is critical for ensuring optimal patient care, both for particular patients and for others in their care setting, and for the workforce to be supported and resourced to provide the care required. If resourcing is not adequate, diverting care to a high acuity patient can make other patients on the ward more vulnerable, which can also impact on staff wellbeing.

As part of the development of the Strategy, this patient group was termed 'transitional care' patients, with 'transitional' indicating that the clinical needs for patients within the group are expected to be short, and only comprise part of their inpatient stay. It was agreed that a key principle of caring for these transitional care patients is that care should follow the patient wherever possible - as opposed to moving the patient to a specific care setting (e.g., from the ward to HDU). A second principle was also agreed:

> "transitional care patients should be identified in a timely manner from Level 2 (ED and the Clinical Decision Unit) / PACU / on the ward and be evaluated by a senior clinician from the admitting / home team, in consultation with senior nursing staff. Input from the PAR team and /or critical care should also be sought if required. This is to confirm the patient is appropriate for transitional care, and to develop a clear management plan, including goals of care and actions to take if the patient deteriorates. This decision will consider patient and ward context factors, including resourcing and availability of after-hours staff. Patients will be revaluated to ensure that they continue to be appropriate for transitional care if their condition changes, or at least 12-hourly."

The main challenge for the wards to deliver care for transitional patients is prioritisation of resources to care settings where 'transitional' patients are, in the context of patient needs in the setting. While the nursing workforce is a key component of this resource, medical, allied health, and non-regulated workforce resource also contributes. The expected benefit of addressing this challenge includes improved patient care in 'transitional care' areas, and patient flow as an intermediate care level actively provides for patients between HDU and general ward level care. This may assist with reducing exit block for HDU, which in turn allows inflow to occur, potentially also reducing the cancellation of surgeries.

To understand the extent of the 'gap' between general ward care and HDU-level care at Auckland DHB, a stocktake of existing services for 'higher acuity' patients was undertaken, and stakeholders were engaged to discuss issues with existing arrangements.

Medical services

Through engagement with stakeholders, two clear medical transitional care patient types were identified:

- The acute deteriorating patient on the ward - who may code and be attended by the PAR team and/or critical care registrars or consultants
- The Level 2 patient who has a high EWS and is unstable and is under observation on Level 2 for a prolonged period (e.g., 3 or more hours).

The following areas were engaged with:

- Level 2
- General Medicine Medical Observation Unit (Ward 65)
- Neurology Progressive Care Unit (Ward 81)
- Coronary Care Unit (Ward 34)
- Hyper-Acute Stroke Unit
- Motutapu Ward.

Of these areas, Level 2 services and the Medical Observation Unit (MOU) were identified as the most challenging areas for managing transitional care patients.

For the MOU, patient demand is unpredictable which makes it hard to sustain the arrangement, and therefore, difficult to then staff appropriately. As a result other parts of the hospital are not as willing to send their patient to the MOU and this compounds the unpredictability.

For Level 2 services, these patients are somewhat unpredictable and often require space in resus or observation areas of Level 2 for an extended period of time. It is acknowledged that this is not the most appropriate setting for the patient to be in, however, there are difficulties in getting the patient admitted to the most appropriate ward for their ongoing care.

Surgical services

Through engagement with stakeholders, two clear surgical transitional care patient types were identified:

- Post operative patients in PACU who require increased monitoring and nursing (and potentially medical) care beyond the usual post-op period
- The acute deteriorating patient on the ward - who may code and be attended by the PAR team and/or critical care registrars or consultants.

The following areas were engaged with:

- General Surgery Room 9 (Ward 76)
- ORL (Ward 74)
- Maternity Critical Care
- CTSU (Ward 42)
- Neurosurgery Progressive Care Unit (Ward 83)
- PACU Levels 4, 8 and 9.

Opportunities to better support transitional care patients in some of these areas were highlighted, e.g., more consistent medical presence in the Neurosurgery Progressive Care Unit, however, in general there were challenges with maintaining skill-mix to manage patient complexity. The possibility of running an 'Extended PACU' model was raised as a possible solution.

Transitional care arrangements

A range of possible transitional care arrangements were identified as part of the Strategy. These range from wrapping care around a patient in their ward bed, to an HDU model where patients are cared for until their care needs have decreased to an appropriate level (Figure 36).

