

30 October 2019

9(2)(a)

E-mail: 9(2)(a)

Dear 9(2)(a)

### Official Information Act (1982) Request

I write in response to your Official Information Act request, dated 29 October 2019. You requested the following information:

- **A copy of the multi-morbidities report, mentioned on page 027 of the below minutes.**  
[https://countiesmanukau.health.nz/assets/About-CMH/Board-and-committees/CMDHB/20191031\\_CMDHB-Agenda\\_and\\_Combined\\_papers.pdf](https://countiesmanukau.health.nz/assets/About-CMH/Board-and-committees/CMDHB/20191031_CMDHB-Agenda_and_Combined_papers.pdf)

Please find attached a copy of the Report, titled *“Complexity and Multi-Morbidity of General Medicine and Medical Subspecialties in Middlemore Hospital”*, which was presented to the October meeting of the Hospital Advisory Committee (HAC) of the Counties Manukau District Health Board.

The public agenda and papers of all Counties Manukau Board and sub-committee meetings are publicly available on our CMDHB website, prior to each meeting. Link:  
<https://countiesmanukau.health.nz/about-us/who-we-are/governance/board-and-committees/>

I trust this information satisfactorily answers your query. If you are not satisfied with this response you are entitled to seek a review of the response by the Ombudsman under section 28(3) of the Official Information Act.

Please note that this response or an edited version of this may be published on the Counties Manukau DHB website.

Yours sincerely,



Fepulea'i Margie Apa  
Chief Executive Officer  
**Counties Manukau Health**

**Counties Manukau District Health Board**  
**Hospital Advisory Committee**  
**Complexity and Multi-Morbidity of General Medicine**  
**and Medical Subspecialties in Middlemore Hospital**

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## **Recommendation**

It is recommended that the Hospital Advisory Committee:

**Receive** the attached paper.

**Note** the range of multi-morbidity indices that may provide an alternative way of measuring clinical complexity experienced by clinicians. The increase in average multi-morbidity per hospitalisation may be associated with hospital capacity constraints and high bed occupancy in Middlemore Hospital.

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**Prepared and submitted by:** Dr Wing Cheuk Chan, Public Health Physician on behalf of Dr Gary Jackson, Director of Population Health.

## **Purpose**

To use a range of multi-morbidity measures to describe inpatient complexity of general medicine and medical subspecialties across the main metro Auckland hospitals.

## **Executive Summary**

The current inpatient pricing mechanisms may not truly reflect the workload clinicians face in managing the complexity related to multi-morbidity. The increase in multi-morbidity over time has not been captured in the prices set.

A range of multi-morbidity measures including a) original Charlson, b) updated Charlson, and c) the M3 index were used to explore inpatient complexity across the main metro Auckland hospitals. General Internal Medicine patients in Middlemore Hospital have consistently higher level of multi-morbidity than patients in other acute public hospitals in the Auckland metro region. A similar pattern is also seen in across a number of medical subspecialties provided in Middlemore Hospital.

Comparing the 55 M3 index disease categories between 2009 and 2018, there has been a substantial increase in morbidity (in both relative and absolute terms) related to diabetes, renal disease, metastatic cancer and dementia among general medical patients in Middlemore Hospital. In 2018, compared to Auckland City Hospital general medical patients, Middlemore Hospital patients have higher morbidity related to diabetes, pulmonary disease, and cancer (lung, upper gastrointestinal and metastatic cancer).

Simple measures such as FTE to weighted discharge ratio and average length of stay may give misleading views on hospital efficiency and clinical workload unless increased patient complexity is taken into account. Hospital capacity constraints and high bed occupancy may be associated with increase in average multi-morbidity per hospitalisation in Middlemore Hospital.

# Complexity and Multi-morbidity of General Medicine and Medical subspecialties in Middlemore Hospital

Wing Cheuk Chan, Dean Papaconstantinou, Mildred Lee 16/09/2019

## Key Points

- The current inpatient pricing mechanisms may not truly reflect the workload clinicians face in managing the complexity related to multi-morbidity. The increase in multi-morbidity over time has not been captured in the prices set
- A range of multi-morbidity measures including original Charlson, updated Charlson and the M3 index were used to explore inpatient complexity across the main metro Auckland hospitals. General Internal Medicine patients in Middlemore Hospital have consistently higher level of multi-morbidity than patients in other acute public hospitals in the Auckland metro region. A similar pattern is also seen in across a number of medical subspecialties provided in Middlemore Hospital
- Comparing the 55 M3 index disease categories between 2009 and 2018, there has been a substantial increase in morbidity (in both relative and absolute terms) related to diabetes, renal disease, metastatic cancer and dementia among general medical patients in Middlemore Hospital. In 2018, compared to Auckland City Hospital general medical patients, Middlemore Hospital patients have higher morbidity related to diabetes, pulmonary disease, and cancer (lung, upper gastrointestinal and metastatic cancer)
- Simple measures such as FTE to weighted discharge ratio and average length of stay may give misleading views on hospital efficiency and clinical workload unless increased patient complexity is taken into account
- Hospital capacity constraints and high bed occupancy may be associated with increase in average multi-morbidities per hospitalisation in Middlemore Hospital.

## Background

Many clinicians have noted that there has been an increase in general medical patients' complexity over time in Middlemore Hospital, but standard cost weights (such as Weighted Inlier Equivalent Separations: WIES) have not consistently shown an increase in complexity over time. This paper uses a range of validated morbidity scores to describe complexity of General Medicine patients in Middlemore Hospital over time compared to other acute public hospitals located in Auckland Metro region. Trends of complexity in other medical specialities are also reviewed.

## Methods

Data is sourced from the Ministry of Health (MOH) National Minimum Dataset (NMDS) covering all publicly-funded inpatient hospital events. Speciality is recorded at the time of discharge in the NMDS. General Medicine and Emergency Medicine are defined by speciality M00 code, and M05 code respectively. Other specialities are grouped by purchase unit codes. Adult Rehabilitation & Health of Older People (ARHOP) and Psychogeriatric are also included. Casemix restrictions were applied to exclude any day cases in ambulatory settings. Inpatient stays are defined as events that are longer than three hours as per NMDS. In order to assess the impact of model of care, and differences in coding day events in the NMDS between hospitals, additional sensitivity analyses are undertaken for events with a length of stay 1 or above (events that have crossed the midnight census) for each selected speciality.

**Charlson score** is a commonly used metric of measuring co-morbidities that has been validated to predict one year and inpatient mortality.<sup>1</sup> The original version was updated in 2010.<sup>1,2</sup> Both Charlson and **updated Charlson** scores were calculated for each hospital event. Recently, a more comprehensive co-morbidity score has been developed in New Zealand called the **M3 index**.<sup>3</sup> The M3 multi-morbidity index considers the presence of 55 chronic conditions, and has been shown to have a better predictive accuracy for one year mortality compared to the Charlson score in a New Zealand setting. Weights for each index are shown in Appendix 1.

For each hospital event in General Medicine, the same disease definition of the M3 index for each individual event is applied to calculate M3 index scores, and the number of disease categories out of the possible 55 chronic conditions are counted. The results of the M3 index are presented in log hazard ratio (beta coefficient) form. It is important to note that M3 index log hazard ratios were originally derived and validated at an individual level with a 5 year look back period for hospital diagnoses, but not at the single hospital event level. Therefore, while M3 index log hazard ratios provide a systematic comparison of multi-morbidity, the M3 index log hazard ratios at the event level have not been formally validated to predict one year mortality. Unpaired T tests were used to test for statistically significant changes over time between 2009 and 2018.

Number of hospital beds, bed occupancy descriptive statistics in Middlemore Hospital is derived from each of the update of the Counties Manukau bed model.

## Results

The General Medicine department in Middlemore Hospital has highest number of discharges in the Northern region of New Zealand.

*Table 1: Number of hospitalisations by General Medicine (Speciality code M00 code) from 2009 to 2018 in selected public hospitals in Auckland Metro.*

	<b>Middlemore Hospital</b>	<b>North Shore Hospital</b>	<b>Waitakere Hospital</b>	<b>Auckland City Hospital</b>	<b>Whangarei Hospital</b>
2009	16,218	16,824	6,123	11,423	4,707
2010	17,238	17,272	6,919	10,938	5,014
2011	18,283	17,006	7,821	10,869	5,386
2012	18,288	17,626	8,544	12,072	5,098
2013	18,293	17,690	8,827	12,727	5,388
2014	19,512	18,098	9,294	12,559	5,619
2015	19,557	17,912	9,881	12,624	5,899
2016	19,096	16,890	11,433	12,682	6,411
2017	19,753	18,929	12,240	13,048	7,011
2018	19,274	18,285	12,474	14,123	6,945

*Table 2: Number of hospital discharges by Emergency Medicine Speciality (M05) speciality code from 2009 to 2018 in selected public hospitals in Auckland Metro.*

	<b>Middlemore Hospital</b>	<b>North Shore Hospital</b>	<b>Waitakere Hospital</b>	<b>Auckland City Hospital</b>	<b>Whangarei Hospital</b>
2009	12,974	8,707	4,781	17,446	4,375
2010	12,914	8,651	5,683	17,579	4,565
2011	13,243	9,168	7,284	16,245	4,464
2012	14,176	9,246	8,416	16,332	4,682
2013	14,531	10,057	8,419	17,401	4,690
2014	14,633	10,296	9,107	17,674	4,998
2015	14,914	9,493	8,422	18,648	4,944
2016	15,482	9,693	8,664	19,761	5,364
2017	15,249	9,918	8,538	20,147	5,735
2018	15,014	10,158	10,312	19,806	6,443

Auckland City Hospital had the highest number of medical sub-speciality discharges (Table 3).

*Table 3: Number of hospitalisations by Adult Medical Specialties (except General Medicine and Emergency Medicine) from 2009 to 2018 in selected public hospitals in Auckland Metro.*

	<b>Middlemore Hospital</b>	<b>North Shore Hospital</b>	<b>Waitakere Hospital</b>	<b>Auckland City Hospital</b>	<b>Whangarei Hospital</b>
2009	6,077	2,369	505	17,920	589
2010	6,746	3,163	637	18,724	590
2011	7,123	3,679	744	19,200	410
2012	7,568	4,507	733	20,288	421
2013	7,336	4,798	508	20,327	393
2014	7,247	4,977	1,152	20,094	388
2015	7,278	5,275	1,567	20,543	455
2016	7,362	5,248	1,691	21,413	651
2017	7,407	5,349	1,819	22,563	497
2018	7,316	5,712	2,102	22,562	582

Auckland City Hospital has a number of medical sub-speciality inpatient teams such as infectious disease, neurology and oncology that provide regional services for a selected group of patients. The model of care of subspecialist care provision in Middlemore and North Shore Hospitals are different from Auckland City Hospital. For example, a patient with Parkinson disease may be managed by the Neurology team in Auckland City Hospital, but the same patient with the same condition and presentation may be managed by a general medical team in Middlemore or North Shore Hospital. They may have neurologist input, but will not be formally recorded to be under the neurology speciality purchase unit. Since there are some service provision overlaps depending on the model of care, not all services provided by a subspecialty team in Auckland Hospital are necessarily tertiary services. The decrease in the number of hospitalisations by gastroenterology and haematology specialities in Middlemore Hospital since 2013 are related to changes in coding practices with day stay events regardless of complexity are coded as outpatients (and hence recorded in the NNPA data set).

Table 4: Number of hospitalisations by Adult Medical subspecialties (except General Medicine) from 2009 to 2018 in selected public hospitals in Auckland Metro.

Medical subspecialty	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
<b>M00.01 General Internal Medical Services</b>										
3214 Middlemore	16,218	17,238	18,283	18,288	18,293	19,512	19,557	19,096	19,753	19,274
3215 North Shore Hospital	16,824	17,272	17,006	17,626	17,690	18,098	17,912	16,890	18,929	18,285
3216 Waitakere Hospital	6,123	6,919	7,821	8,544	8,827	9,294	9,881	11,433	12,240	12,474
3260 Auckland City Hospital	11,423	10,938	10,869	12,072	12,727	12,559	12,624	12,682	13,048	14,123
4111 Whangarei Hospital	4,707	5,014	5,386	5,098	5,388	5,619	5,899	6,411	7,011	6,945
<b>M05 Emergency Medicine</b>										
3214 Middlemore	12,974	12,914	13,243	14,176	14,531	14,633	14,914	15,482	15,249	15,014
3215 North Shore Hospital	8,707	8,651	9,168	9,246	10,057	10,296	9,493	9,693	9,918	10,158
3216 Waitakere Hospital	4,781	5,683	7,284	8,416	8,419	9,107	8,422	8,664	8,538	10,312
3260 Auckland City Hospital	17,446	17,579	16,245	16,332	17,401	17,674	18,648	19,761	20,147	19,806
4111 Whangarei Hospital	4,375	4,565	4,464	4,682	4,690	4,998	4,944	5,364	5,735	6,443
<b>M10.01 Cardiology</b>										
3214 Middlemore	2,142	2,277	2,396	2,418	2,326	2,431	2,370	2,510	2,516	2,631
3215 North Shore Hospital	1,269	1,949	2,150	2,712	2,671	2,781	2,789	2,739	2,896	3,087
3216 Waitakere Hospital	246	258	189	90	49	453	693	688	736	907
3260 Auckland City Hospital	4,254	4,501	4,457	4,790	4,640	4,712	4,848	5,090	5,230	5,359
4111 Whangarei Hospital	0	4	46	14	13	18	16	16	9	8
<b>M15.01 Dermatology</b>										
3214 Middlemore	26	4	35	11	0	0	0	0	0	0
3215 North Shore Hospital	0	1	0	0	0	7	0	0	0	0
3216 Waitakere Hospital	0	0	0	0	0	0	0	0	0	6
3260 Auckland City Hospital	210	148	154	301	296	275	207	259	467	381
4111 Whangarei Hospital	0	0	0	0	0	0	0	0	0	0
<b>M20.01 Endocrinology &amp; Diabetic</b>										
3214 Middlemore	28	83	47	94	112	92	86	93	99	89
3215 North Shore Hospital	31	29	49	20	17	9	6		4	2
3216 Waitakere Hospital	38	70	73	81	57	77	81	69	74	86
3260 Auckland City Hospital	651	684	548	586	528	538	529	584	716	911
4111 Whangarei Hospital	0	0	0	0	0	0	0	0	0	0

<b>M24.01 Metabolic Services</b>										
3214 Middlemore	0	0	0	0	0	0	0	0	0	0
3215 North Shore Hospital	0	0	0	0	0	0	0	0	0	0
3216 Waitakere Hospital	0	0	0	0	0	0	0	0	0	0
3260 Auckland City Hospital	0	0	0	0	0	0	34	82	68	45
4111 Whangarei Hospital	0	0	0	0	0	0	0	0	0	0
<b>M25.01 Gastroenterology</b>										
3214 Middlemore	1,117	1,364	1,446	1,418	1,302	1,425	1,464	1,184	1,206	974
3215 North Shore Hospital	550	592	670	667	753	702	774	705	610	634
3216 Waitakere Hospital	106	171	252	212	98	193	186	249	193	238
3260 Auckland City Hospital	1,350	1,412	1,469	1,532	1,604	1,594	1,707	1,778	1,786	1,884
4111 Whangarei Hospital	86	21	4	3	6	7	4	5	32	38
<b>M30.01 Haematology</b>										
3214 Middlemore	584	657	694	827	818	417	444	426	406	377
3215 North Shore Hospital	402	418	323	304	376	347	473	433	436	476
3216 Waitakere Hospital	94	86	122	179	124	211	264	348	391	378
3260 Auckland City Hospital	1,390	1,377	1,450	1,349	1,332	1,321	1,416	1,477	1,581	1,474
4111 Whangarei Hospital	0	0	0	16	0	0	0	71	59	99
<b>M40.01 Infectious Diseases (incl Venereology)</b>										
3214 Middlemore	3	15	14	19	9	15	11	5	7	7
3215 North Shore Hospital	25	6	13	2	2		3	1		4
3216 Waitakere Hospital	0	0	0	0	1	0	0	0	0	1
3260 Auckland City Hospital	239	279	305	271	290	209	278	315	287	320
4111 Whangarei Hospital	0	0	0	0	0	0	0	0	0	0
<b>M45.01 Neurology</b>										
3214 Middlemore	0	0	0	0	4	0	0	0	0	0
3215 North Shore Hospital	0	0	0	0	0	0	0	0	1	0
3216 Waitakere Hospital	0	0	0	0	0	0	0	0	0	0
3260 Auckland City Hospital	1,214	1,402	1,397	1,453	1,589	1,773	1,825	1,873	2,082	1,996
4111 Whangarei Hospital	0	0	0	0	0	0	0	0	0	0
<b>M50.01 Oncology</b>										
3214 Middlemore	0	0	0	0	0	0	0	0	0	0
3215 North Shore Hospital	3	5	3	4	0	0	0	0	0	0



3216 Waitakere Hospital	0	0	0	0	0	0	0	0	0	0
3260 Auckland City Hospital	2,807	3,046	3,199	3,634	3,754	3,324	3,501	3,430	3,514	3,315
4111 Whangarei Hospital	1	1	6	38	22	17	26	106	36	33
<b>M60.01 Renal Medicine</b>										
3214 Middlemore	1,320	1,398	1,506	1,625	1,595	1,714	1,697	1,620	1,496	1,690
3215 North Shore Hospital	18	59	344	659	818	942	1,031	1,131	1,202	1,312
3216 Waitakere Hospital	9	40	90	147	141	165	227	179	140	132
3260 Auckland City Hospital	2,513	2,426	2,313	1,934	2,051	2,179	2,092	2,295	2,208	2,320
4111 Whangarei Hospital	501	564	354	350	352	346	409	453	354	382
<b>M65.01 Respiratory</b>										
3214 Middlemore	737	800	866	1,026	1,023	1,053	1,079	1,362	1,506	1,423
3215 North Shore Hospital	57	81	82	76	62	77	54	103	107	130
3216 Waitakere Hospital	6	5	8	8	18	6	7	9	9	6
3260 Auckland City Hospital	2,057	2,107	2,527	2,768	2,649	2,576	2,556	2,514	2,830	2,829
4111 Whangarei Hospital	0	0	0	0	0	0	0	0	7	22
<b>M70.01 Rheumatology (incl Immunology)</b>										
3214 Middlemore	120	148	119	130	147	100	127	162	171	125
3215 North Shore Hospital	14	23	45	63	99	112	145	136	93	67
3216 Waitakere Hospital	6	7	10	16	20	47	109	149	276	348
3260 Auckland City Hospital	1,235	1,342	1,381	1,670	1,594	1,593	1,550	1,716	1,794	1,728
4111 Whangarei Hospital	1	0	0	0	0	0	0	0	0	0

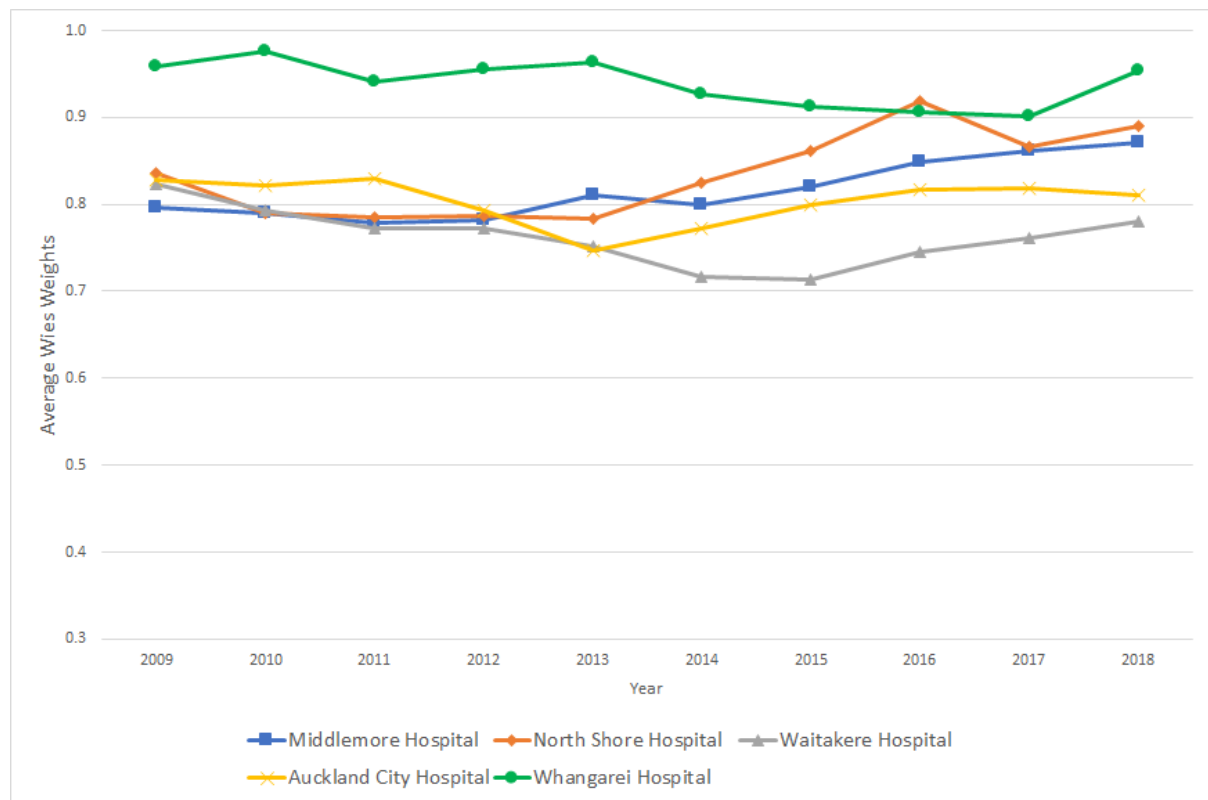
Table 5: Number of hospitalisations for Adult Rehabilitation & Health of Older People (ARHOP) and Psychogeriatric services in selected Auckland Metro hospitals from 2009 to 2018

Specialty	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
<b>ARHOP</b>										
3214 Middlemore	1,118	1,133	1,309	1,431	1,497	1,378	1,409	1,308	1,253	1,068
3215 North Shore Hospital	1,045	1,220	1,172	1,056	1,044	954	1,105	1,024	1,194	1,332
3216 Waitakere Hospital	834	717	772	694	726	718	640	631	556	650
3260 Auckland City Hospital	1,873	1,980	1,911	1,895	2,048	1,833	1,889	1,956	2,034	1,820
4111 Whangarei Hospital	331	347	381	405	303	293	261	271	258	256
<b>Psychogeriatric</b>										
3214 Middlemore	120	167	167	181	161	192	204	217	218	220
3215 North Shore Hospital	144	114	156	189	194	262	226	192	174	195
3216 Waitakere Hospital	0	0	0	8	1	0	0	0	0	0
3260 Auckland City Hospital	0	0	0	0	0	0	0	0	0	0
4111 Whangarei Hospital	0	0	0	0	0	0	0	0	0	0

### Complexity measured by WIES weights

The level of complexity of general medical patients in Middlemore Hospital has increased slightly based on the average WIES weights from 0.8 WIES per discharge in 2009 to 0.87 WIES in 2018 (Figure 1). North Shore Hospital has the highest average WIES among all the Auckland Metro Hospital for General Medicine in 2018. However, Whangarei hospital has the highest average WIES weights in the Northland region of New Zealand.

Figure 1: Average WIES weights per hospitalisation by General Medicine speciality in selected public hospitals in Northern region of New Zealand from 2009 to 2018



The average cost weights by neurology, and haematology in Auckland City Hospital has increased by 36% and 28% respectively from 2009 to 2018 (Table 6).

Table 6: Average WIES weights per hospitalisation by medical subspecialty in selected Auckland Metro hospitals from 2009 to 2018

Medical subspecialty	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% change from 09 to 18
<b>M00 General Internal Medical</b>											
3214 Middlemore	0.80	0.79	0.78	0.78	0.81	0.80	0.82	0.85	0.86	0.87	9%**
3215 North Shore Hospital	0.84	0.79	0.78	0.79	0.78	0.82	0.86	0.92	0.87	0.89	6%**
3216 Waitakere Hospital	0.82	0.79	0.77	0.77	0.75	0.72	0.71	0.74	0.76	0.78	-5%**
3260 Auckland City Hospital	0.83	0.82	0.83	0.79	0.75	0.77	0.80	0.82	0.82	0.81	-2%*
4111 Whangarei Hospital	0.96	0.98	0.94	0.96	0.96	0.93	0.91	0.91	0.90	0.95	-1%
<b>M05 Emergency Medicine</b>											
3214 Middlemore	0.32	0.33	0.31	0.30	0.30	0.31	0.31	0.30	0.30	0.30	-6%**
3215 North Shore Hospital	0.30	0.30	0.29	0.28	0.28	0.29	0.29	0.28	0.28	0.28	-7%**
3216 Waitakere Hospital	0.28	0.29	0.29	0.29	0.29	0.29	0.28	0.27	0.27	0.27	-4%*
3260 Auckland City Hospital	0.31	0.30	0.28	0.27	0.27	0.28	0.28	0.27	0.27	0.27	-13%**
4111 Whangarei Hospital	0.29	0.30	0.29	0.27	0.27	0.28	0.28	0.27	0.27	0.27	-7%**
<b>M10.01 Cardiology</b>											
3214 Middlemore	1.37	1.29	1.32	1.37	1.37	1.36	1.25	1.34	1.34	1.36	-1%
3215 North Shore Hospital	1.33	1.27	1.25	1.36	1.48	1.54	1.49	1.45	1.47	1.45	9%*
3216 Waitakere Hospital	1.07	0.90	0.88	0.88	0.74	0.83	0.82	0.85	0.86	0.84	-21%**
3260 Auckland City Hospital	1.68	1.68	1.81	1.85	1.69	1.72	1.69	1.73	1.76	1.68	0%
4111 Whangarei Hospital	-	s <sup>1</sup>	0.31	s	s	s	s	s	s	s	-
<b>M15.01 Dermatology</b>											
3214 Middlemore	0.67	s	0.75	s	-	-	-	-	-	-	-
3215 North Shore Hospital	-	s	-	-	-	s	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	s	-
3260 Auckland City Hospital	0.96	0.73	0.74	0.66	0.69	0.67	0.71	0.65	0.55	0.57	-41%**
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M20.01 Endocrinology &amp; Diabetic</b>											
3214 Middlemore	0.68	0.78	1.02	0.95	0.89	0.85	0.98	1.04	1.03	0.95	40%*
3215 North Shore Hospital	0.41	0.43	0.37	0.42	0.38	s	s	-	s	s	-
3216 Waitakere Hospital	0.36	0.43	0.34	0.32	0.28	0.34	0.36	0.38	0.46	0.49	36%**

<sup>1</sup> Averages with n=20 or under are suppressed.