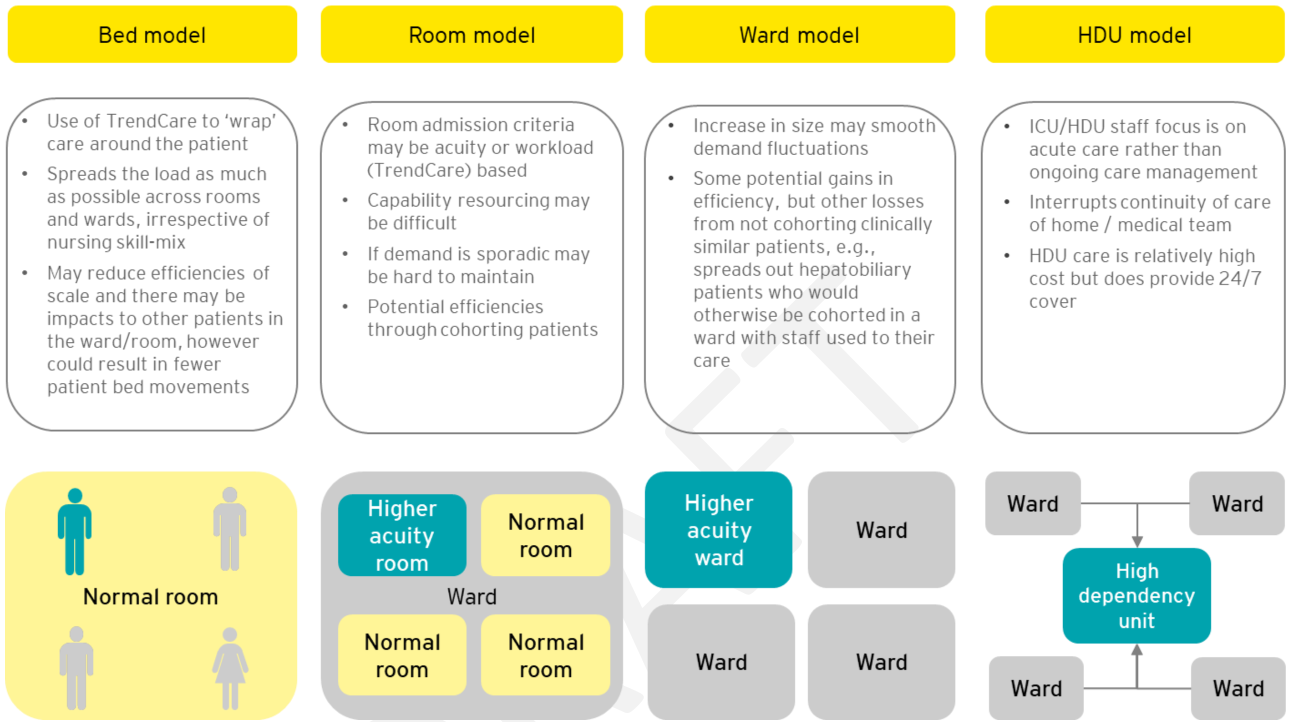

Figure 36: Conceptual framework for higher acuity care

Given the numbers of patients that may fall into the group of 'transitional care' patients, a range of feasibility factors were also identified. Central to the feasibility factors is a patient and whānau-centred approach, where any arrangement considers what would be best for them (Figure 37).