3260 Auckland City Hospital	0.49	0.52	0.51	0.55	0.57	0.55	0.54	0.53	0.56	0.61	24%*
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M24.01 Metabolic Services</b>											
3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	-	-	-	-	-	-	0.78	0.90	1.47	1.07	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M25.01 Gastroenterology</b>											
3214 Middlemore	0.89	0.94	0.89	0.93	0.91	0.93	0.96	1.01	1.01	1.13	27%**
3215 North Shore Hospital	0.45	0.44	0.45	0.47	0.47	0.44	0.42	0.47	0.50	0.48	7%
3216 Waitakere Hospital	0.46	0.41	0.43	0.43	0.36	0.39	0.43	0.37	0.38	0.42	-9%
3260 Auckland City Hospital	0.98	0.99	0.91	0.90	0.92	0.90	0.85	0.80	0.95	1.00	2%
4111 Whangarei Hospital	0.79	0.58	s	s	s	s	s	s	0.52	0.76	-4%
<b>M30.01 Haematology</b>											
3214 Middlemore	0.90	0.90	0.92	0.91	0.90	1.25	1.28	1.45	1.44	1.55	72%**
3215 North Shore Hospital	0.87	0.86	0.80	1.10	1.18	1.03	1.13	1.22	1.16	1.39	60%**
3216 Waitakere Hospital	0.36	0.33	0.28	0.29	0.27	0.27	0.28	0.25	0.26	0.33	-8%
3260 Auckland City Hospital	1.73	1.76	1.62	1.83	1.86	1.88	1.96	2.04	2.01	2.14	24%**
4111 Whangarei Hospital	-	-	-	s	-	-	-	0.38	0.45	0.49	-
<b>M40.01 Infectious Diseases</b>											
3214 Middlemore	s	s	s	s	s	s	s	s	s	s	-
3215 North Shore Hospital	0.40	s	s	s	s	-	s	s	-	s	-
3216 Waitakere Hospital	-	-	-	-	s	-	-	-	-	s	-
3260 Auckland City Hospital	1.44	1.56	1.54	1.74	1.49	1.77	1.50	1.51	1.71	1.29	-10%
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M45.01 Neurology</b>											
3214 Middlemore	-	-	-	-	s	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	s	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	1.06	1.20	1.17	1.37	1.03	1.12	1.12	1.15	1.14	1.44	36%**
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M50.01 Oncology</b>											

3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-	-
3215 North Shore Hospital	s	s	s	s	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	1.01	1.00	0.95	0.92	0.87	0.95	0.86	0.86	0.87	0.88	-13%**	
4111 Whangarei Hospital	s	s	s	0.39	0.47	s	0.47	0.43	0.38	0.33	-	
<b>M60.01 Renal Medicine</b>												
3214 Middlemore	1.17	1.24	1.15	1.14	1.22	1.16	1.16	1.17	1.13	1.15	-2%	
3215 North Shore Hospital	s	0.67	1.04	1.04	1.14	1.00	1.05	0.97	0.99	0.93	-	
3216 Waitakere Hospital	s	0.27	0.37	0.46	0.43	0.33	0.24	0.21	0.22	0.23	-	
3260 Auckland City Hospital	1.33	1.37	1.46	1.47	1.44	1.50	1.61	1.50	1.53	1.44	8%	
4111 Whangarei Hospital	1.08	0.80	0.98	1.20	1.01	0.99	0.99	1.12	1.10	1.17	8%	
<b>M65.01 Respiratory</b>												
3214 Middlemore	1.36	1.36	1.43	1.31	1.28	1.33	1.41	1.49	1.24	1.41	4%	
3215 North Shore Hospital	0.52	0.58	0.48	0.54	0.57	0.71	1.24	0.53	0.57	0.51	-2%	
3216 Waitakere Hospital	s	s	s	s	s	s	s	s	s	s	-	
3260 Auckland City Hospital	1.77	1.68	1.43	1.23	1.14	1.31	1.35	1.32	1.38	1.27	-28%**	
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	s	0.66	-	
<b>M70.01 Rheumatology/ Immunology</b>												
3214 Middlemore	0.83	0.88	0.68	0.76	0.72	0.85	0.87	0.74	0.97	1.24	49%*	
3215 North Shore Hospital	s	0.45	0.44	0.40	0.45	0.43	0.41	0.40	0.45	0.59	-	
3216 Waitakere Hospital	s	s	s	s	s	0.31	0.33	0.36	0.46	0.54	-	
3260 Auckland City Hospital	0.55	0.57	0.61	0.51	0.54	0.53	0.50	0.50	0.45	0.49	-11%**	
4111 Whangarei Hospital	s	-	-	-	-	-	-	-	-	-	-	

\*\*p <.001

\*≥.001

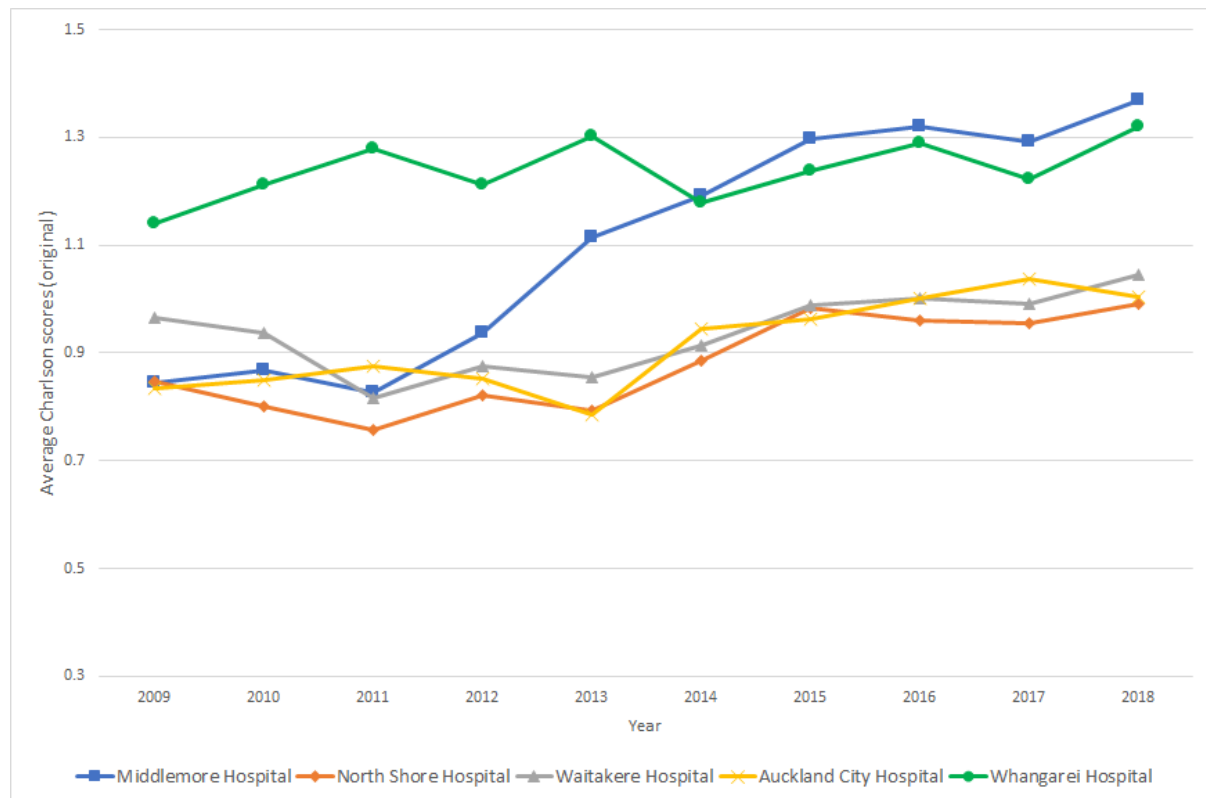
and

<0.05

## Complexity measured by Charlson scores

General Medicine patients in Middlemore Hospital had a 62% increase in average (original) Charlson score<sup>1</sup> per hospitalisation from 2009 to 2018. Unlike WIES weights, General Medicine patients in Middlemore have the highest level of complexity according to the Charlson score, rising faster than the other hospitals compared.

Figure 2: Average Charlson Score (original) per hospitalisation by General Medicine speciality in public hospitals in Northern region of New Zealand from 2009 to 2018<sup>2</sup>



## Breakdown of Charlson score categories

The increase in Charlson scores between 2009 and 2018 for General Medicine in Middlemore Hospital was related to substantial increases in diabetes and diabetes complications, renal disease, and metastatic cancer. However, there was a fall in acute myocardial infarction. Compared to Auckland City Hospital general medical patients, Middlemore patients have higher morbidity related to cancer and metastatic cancer, stroke, diabetes, paraplegia and renal and pulmonary disease.

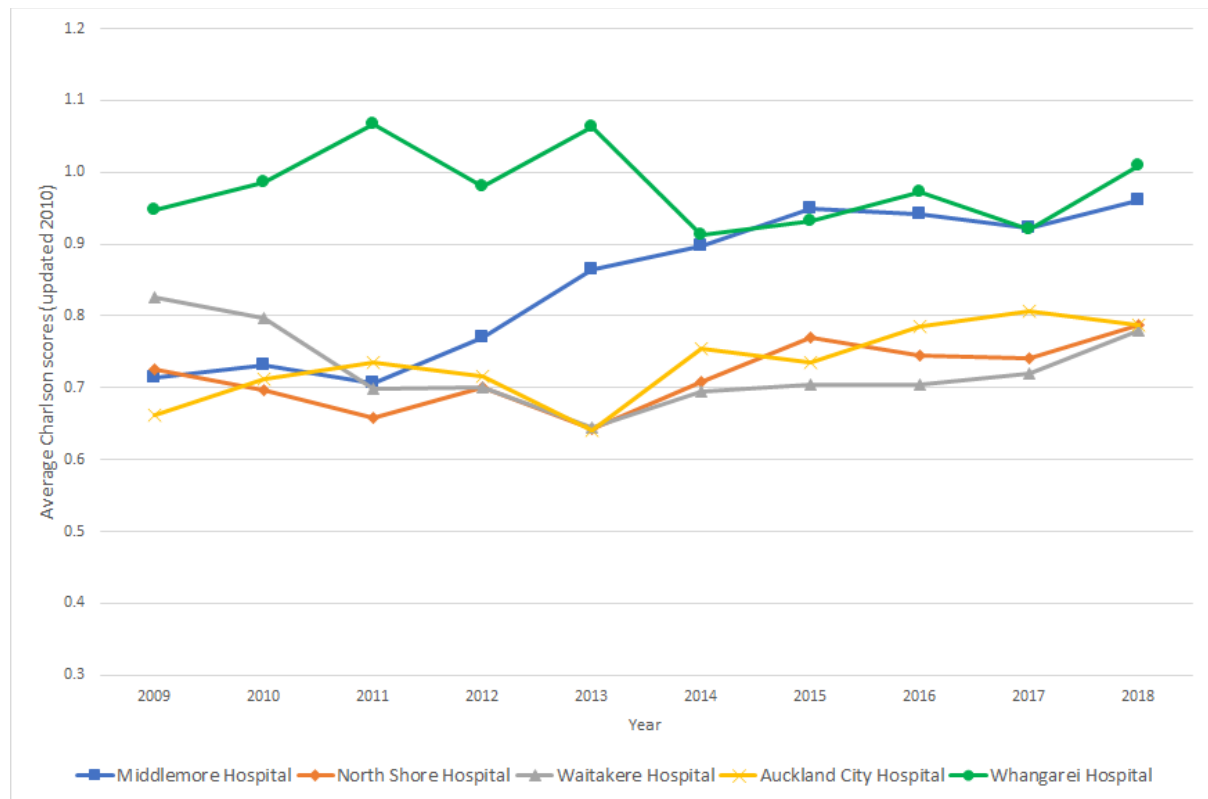
Table 7: Breakdown of Charlson scores by disease categories of General Medical patients in Middlemore Hospital over time and comparison to corresponding patients in Auckland City Hospital in 2018 (Charlson weights per 10,000 hospitalisations)