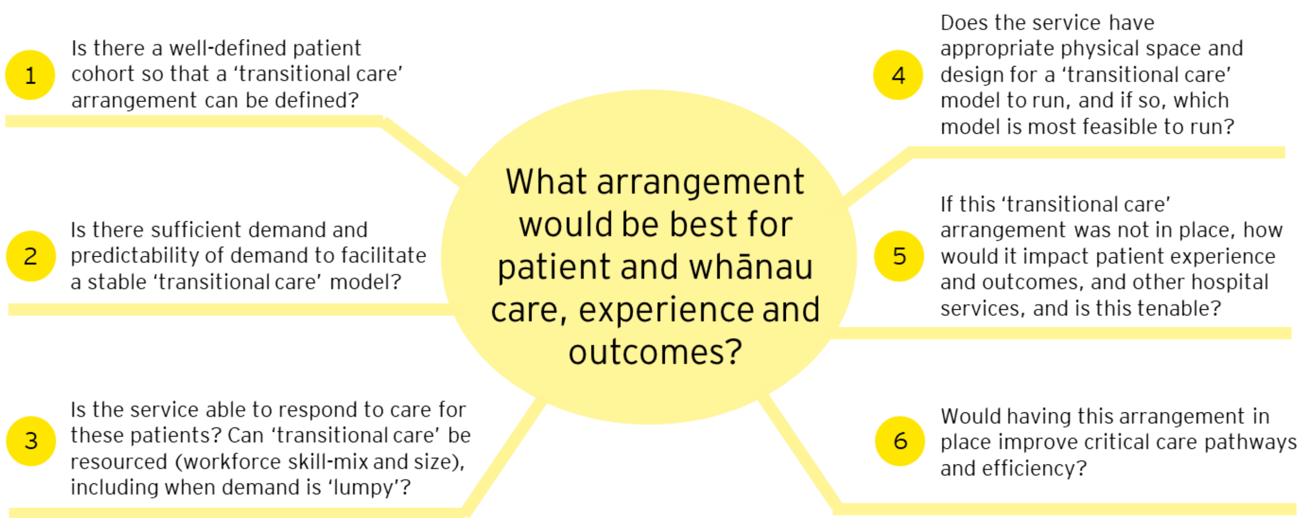

Figure 37: Feasibility framework for transitional care

Given the range of different clinical needs within the 'transitional care' group, stakeholders agreed that a range of models will be required. However, there was consensus that:

- Designated ward-based areas will allow for most efficient resourcing of care, including skill-mix
- Further expansion of HDU capacity should be considered, with clearer, standardised admission criteria to support improved patient flow from Level 2
- Nursing resource and skill-mix requirements should be developed for transitional care patients as part of CCDM, and included in FTE establishments based on an agreed care model
- An appropriate medical model should be defined including input of home teams and critical care (as required), and consideration of after-hours cover at nights and weekends
- That a Working Group is convened to develop and drive a work programme for transitional care, with appropriate connection with current programmes of work, e.g., the existing General Medicine nursing and physician review.

Supporting effective transitional care arrangements

To support effective transitional care arrangements, a range of opportunities were identified:

- Collaborating with and supporting the roll-out of TrendCare / CCDM, as it is expected to ensure that transitional care areas are appropriately resourced. It will also be important to consider:
    - that in some cases these systems need to be more sensitive to particular indications which signal high acuity needs or potential for acute deterioration, e.g., neurological conditions
    - how other professionals and non-regulated staff, e.g., allied health staff or health care assistants, could assist transitional care areas.
- Analysing patient journeys where the patients are expected to follow a predictable pathway, and from this identify the number of patients and the period of time they would be considered transitional care patients – this would identify the impacts on resourcing
- Maintaining processes with sufficient flexibility to respond to patient needs in unpredictable circumstances, e.g., transitional care patients arriving at Level 2. This includes systems to increase resourcing rapidly if required, and processes to deliver care most effectively. Examples of how this could be implemented include:
    - Pulling available nurse/s who are not familiar with the ward / patient type and assigning them low acuity patients to backfill an appropriate nurse from the ward who would be assigned the transitional patient
    - Running a flexible pool of experienced nurses that can operate across wards on an as needed basis. This could build on the PAR team, or be standalone.
- Leveraging remote monitoring of transitional care patients to reduce the burden on individual rooms or units. This could potentially be explored as a feature of the Integrated Operations Centre, which is the digitally-enabled operations 'control tower' currently being developed by the DHB. Internationally remote monitoring has been used to establish virtual care centres, such as the Mercy Virtual Care Center which delivers virtual hospitalist services to close any gaps in clinician coverage and inpatient care with the goal of reducing ED waiting times and improving patient safety and experience.

To take this forward, key actions include:

- Identifying the optimal model for Level 2 and General Medicine transitional care patients
- Establishing a Working Group for transitional care
- Designing and trialing models of care, including consideration of settings of care and medical/nursing models.