Charlson disease category	% change in Middlemore Hospital between 2009 and 2018	Absolute change in Middlemore Hospital per 10,000 events between 2009 and 2018	Absolute difference comparing Middlemore Hospital to Auckland City Hospital per 10,000 events in 2018
Acute myocardial infarction	-57%	-232	16
Cancer	25%	184	362
Cerebral vascular accident	5%	34	481
Congestive heart failure	-9%	-80	-71
Connective tissue disorder	-22%	-10	-17
Dementia	70%	79	-244
Diabetes	518%	984	363
Diabetes complications	331%	2,760	1,090
HIV	-16%	-2	8
Liver disease	71%	13	7
Metastatic cancer	40%	528	726
Peptic ulcer	-8%	-5	-1
Paraplegia	0%	-3	414
Peripheral vascular disease	76%	15	1
Pulmonary disease	-24%	-284	156
Renal disease	111%	1,241	363
Severe liver disease	62%	15	-21
Overall	62%	5,235	3,633



In 2010, the Charlson score weighting was updated.<sup>2</sup> Using the updated weights of Charlson score showed a similar pattern, with General Medical patients in Middlemore Hospital having the highest level of co-morbidities in metro Auckland. However, Whangarei Hospital has a marginally higher average updated Charlson Score per hospitalisation. The average Charlson score per hospitalisation (using the updated method) increases by 35% from 2009 to 2018 in Middlemore Hospital.

Figure 3: Average Charlson Score (updated) per hospitalisation by General Medicine speciality in selected hospitals in Northern region of New Zealand from 2009 to 2018<sup>2</sup>



Using the updated Charlson score, there has been an increase in complexity across a number of medical specialities in Middlemore Hospital from 2009 to 2018 (Table 8). However, this pattern is not seen in Auckland City Hospital. Restricting to hospital events with length of stay of 1 day or greater revealed a similar pattern, with Middlemore Hospital generally have patients with more morbidity compared to other hospitals in metro Auckland except for small volume subspecialty services such as Endocrine (n=85) and Haematology services (n=352) (see Appendix 3). General medical services in Whangarei has the highest average updated Charlson score in the Northern region. This observation may be partly related to more limited range of medical sub-specialities provided by the Whangarei Hospital.

Table 8: Average (updated) Charlson Score (updated) per hospitalisation by medical subspecialty in selected Auckland Metro hospitals from 2009 to 2018

Medical subspecialty	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% change from 09 to 18
<b>M00 General Internal Medical</b>											
3214 Middlemore	0.71	0.73	0.71	0.77	0.86	0.90	0.95	0.94	0.92	0.96	35%**
3215 North Shore Hospital	0.73	0.70	0.66	0.70	0.64	0.71	0.77	0.74	0.74	0.79	8%*
3216 Waitakere Hospital	0.83	0.80	0.70	0.70	0.64	0.69	0.70	0.71	0.72	0.78	-6%
3260 Auckland City Hospital	0.66	0.71	0.74	0.72	0.64	0.75	0.74	0.79	0.81	0.79	20%**
4111 Whangarei Hospital	0.95	0.99	1.07	0.98	1.06	0.91	0.93	0.97	0.92	1.01	6%
<b>M05 Emergency Medicine</b>											
3214 Middlemore	0.12	0.11	0.10	0.12	0.12	0.12	0.13	0.13	0.13	0.14	17%*
3215 North Shore Hospital	0.11	0.10	0.08	0.07	0.09	0.08	0.07	0.08	0.07	0.08	-27%**
3216 Waitakere Hospital	0.15	0.15	0.12	0.12	0.11	0.11	0.11	0.10	0.11	0.11	-27%**
3260 Auckland City Hospital	0.08	0.08	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	-13%*
4111 Whangarei Hospital	0.14	0.13	0.13	0.17	0.16	0.14	0.16	0.14	0.14	0.17	21%
<b>M10.01 Cardiology</b>											
3214 Middlemore	0.51	0.54	0.46	0.52	0.59	0.67	0.65	0.71	0.66	0.69	35%**
3215 North Shore Hospital	0.24	0.28	0.27	0.29	0.29	0.29	0.30	0.30	0.35	0.34	42%**
3216 Waitakere Hospital	0.39	0.39	0.29	0.48	0.33	0.47	0.46	0.50	0.57	0.54	38%*
3260 Auckland City Hospital	0.40	0.31	0.34	0.36	0.35	0.46	0.42	0.41	0.42	0.40	0%
4111 Whangarei Hospital	-	s	0.07	s	s	s	s	s	s	s	-
<b>M15.01 Dermatology</b>											
3214 Middlemore	0.04	s	0.00	s	-	-	-	-	-	-	-
3215 North Shore Hospital	-	s	-	-	-	s	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	s	-
3260 Auckland City Hospital	0.23	0.09	0.06	0.08	0.13	0.12	0.17	0.12	0.10	0.13	-43%
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M20.01 Endocrinology &amp; Diabetic</b>											
3214 Middlemore	0.29	0.40	0.43	0.49	0.46	0.63	0.81	0.82	0.37	0.65	124%*
3215 North Shore Hospital	0.81	1.00	0.69	0.85	0.59	s	s	0.00	s	s	-
3216 Waitakere Hospital	0.03	0.09	0.16	0.07	0.04	0.05	0.06	-	0.04	0.02	-33%
3260 Auckland City Hospital	0.65	0.82	0.63	0.64	0.88	0.85	0.74	0.47	0.38	0.51	-22%*
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M24.01 Metabolic Services</b>											

3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	-	-	-	-	-	-	0.18	0.10	0.18	0.29	-	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-	-
<b>M25.01 Gastroenterology</b>												
3214 Middlemore	0.93	0.93	1.08	1.31	1.44	1.22	1.41	1.17	1.04	1.23	32%*	-
3215 North Shore Hospital	0.46	0.57	0.36	0.39	0.50	0.29	0.36	0.44	0.40	0.43	-7%	-
3216 Waitakere Hospital	0.33	0.50	0.09	0.17	0.26	0.22	0.25	0.18	0.28	0.20	-39%	-
3260 Auckland City Hospital	0.72	0.54	0.48	0.58	0.37	0.40	0.37	0.31	0.23	0.27	-63%**	-
4111 Whangarei Hospital	0.73	0.76	s	s	s	s	s	s	0.25	0.58	-21%	-
<b>M30.01 Haematology</b>												
3214 Middlemore	1.40	1.17	1.26	1.12	1.15	1.64	1.52	1.75	1.57	1.39	-1%	-
3215 North Shore Hospital	1.23	1.31	1.06	1.02	1.36	1.13	1.23	1.26	1.34	1.35	10%	-
3216 Waitakere Hospital	0.61	1.22	0.69	0.36	0.52	0.38	0.07	0.09	0.20	0.16	-74%**	-
3260 Auckland City Hospital	1.86	1.83	1.72	1.61	1.65	1.48	1.44	1.39	1.41	1.32	-29%**	-
4111 Whangarei Hospital	-	-	-	s	-	-	-	1.27	1.46	1.18	-	-
<b>M40.01 Infectious Diseases</b>												
3214 Middlemore	s	s	s	s	s	s	s	s	s	s	-	-
3215 North Shore Hospital	0.44	s	s	s	s	-	s	s	-	s	-	-
3216 Waitakere Hospital	-	-	-	-	s	-	-	-	-	s	-	-
3260 Auckland City Hospital	1.38	1.16	0.96	0.84	1.11	1.16	1.06	1.08	1.08	0.89	-36%*	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-	-
<b>M45.01 Neurology</b>												
3214 Middlemore	-	-	-	-	s	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	s	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	0.29	0.43	0.52	0.46	0.52	0.52	0.53	0.54	0.65	0.68	134%**	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-	-
<b>M50.01 Oncology</b>												
3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-	-
3215 North Shore Hospital	s	s	s	s	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	6.21	5.71	5.40	4.51	4.31	4.43	4.25	4.32	4.36	4.34	-30%**	-
4111 Whangarei Hospital	s	s	s	4.42	4.45	s	4.50	1.95	3.92	4.67	-	-

<b>M60.01 Renal Medicine</b>											
3214 Middlemore	1.28	1.26	1.14	1.25	1.27	1.50	1.72	1.60	1.64	1.58	23%**
3215 North Shore Hospital	s	0.85	1.01	1.16	1.15	1.25	1.44	1.28	1.33	1.31	-
3216 Waitakere Hospital	s	0.73	0.80	1.03	1.35	1.23	1.03	1.04	1.16	0.99	-
3260 Auckland City Hospital	0.94	1.02	0.87	0.92	0.99	1.11	1.25	1.26	1.28	1.27	35%**
4111 Whangarei Hospital	1.41	1.27	1.29	1.41	1.53	1.45	1.45	1.53	1.40	1.55	10%
<b>M65.01 Respiratory</b>											
3214 Middlemore	1.86	2.12	2.04	1.74	2.06	1.90	1.88	2.17	1.88	1.97	6%
3215 North Shore Hospital	2.33	3.09	1.55	1.36	1.55	2.19	2.76	1.92	2.38	2.53	9%
3216 Waitakere Hospital	s	s	s	s	s	s	s	s	s	s	-
3260 Auckland City Hospital	1.13	1.48	0.96	0.70	0.65	0.76	0.77	0.73	0.72	0.63	-44%**
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	s	2.05	-
<b>M70.01 Rheumatology/ Immunology</b>											
3214 Middlemore	0.51	0.62	0.55	0.55	0.63	0.49	0.61	0.56	0.41	0.63	24%
3215 North Shore Hospital	s	0.39	0.76	0.73	0.58	0.57	0.79	0.75	0.56	0.49	-
3216 Waitakere Hospital	s	s	s	s	s	0.19	0.42	0.55	0.62	0.65	-
3260 Auckland City Hospital	0.10	0.11	0.12	0.09	0.10	0.11	0.11	0.10	0.12	0.06	-40%*
4111 Whangarei Hospital	s	-	-	-	-	-	-	-	-	-	-

\*\* p<.001      \*≥.001 and <0.05

Average updated Charlson scores for Adult Rehabilitation & Health of Older People in Middlemore Hospital is higher than corresponding patients in Auckland City Hospital but lower than Waitakere Hospital in 2018. While the average updated Charlson scores are relatively stable for Auckland City and Waitakere Hospital for ARHOP services, there has been an increase in morbidity since 2009 in Middlemore Hospital.

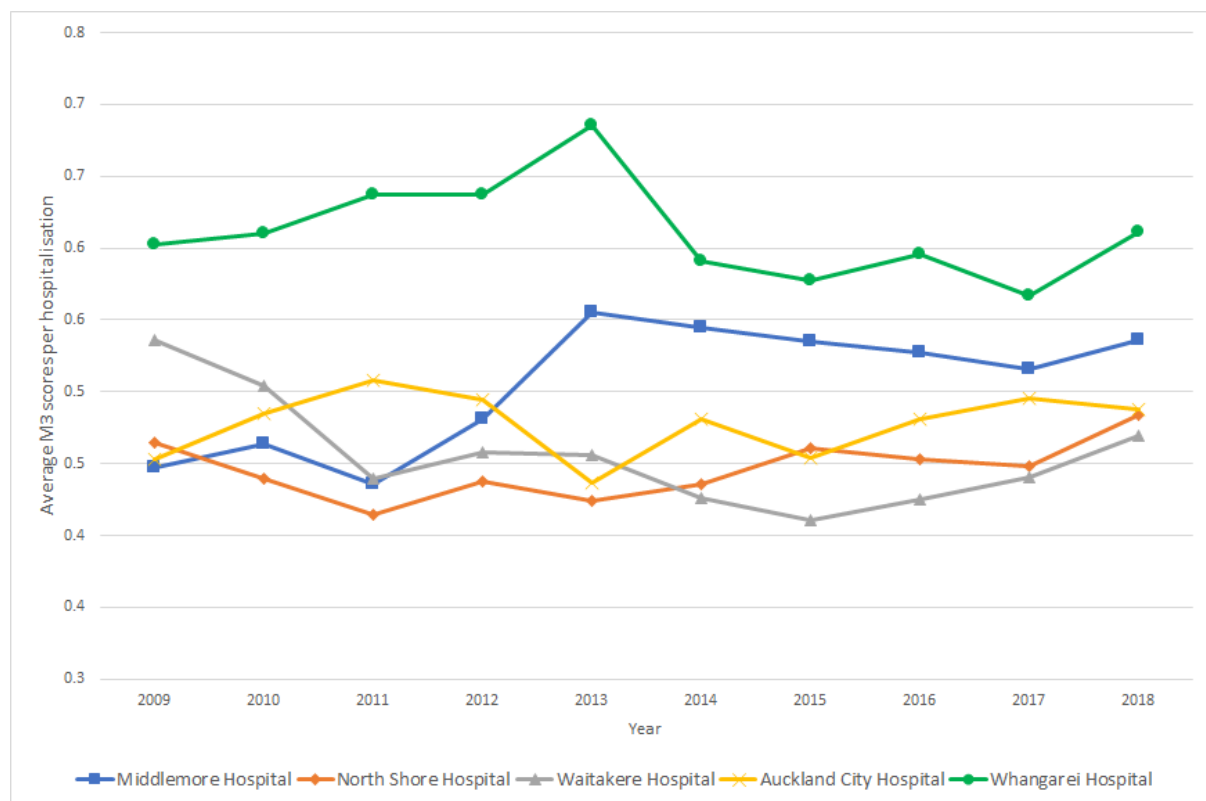
Table 9: Average (updated) Charlson Score (updated) per hospitalisation for Adult Rehabilitation & Health of Older People (ARHOP) and Psychogeriatric speciality in selected Auckland Metro hospitals from 2009 to 2018, for hospital events with length of stay 1 or greater)

Specialty	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% change from 09 to 18
<b>ARHOP</b>											
3214 Middlemore	0.96	1.07	1.07	1.25	1.12	1.22	1.15	1.08	1.00	1.14	18%*
3215 North Shore Hospital	1.11	1.06	0.88	0.92	0.77	0.89	0.89	0.88	0.96	0.84	-24%**
3216 Waitakere Hospital	1.28	1.28	1.12	1.10	0.84	1.03	1.13	1.06	1.20	1.27	-1%
3260 Auckland City Hospital	1.02	1.17	1.07	1.00	0.97	1.14	1.16	1.15	1.19	1.03	1%
4111 Whangarei Hospital	1.34	1.22	1.19	1.02	1.25	1.03	0.95	1.02	1.09	1.12	16%
<b>Psychogeriatric</b>											
3214 Middlemore	1.22	1.09	0.86	0.92	1.22	0.95	0.89	0.91	0.99	1.18	-3%
3215 North Shore Hospital	0.84	0.43	0.51	0.44	0.39	0.44	0.60	0.65	0.79	0.41	-51%**
3216 Waitakere Hospital	-	-	-	s	s	-	-	-	-	-	-
3260 Auckland City Hospital	-	-	-	-	-	-	-	-	-	-	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-

### Complexity measured by the validated New Zealand M3 multi-morbidity index

The average M3 multi-morbidity index scores per hospitalisation have increased by 20% at Middlemore Hospital from 2009 to 2018. In contrast, the M3 index score has only increased by 4.3% and 8.9% in North Shore and Auckland City Hospital respectively over the same time period. Consistent with Charlson scores, Middlemore General Medical patients have a higher level of co-morbidities relative to other hospitals in Auckland metro in 2018 (Figure 4). Consistent with WIES and updated Charlson scores, Whangarei Hospital has the highest M3 index score in the Northern region for General Medicine (Table 11).

Figure 4: Average M3 index score per hospitalisation by General Medicine speciality in selected hospitals in the Northern region of New Zealand from 2009 to 2018<sup>3</sup>



Comparing the 55 M3 index disease categories between 2009 and 2018, there has been a substantial increase in morbidity (in both relative and absolute terms) related to diabetes, renal disease, metastatic cancer and dementia among general medical patients in Middlemore Hospital. In 2018, compared to Auckland City Hospital general medical patients, Middlemore Hospital patients have higher morbidity related to diabetes, pulmonary disease, and cancer (lung, upper gastrointestinal and metastatic cancer). However, Middlemore patients have less morbidity related to dementia in absolute terms, partly because Counties Manukau DHB have a younger population structure than Auckland DHB.

Table 10: Breakdown of M3 multi-morbidity scores by disease categories of General Medical patients in Middlemore Hospital over time and comparison to corresponding patients in Auckland City Hospital in 2018. (M3 index scores per 10,000 hospitalisation)

M3 index score category	% change in Middlemore Hospital between 2009 and 2018	Absolute change in Middlemore Hospital per 10,000 events between 2009 and 2018	Absolute difference comparing Middlemore Hospital to Auckland City Hospital per 10,000 events in 2018
AIDS	40%	1	-0.5
Alcohol abuse	-9%	-6	-96.9
Anemia deficiency	82%	28	7.1
Anxiety and Behavioural disorder	-5%	-1	-10.9
Aortic and other aneurysms	74%	3	3.0
Bone disorders	-27%	-1	-3.7
Bowel disease inflammatory	-47%	-2	-0.5
Breast cancer	-10%	-2	9.3
Cardiac arrhythmia	-7%	-14	13.3
Cardiac valve	-41%	-21	0.5
Cerebrovascular disease	5%	3	46.8
Chronic pulmonary	-23%	-182	105.2
Chronic renal	110%	211	66.2
Coagulopathy and other blood	16%	12	13.9
Colorectal cancer	32%	4	5.4
Congestive heart failure	-3%	-18	-27.7
Connective tissue	-16%	-3	-5.9
Dementia	27%	58	-413.4
Diabetes complicated	122%	332	144.2
Diabetes uncomplicated	618%	225	81.7
Drug abuse	68%	7	-38.4
Endocrine disorder	7%	1	-3.0
Epilepsy	-32%	-23	17.8
Eye problem long term	-55%	-29	15.6
GI ulcer upper GI	-3%	0	-0.9
Gynaecological cancers	230%	13	5.2
Hepatitis Chronic viral	63%	46	-3.4
Hypertension uncomplicated	-27%	-33	29.8
Immune system disorder	33%	2	-7.1
Inner ear disorder	5%	0	-4.4
Joint spinal disorder	-17%	-1	-5.7
Liver disease moderate or se	-3%	-1	-9.0
Lung cancer	5%	10	122.2
Lymphomas and leukaemias	51%	11	5.5
Major psychiatric disorder	-12%	-2	-12.7

Malignant melanoma	-28%	-1	-0.2
Malnutrition nutritional	289%	33	-52.8
Mental and behavioural disorder	118%	0	0.0
Mental retardation	-28%	-9	7.7
Metabolic disorder	-52%	-2	0.4
Metastatic cancer	40%	219	298.9
Muscular peripheral nerve disease	-66%	-17	0.2
Myocardial infarction	-57%	-46	3.0
Obesity	-84%	-53	-2.9
Osteoporosis Uncomplicated	-4%	0	0.1
Other cancers	45%	31	28.1
Other neurological disorders	23%	25	24.7
Paralysis	0%	0	57.0
Peripheral vascular	-39%	-6	-14.3
Prostate cancer	18%	3	2.9
Pulmonary circulation disorder	31%	15	5.3
Sleep disorder	73%	11	10.5
Upper gastrointestinal cancer	48%	55	80.9
Urinary tract problem chronic	136%	1	0.0
Venous insufficiency	231%	4	-22.8
<b>Overall</b>	<b>20%</b>	<b>891</b>	<b>475.6</b>

Out of the medical subspecialty services provided in Middlemore Hospital, the average M3 index scores are consistently higher than the Auckland Hospital counterparts. In contrast with Auckland City Hospital, average M3 multi-morbidity index scores per hospitalisation have increased in Middlemore Hospital over the last 10 year period.



Table 11: Average M3 index score per hospitalisation by medical subspecialty in selected Auckland Metro hospitals from 2009 to 2018

Medical subspecialty	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% change from 09 to 18
<b>M00 General Internal Medical</b>											
3214 Middlemore	0.45	0.46	0.44	0.48	0.56	0.54	0.54	0.53	0.52	0.54	20%**
3215 North Shore Hospital	0.46	0.44	0.41	0.44	0.42	0.44	0.46	0.45	0.45	0.48	4%*
3216 Waitakere Hospital	0.54	0.50	0.44	0.46	0.46	0.43	0.41	0.43	0.44	0.47	-13%**
3260 Auckland City Hospital	0.45	0.48	0.51	0.49	0.44	0.48	0.45	0.48	0.50	0.49	9%**
4111 Whangarei Hospital	0.60	0.61	0.64	0.64	0.69	0.59	0.58	0.60	0.57	0.61	2%
<b>M05 Emergency Medicine</b>											
3214 Middlemore	0.11	0.10	0.10	0.12	0.13	0.12	0.12	0.12	0.11	0.11	0%
3215 North Shore Hospital	0.10	0.09	0.08	0.08	0.09	0.08	0.08	0.09	0.08	0.08	-20%**
3216 Waitakere Hospital	0.13	0.11	0.10	0.10	0.11	0.10	0.09	0.09	0.10	0.10	-23%**
3260 Auckland City Hospital	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.08	0.09	0.09	13%*
4111 Whangarei Hospital	0.11	0.10	0.10	0.13	0.13	0.13	0.12	0.11	0.11	0.12	9%
<b>M10.01 Cardiology</b>											
3214 Middlemore	0.43	0.43	0.40	0.45	0.52	0.51	0.48	0.50	0.48	0.48	12%**
3215 North Shore Hospital	0.28	0.30	0.27	0.30	0.33	0.31	0.31	0.31	0.33	0.33	18%**
3216 Waitakere Hospital	0.40	0.37	0.33	0.44	0.43	0.41	0.40	0.44	0.47	0.45	13%
3260 Auckland City Hospital	0.42	0.35	0.36	0.36	0.35	0.39	0.36	0.37	0.37	0.37	-12%**
4111 Whangarei Hospital	-	s	0.22	s	s	s	s	s	s	s	-
<b>M15.01 Dermatology</b>											
3214 Middlemore	0.10	s	0.02	s	-	-	-	-	-	-	-
3215 North Shore Hospital	-	s	-	-	-	s	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	s	-
3260 Auckland City Hospital	0.18	0.10	0.09	0.06	0.10	0.09	0.12	0.08	0.05	0.07	-61%**
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M20.01 Endocrinology &amp; Diabetic</b>											
3214 Middlemore	0.23	0.40	0.45	0.50	0.50	0.49	0.42	0.43	0.35	0.44	91%*
3215 North Shore Hospital	0.34	0.35	0.30	0.38	0.32	s	s	-	s	s	-
3216 Waitakere Hospital	0.04	0.08	0.13	0.10	0.03	0.08	0.08	0.06	0.08	0.08	100%
3260 Auckland City Hospital	0.39	0.46	0.41	0.44	0.54	0.52	0.47	0.36	0.30	0.30	-23%*
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M24.01 Metabolic Services</b>											

3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	-	-	-	-	-	-	0.28	0.17	0.24	0.18	-	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-	-
<b>M25.01 Gastroenterology</b>												
3214 Middlemore	0.61	0.58	0.59	0.77	0.82	0.74	0.82	0.72	0.65	0.72	18%*	-
3215 North Shore Hospital	0.34	0.39	0.28	0.31	0.33	0.24	0.27	0.33	0.29	0.28	-18%	-
3216 Waitakere Hospital	0.23	0.27	0.18	0.16	0.16	0.16	0.16	0.19	0.17	0.12	-48%*	-
3260 Auckland City Hospital	0.42	0.36	0.32	0.34	0.26	0.27	0.28	0.24	0.21	0.21	-50%**	-
4111 Whangarei Hospital	0.47	0.65	s	s	s	s	s	s	0.13	0.40	15%	-
<b>M30.01 Haematology</b>												
3214 Middlemore	0.93	0.83	0.91	0.87	0.86	1.11	1.08	1.16	1.10	1.02	10%&	-
3215 North Shore Hospital	0.85	0.88	0.79	0.80	0.97	0.87	0.94	0.96	0.96	1.00	18%*	-
3216 Waitakere Hospital	0.54	0.76	0.55	0.39	0.50	0.43	0.25	0.28	0.31	0.30	-44%**	-
3260 Auckland City Hospital	1.21	1.20	1.14	1.10	1.09	1.00	0.99	0.97	1.01	0.98	-19%**	-
4111 Whangarei Hospital	-	-	-	s	-	-	-	0.82	0.90	0.75	-	-
<b>M40.01 Infectious Diseases</b>												
3214 Middlemore	s	s	s	s	s	s	s	s	s	s	-	-
3215 North Shore Hospital	0.37	s	s	s	s	-	s	s	-	s	-	-
3216 Waitakere Hospital	-	-	-	-	s	-	-	-	-	s	-	-
3260 Auckland City Hospital	0.38	0.43	0.44	0.42	0.50	0.53	0.43	0.42	0.46	0.35	-8%	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-	-
<b>M45.01 Neurology</b>												
3214 Middlemore	-	-	-	-	s	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	s	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	0.40	0.46	0.48	0.46	0.45	0.46	0.47	0.44	0.48	0.47	18%**	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-	-
<b>M50.01 Oncology</b>												
3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-	-
3215 North Shore Hospital	s	s	s	s	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	2.66	2.52	2.39	2.03	1.95	2.04	1.94	2.01	2.05	2.05	-23%**	-
4111 Whangarei Hospital	s	s	s	1.95	2.14	s	1.96	1.11	1.89	1.91	-	-

<b>M60.01 Renal Medicine</b>											
3214 Middlemore	0.70	0.66	0.65	0.75	0.75	0.74	0.69	0.66	0.66	0.64	-9%*
3215 North Shore Hospital	s	0.42	0.53	0.58	0.59	0.54	0.59	0.55	0.58	0.57	-
3216 Waitakere Hospital	s	0.39	0.43	0.46	0.54	0.55	0.55	0.56	0.59	0.56	-
3260 Auckland City Hospital	0.53	0.57	0.49	0.52	0.56	0.58	0.53	0.53	0.55	0.53	0%
4111 Whangarei Hospital	0.69	0.64	0.62	0.71	0.79	0.65	0.62	0.66	0.60	0.65	-6%
<b>M65.01 Respiratory</b>											
3214 Middlemore	1.23	1.35	1.29	1.14	1.30	1.21	1.19	1.33	1.23	1.26	2%
3215 North Shore Hospital	s	1.87	1.14	1.09	1.33	1.44	1.75	1.13	1.44	1.44	-
3216 Waitakere Hospital	s	s	s	s	s	s	s	s	s	s	-
3260 Auckland City Hospital	0.89	1.06	0.77	0.68	0.66	0.69	0.69	0.68	0.66	0.62	-30%**
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	s	1.28	-
<b>M70.01 Rheumatology/ Immunology</b>											
3214 Middlemore	0.33	0.42	0.29	0.36	0.38	0.35	0.34	0.27	0.27	0.36	9%
3215 North Shore Hospital	s	0.29	0.29	0.28	0.25	0.29	0.35	0.33	0.29	0.31	-
3216 Waitakere Hospital	s	s	s	s	s	0.14	0.20	0.22	0.27	0.25	-
3260 Auckland City Hospital	0.31	0.33	0.35	0.28	0.27	0.23	0.21	0.22	0.23	0.24	-23%**
4111 Whangarei Hospital	s	-	-	-	-	-	-	-	-	-	-

Average M3 index score per hospitalisation for Adult Rehabilitation & Health of Older teams has increased by 12% in Middlemore Hospital between 2009 and 2018, compared to a fall in M3 index scores in other hospitals in metro Auckland.

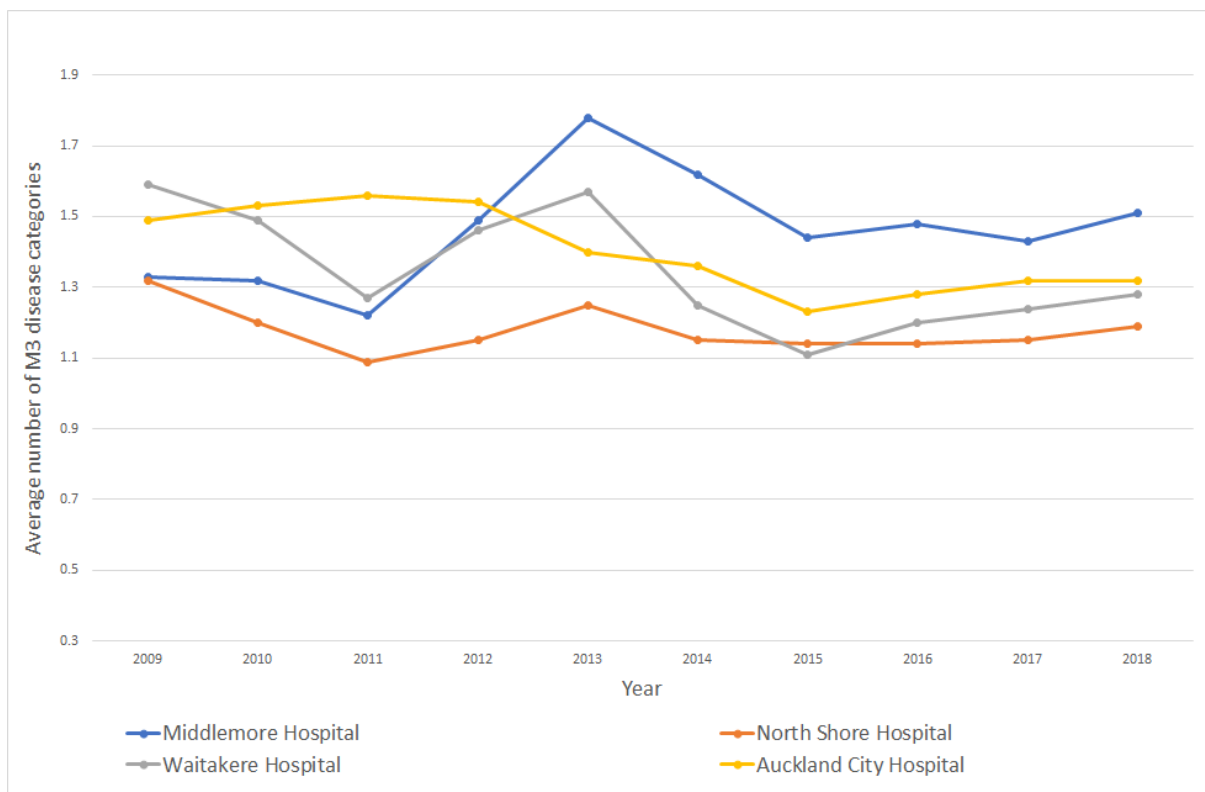
Table 12: Average M3 index score per hospitalisation for Adult Rehabilitation & Health of Older People (ARHOP) and Psychogeriatric in selected Auckland Metro hospitals from 2009 to 2018

Specialty	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% change from 09 to 18
<b>ARHOP</b>											
3214 Middlemore	0.62	0.72	0.71	0.76	0.73	0.76	0.70	0.66	0.64	0.69	12%*
3215 North Shore Hospital	0.70	0.69	0.57	0.61	0.55	0.60	0.57	0.59	0.60	0.56	-20%**
3216 Waitakere Hospital	0.87	0.79	0.70	0.72	0.62	0.67	0.69	0.66	0.70	0.73	-16%*
3260 Auckland City Hospital	0.70	0.81	0.73	0.67	0.63	0.73	0.70	0.73	0.73	0.67	-5%
4111 Whangarei Hospital	0.74	0.65	0.63	0.61	0.75	0.58	0.54	0.51	0.61	0.60	-19%*
<b>Psychogeriatric</b>											
3214 Middlemore	1.02	0.85	0.89	0.83	1.01	0.88	0.80	0.77	0.78	0.84	-18%*
3215 North Shore Hospital	0.86	0.69	0.64	0.57	0.57	0.63	0.65	0.75	0.71	0.57	-33%**
3216 Waitakere Hospital	-	-	-	s	s	-	-	-	-	-	-
3260 Auckland City Hospital	-	-	-	-	-	-	-	-	-	-	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-

Sensitivity analyses of M3 index of hospital events with a length of stay of 1 or more, show a similar pattern (see Appendix 3). The M3 index scores of internal medicine patients in Middlemore Hospital have increased by 22% from 2009 to 2018, with the highest level of multi-morbidity among the acute hospitals in Auckland Metro. After excluding all day patients, the level of multi-morbidity of gastroenterology inpatients in Middlemore are much higher than the counterparts in other acute hospital in Metro Auckland. A higher level of multi-morbidity is also seen in Respiratory patients in Middlemore Hospital compared to Auckland City Hospital. However, haematology patients in Middlemore Hospital have marginally lower multi-morbidity for inpatients with a length of stay 1 or greater.

The average number of long term condition categories of the M3 index per General Medical hospitalisation in Middlemore Hospital has increased by 14% from 2009 and 2018. This is in contrast to other hospitals in Auckland Metro, where there had been a decrease in the average number of long term condition categories of the M3 index score by 9.8% - 19.5%.

Figure 5: Average number of M3 disease categories per hospitalisation by General Medicine speciality in selected Auckland Metro hospitals from 2009 to 2018<sup>3</sup>

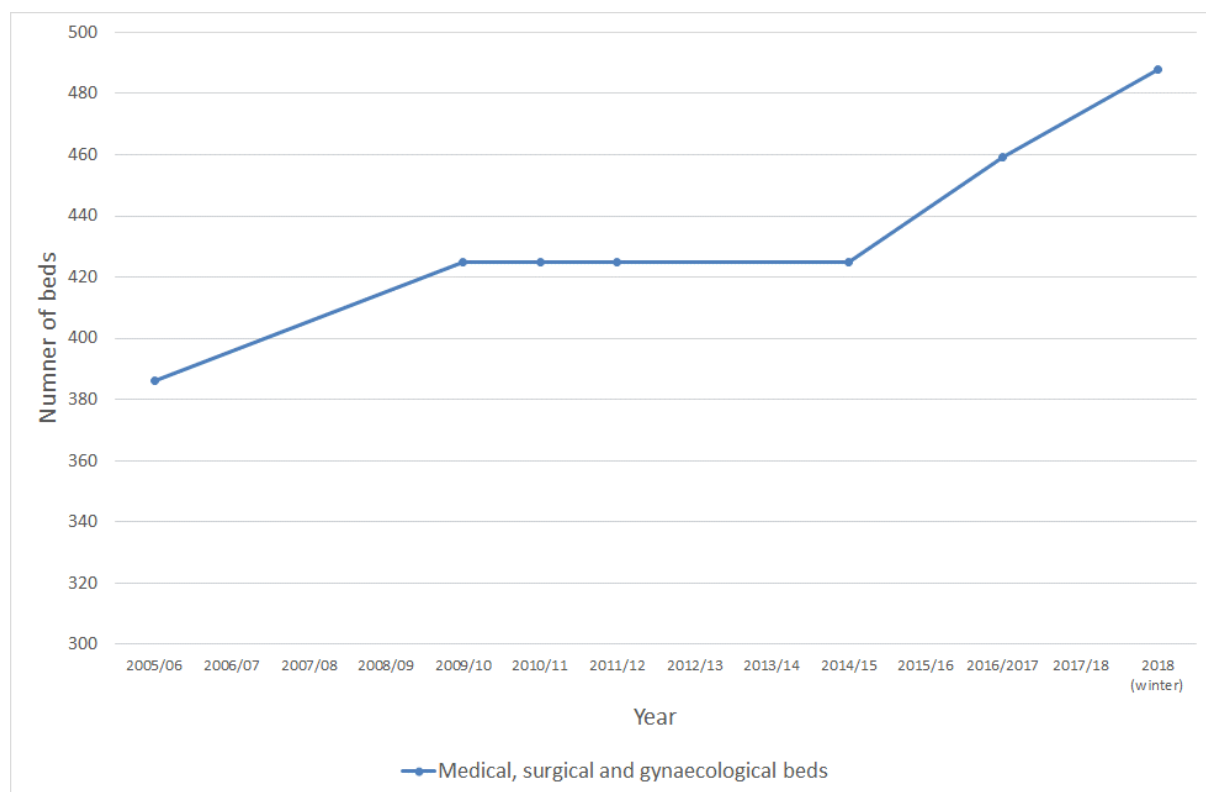


## Other contextual factors

### Hospital physical bed capacity

The lack of hospital capacity may be a potentially contributor to the increase in average hospitalisation complexity. While clinically sub-optimal, the number of beds between medical, surgical and gynaecological services are often pooled with patients outlying in another speciality service. Of note, there was no increase in the number of medical, surgical, and gynaecological physical beds from 2010/11 to 2014/15.

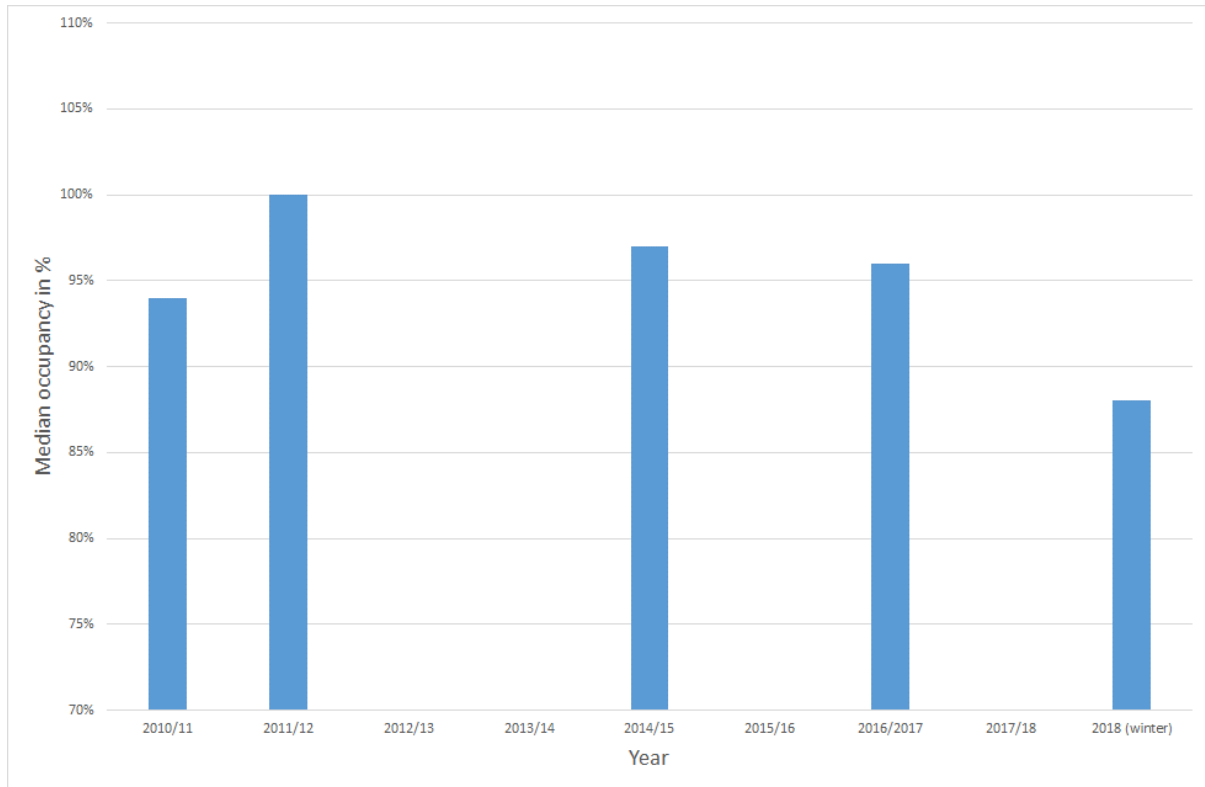
Figure 6: Number of medical, surgical and gynaecological physical beds in Middlemore Hospital from 2005/06 to 2018



## Median bed occupancy

The median bed occupancy has remained very high for general medical and medical subspecialties from 2010/11 to 2018.

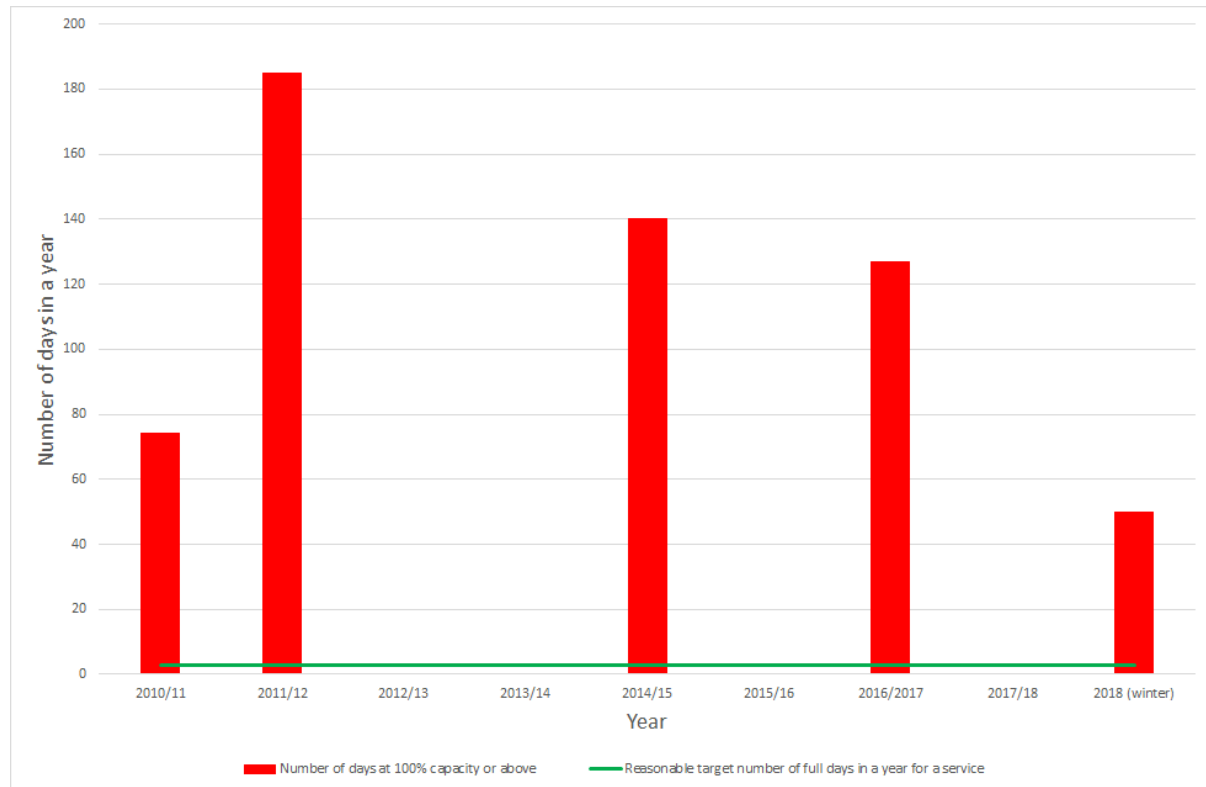
Figure 7: Median bed occupancy for general medicine and medical subspecialties in Middlemore Hospital from 2010/11 to 2018



Number of days in a year of which medical services reach 100% bed occupancy or above

The number of days in a year of which general medicine and medical subspecialties in Middlemore Hospital had reached 100% physical bed capacity or above remained consistently high at least since 2010/11. A target of 3 or less days in a year reaching full capacity or above may be reasonable goal for a service for patient safety and to limit the number of patients outlying in other speciality wards.

Figure 8: Number of days in a year of which for General Medicine and Medical subspecialties occupancy was at 100% capacity in a year or above in Middlemore Hospital.



## Discussion

A range of multi-morbidity indexes have consistently shown that general medical patients in Middlemore Hospital have the highest level of morbidities compared to other general medical patients in public hospitals in Auckland Metro. A similar pattern of increasing multi-morbidity is also seen in medical subspecialties provided by Middlemore Hospital. The level of complexity appears to have increased over the last 10 years. The finding is consistent with the recent Global Burden of Disease study demonstrating many countries such as New Zealand are experiencing expansion of morbidity.<sup>4</sup> While people are living longer in healthy life years, people are also living longer in ill health and more complex morbidity because of improvements in survival. People who are healthy living in the community are much less likely to attend hospital services. However, the people who are seen by clinicians in hospitals are more likely to have increasing morbidity because improvements in survival have been faster than reductions of morbidity. Roughly one year in three added years of life expectancy has been in ill-health.

General medicine and medical sub-specialties in Middlemore Hospital have experienced significant capacity constraints, as demonstrated by the consistently high median occupancy and high number of days in year of which 100% capacity or above was reached. For example in 2011/12, for around



half of the days in the year the bed occupancy of general medicine and the medical subspecialties was at 100% or above. The relative lack of increase in physical beds availability over the 2009/10 to 2014/15 period may be associated with increase in average multi-morbidity per hospitalisation over that period.

Both the Charlson and the M3 index are designed to examine long term conditions systematically, and are calibrated to predict inpatient or one year mortality. However, not all general medical patients have a long term condition because many patients present with a symptom requiring assessment and investigation with sinister causes to be excluded (e.g. chest pain), without a formal longer condition diagnosis being made.

The distribution of Charlson and M3 index scores are highly skewed, with average scores much higher than the median score. For example, the median M3 index disease category per hospitalisation is 1 vs the average of 1.51 in 2018. This means a significant proportion of people with high multi-morbidity raising the average relative to the median.

One of the limitations of the morbidity scores is that if more than one diagnosis is made within a disease category, this is counted as only one and has the same disease weighting towards the final score, regardless of how many diagnoses are made within the same disease category. Therefore, the level of morbidity is likely to be under-counted overall. Furthermore, none of the long term condition indices perfectly capture the severity of a condition or the costs related to a procedure. This may explain some of the discrepancies between cost weights and Charlson and M3 index. Both Charlson and M3 index are dependent on the coding for long term conditions – the quality of coding may be variable across different hospitals. This is particularly noticeable for the obesity category in the M3 list of diagnoses, where internal work at CM Health has revealed a very large shortfall in obesity coding.

Since the M3 index score examine a wider range of long term conditions it has a better sensitivity in capturing a range a wider range of diagnoses compared to the Charlson score. For example, the majority of general medical patient hospitalised in Auckland City Hospital have a Charlson score of zero. While the indices were not specifically designed to capture complexity of care per se, on face value one would expect that people at more risk of dying as an inpatient or in the year after discharge will be more complex and present more challenges in caring for them.

WIES was designed to estimate prices or cost weights, and not necessarily specifically designed to look at the morbidity of patients in terms of prognosis. Nevertheless, the difference in results between WIES and a range of multiple morbidity scores does raise the question as to whether the WIES methodology is adequately capturing the level of complexity related to comorbidity or the clinical complexity relating to a combination of morbidities. For most conditions WIES has a simple binary switch – either with or without complications. Compare that with the richness of the co-morbidity indices in capturing a large range of different diagnoses. Where those co-morbidities do start to drive higher costs and lengths of stay then they should be looked to be captured in the WIES.

Further work is planned on examining the wider population view. The current analysis is based on hospitalisation data, and so reflects the multi-morbidity for those conditions and severity where people get hospitalised. We are considering how best to combine this with data that can also reflect conditions like mental health, other long-term conditions (e.g. musculoskeletal conditions, diabetes), and disabilities where the person is less likely to be hospitalised but the condition still represents increased complexity.

## References

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2. Quan H, Li B, Couris CM, et al. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. *Am J Epidemiol* 2011; **173**(6): 676-82.
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## Appendix 1 - Speciality code mapping

### Adult medical speciality

#### *Speciality codes*

M00 General Internal Medical Services

M05 Emergency Medicine

#### *Purchase unit codes*

M10.01 Cardiology

M15.01 Dermatology

M20.01 Endocrinology & Diabetic

M24.01 Metabolic Services

M25.01 Gastroenterology

M30.01 Haematology

M40.01 Infectious Diseases (incl Venereology)

M45.01 Neurology

M50.01 Oncology

M60.01 Renal Medicine

M65.01 Respiratory

M70.01 Rheumatology (incl Immunology)

### Paediatric medical speciality

M10.05 Specialist Paediatric Cardiac

M34.01 Specialist Paediatric Haematology

M49.01 Specialist Paediatric Neurology Inpatient Services

M54.01 Specialist Paediatric Oncology

M55.01 Paediatric Medical

## Appendix 2 - Comorbidity lists and weights

Table 13: Charlson Comorbidity Index by disease variables and the corresponding weights

<b>Charlson comorbidity variable</b>	<b>Updated weight (Quan)</b>	<b>Original Charlson weight (Sundararajan)</b>
Myocardial infarction	0	1
Congestive heart failure	2	1
Peripheral vascular disease	0	1
Cerebrovascular disease	0	1
Dementia	2	1
Chronic pulmonary disease	1	1
Rheumatologic disease	1	1
Peptic ulcer disease	0	1
Mild liver disease	2	1
Diabetes without chronic complications	0	1
Diabetes with chronic complications	1	2
Hemiplegia or paraplegia	2	2
Renal disease	1	2
Any malignancy, including leukaemia and lymphoma	2	2
Moderate or severe liver disease	4	3
Metastatic solid tumour	6	3
AIDS/HIV	4	6

Table 14: M3 Index long term condition list and the corresponding log hazard ratios (beta co-efficient)

M3 Index conditions	Log Hazard ratio	M3 Index conditions	Log Hazard ratio
AIDS	0.45	Immune system disorder	0.40
Alcohol abuse	0.58	Inner ear disorder	0.06
Anaemia deficiency	0.18	Joint or spinal disorder	0.10
Anxiety and behavioural disorders	0.12	Liver disease (moderate or severe)	0.47
Aortic and other aneurysms	0.26	Lung cancer	1.97
Bone disorders	0.13	Lymphoma and leukaemia	1.19
Bowel disease inflammatory	0.09	Major psychiatric disorder	0.21
Breast cancer	0.41	Malignant melanoma	0.34
Cardiac arrhythmia	0.17	Malnutrition and other nutritional disorders	0.33
Cardiac valve	0.26	Mental and behavioural disorders due to brain damage	0.04
Cerebrovascular disease	0.10	Mental retardation	1.41
Chronic pulmonary	0.63	Metabolic disorder	0.01
Chronic renal	0.33	Metastatic cancer	2.47
Coagulopathy and other blood disorders	0.27	Muscular peripheral nerve disorders	0.21
Colorectal cancer	0.37	Myocardial infarction	0.20
Congestive heart failure	0.54	Obesity	0.25
Connective tissue disease	0.29	Osteoporosis (uncomplicated)	0.08
Dementia	1.02	Other cancers	1.10
Diabetes (complicated)	0.27	Other neurologic disorders (excluding epilepsy)	0.56
Diabetes (uncomplicated)	0.30	Paralysis	0.28
Drug abuse	0.56	Peripheral vascular disease	0.35
Endocrine disorder	0.11	Prostate cancer	0.43
Epilepsy	0.59	Pulmonary circulation disorders	0.40
Eye problem long term	0.18	Sleep disorder	0.25
Gastrointestinal ulcer or upper GI disease	0.15	Upper gastrointestinal cancer	1.94
Gynaecological cancers	0.71	Urinary tract problem (chronic)	0.05
Hepatitis, chronic viral	0.57	Venous insufficiency	0.21
Hypertension uncomplicated	0.12		

The hazard ratios of the M3 index (as applied to individuals) are presented here to allow clinicians to appreciate in a more clinically meaningful way the one year mortality hazard associated with each disease category. For example, if hazard ratio (HR) is 2, this means at any particular time within next year, twice as many people with the condition of interest had died compared to the people who did not have the condition. Metastatic cancer is associated with the highest independent hazard of one year mortality out of the 55 disease categories within the M3 index.

Table 15: M3 Index long term condition list and the corresponding hazard ratio.

<b>M3 Index conditions</b>	<b>Hazard ratio</b>	<b>M3 Index conditions</b>	<b>Hazard ratio</b>
AIDS	2.82	Immune system disorder	2.51
Alcohol abuse	3.80	Inner ear disorder	1.15
Anaemia deficiency	1.51	Joint or spinal disorder	1.26
Anxiety and behavioural disorders	1.32	Liver disease (moderate or severe)	2.95
Aortic and other aneurysms	1.82	Lung cancer	93.33
Bone disorders	1.35	Lymphoma and leukaemia	15.49
Bowel disease inflammatory	1.23	Major psychiatric disorder	1.62
Breast cancer	2.57	Malignant melanoma	2.19
Cardiac arrhythmia	1.48	Malnutrition and other nutritional disorders	2.14
Cardiac valve	1.82	Mental and behavioural disorders due to brain damage	1.10
Cerebrovascular disease	1.26	Mental retardation	25.70
Chronic pulmonary	4.27	Metabolic disorder	1.02
Chronic renal	2.14	Metastatic cancer	295.12
Coagulopathy and other blood disorders	1.86	Muscular peripheral nerve disorders	1.62
Colorectal cancer	2.34	Myocardial infarction	1.58
Congestive heart failure	3.47	Obesity	1.78
Connective tissue disease	1.95	Osteoporosis (uncomplicated)	1.20
Dementia	10.47	Other cancers	12.59
Diabetes (complicated)	1.86	Other neurologic disorders (excluding epilepsy)	3.63
Diabetes (uncomplicated)	2.00	Paralysis	1.91
Drug abuse	3.63	Peripheral vascular disease	2.24
Endocrine disorder	1.29	Prostate cancer	2.69
Epilepsy	3.89	Pulmonary circulation disorders	2.51
Eye problem long term	1.51	Sleep disorder	1.78
Gastrointestinal ulcer or upper GI disease	1.41	Upper gastrointestinal cancer	87.10
Gynaecological cancers	5.13	Urinary tract problem (chronic)	1.12
Hepatitis, chronic viral	3.72	Venous insufficiency	1.62
Hypertension uncomplicated	1.32		

## Appendix 3 –Including overnight stays only

### Updated Charlson

Table 16: Average (updated) Charlson Score (updated) per hospitalisation by medical subspecialty in selected Auckland Metro hospitals from 2009 to 2018, for hospital events with length of stay 1 or greater).

Medical subspecialty	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% change from 09 to 18
<b>M00 General Internal Medical</b>											
3214 Middlemore	0.75	0.76	0.74	0.81	0.90	0.96	1.01	0.99	0.97	1.03	37%
3215 North Shore Hospital	0.78	0.76	0.70	0.76	0.71	0.79	0.85	0.80	0.82	0.84	8%
3216 Waitakere Hospital	0.85	0.80	0.71	0.73	0.68	0.74	0.76	0.78	0.81	0.86	1%
3260 Auckland City Hospital	0.72	0.77	0.80	0.80	0.72	0.84	0.82	0.88	0.90	0.86	20%
4111 Whangarei Hospital	1.00	1.01	1.08	1.03	1.11	0.97	0.97	1.03	0.95	1.07	8%
<b>M05 Emergency Medicine</b>											
3214 Middlemore	0.13	0.12	0.11	0.13	0.15	0.12	0.12	0.14	0.14	0.14	11%
3215 North Shore Hospital	0.10	0.08	0.08	0.08	0.09	0.09	0.10	0.07	0.07	0.07	-28%
3216 Waitakere Hospital	0.18	0.19	0.14	0.15	0.14	0.12	0.12	0.10	0.12	0.13	-26%
3260 Auckland City Hospital	0.09	0.09	0.08	0.06	0.06	0.06	0.07	0.06	0.06	0.07	-23%
4111 Whangarei Hospital	0.15	0.13	0.10	0.12	0.16	0.12	0.16	0.09	0.11	0.15	-3%
<b>M10.01 Cardiology</b>											
3214 Middlemore	0.61	0.64	0.55	0.60	0.68	0.79	0.77	0.80	0.75	0.79	31%
3215 North Shore Hospital	0.35	0.38	0.39	0.41	0.36	0.36	0.38	0.38	0.44	0.42	18%
3216 Waitakere Hospital	0.42	0.41	0.30	0.48	0.29	0.47	0.47	0.50	0.58	0.55	30%
3260 Auckland City Hospital	0.50	0.39	0.44	0.44	0.43	0.58	0.53	0.50	0.53	0.51	2%
4111 Whangarei Hospital	-	-	s	-	s	s	s	s	s	s	-
<b>M15.01 Dermatology</b>											
3214 Middlemore	s	s	-	s	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	s	-
3260 Auckland City Hospital	0.38	0.19	0.13	0.12	0.27	0.19	0.16	0.25	0.25	0.22	-42%
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M20.01 Endocrinology &amp; Diabetic</b>											
3214 Middlemore	s	0.56	0.48	0.45	0.48	0.66	0.83	0.85	0.37	0.67	-
3215 North Shore Hospital	s	s	s	s	s	s	s	-	s	s	-

3216 Waitakere Hospital	s	s	s	s	s	s	s	s	s	s	-
3260 Auckland City Hospital	1.10	1.61	1.18	0.75	1.25	1.15	1.24	0.92	0.82	0.98	-11%
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M24.01 Metabolic Services</b>											
3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	-	-	-	-	-	-	0.23	0.11	0.20	0.20	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M25.01 Gastroenterology</b>											
3214 Middlemore	1.29	1.25	1.51	1.83	1.86	1.67	1.81	1.55	1.38	1.29	1%
3215 North Shore Hospital	0.77	1.03	s	0.70	1.08	0.38	0.93	0.34	0.35	0.40	-48%
3216 Waitakere Hospital	s	s	s	s	s	s	s	s	s	0.09	-
3260 Auckland City Hospital	0.91	0.73	0.66	0.89	0.56	0.60	0.61	0.49	0.50	0.54	-40%
4111 Whangarei Hospital	1.20	s	s	s	s	s	s	s	s	1.82	52%
<b>M30.01 Haematology</b>											
3214 Middlemore	1.75	1.55	1.59	1.57	1.66	1.69	1.54	1.80	1.58	1.46	-17%
3215 North Shore Hospital	1.98	2.01	1.84	1.93	1.95	1.70	1.67	1.67	1.71	1.68	-15%
3216 Waitakere Hospital	s	s	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	2.04	2.03	1.86	1.78	1.73	1.49	1.45	1.46	1.53	1.47	-28%
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	s	s	-
<b>M40.01 Infectious Diseases</b>											
3214 Middlemore	s	s	s	s	s	s	s	s	s	s	-
3215 North Shore Hospital	s	-	-	s	s	-	-	s	-	s	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	1.54	1.37	1.20	1.07	1.38	1.35	1.12	1.30	s	s	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M45.01 Neurology</b>											
3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	0.46	0.59	0.68	0.63	0.68	0.69	0.74	0.74	0.92	0.93	103%
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M50.01 Oncology</b>											
3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-



3215 North Shore Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	6.46	6.27	6.14	5.38	4.93	4.69	4.79	4.99	5.05	4.93	-24%	
4111 Whangarei Hospital	-	-	s	-	-	-	-	s	-	-	-	
<b>M60.01 Renal Medicine</b>												
3214 Middlemore	1.36	1.33	1.24	1.31	1.33	1.56	1.76	1.67	1.69	1.62	19%	
3215 North Shore Hospital	-	s	1.09	1.25	1.26	1.39	1.57	1.42	1.50	1.51	-	
3216 Waitakere Hospital	-	-	s	s	-	-	-	s	s	s	-	
3260 Auckland City Hospital	1.15	1.24	1.13	1.16	1.21	1.31	1.38	1.39	1.43	1.39	22%	
4111 Whangarei Hospital	1.59	1.42	1.35	1.50	1.65	1.52	1.54	1.64	1.50	1.62	2%	
<b>M65.01 Respiratory</b>												
3214 Middlemore	1.92	2.16	2.09	1.69	2.00	1.89	1.88	2.18	1.87	1.95	2%	
3215 North Shore Hospital	s	s	s	s	s	s	s	s	s	s	-	
3216 Waitakere Hospital	-	-	s	-	s	s	s	-	s	s	-	
3260 Auckland City Hospital	1.21	1.51	0.97	0.71	0.64	0.75	0.76	0.72	0.70	0.64	-47%	
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	8.00	-	
<b>M70.01 Rheumatology/ Immunology</b>												
3214 Middlemore	0.49	0.66	0.64	0.63	0.66	0.61	0.76	0.71	0.47	0.66	35%	
3215 North Shore Hospital	s	s	-	-	s	s	s	-	s	s	-	
3216 Waitakere Hospital	s	-	s	-	-	-	s	s	s	s	-	
3260 Auckland City Hospital	0.57	0.52	0.61	0.43	0.51	0.36	0.43	0.26	0.32	s	-	
4111 Whangarei Hospital	s	-	-	-	-	-	-	-	-	-	-	

## M3 index

Table 17: Average M3 index score per hospitalisation by medical subspecialty in selected Auckland Metro hospitals from 2009 to 2018 (for hospital events with length of stay 1 or greater).

Medical subspecialty	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% change from 09 to 18
<b>M00 General Internal Medical</b>											
3214 Middlemore	0.47	0.48	0.45	0.50	0.58	0.58	0.56	0.55	0.54	0.57	22%
3215 North Shore Hospital	0.49	0.47	0.44	0.47	0.47	0.48	0.50	0.49	0.49	0.51	4%
3216 Waitakere Hospital	0.55	0.51	0.45	0.47	0.48	0.45	0.44	0.47	0.48	0.51	-8%
3260 Auckland City Hospital	0.49	0.52	0.55	0.55	0.48	0.53	0.50	0.53	0.54	0.53	8%
4111 Whangarei Hospital	0.62	0.62	0.64	0.67	0.72	0.62	0.60	0.62	0.58	0.63	3%
<b>M05 Emergency Medicine</b>											
3214 Middlemore	0.12	0.13	0.12	0.13	0.16	0.13	0.13	0.14	0.12	0.12	0%
3215 North Shore Hospital	0.11	0.10	0.09	0.09	0.10	0.09	0.10	0.09	0.09	0.08	-27%
3216 Waitakere Hospital	0.17	0.16	0.12	0.12	0.13	0.11	0.10	0.09	0.11	0.11	-33%
3260 Auckland City Hospital	0.10	0.10	0.11	0.10	0.09	0.11	0.10	0.09	0.09	0.11	13%
4111 Whangarei Hospital	0.12	0.11	0.10	0.12	0.13	0.11	0.12	0.09	0.10	0.12	0%
<b>M10.01 Cardiology</b>											
3214 Middlemore	0.48	0.49	0.45	0.49	0.56	0.57	0.54	0.54	0.53	0.53	10%
3215 North Shore Hospital	0.37	0.38	0.37	0.39	0.39	0.36	0.37	0.37	0.40	0.40	7%
3216 Waitakere Hospital	0.42	0.38	0.34	0.45	0.42	0.41	0.41	0.44	0.47	0.45	9%
3260 Auckland City Hospital	0.50	0.42	0.42	0.42	0.40	0.45	0.41	0.42	0.43	0.43	-14%
4111 Whangarei Hospital	-	-	s	-	s	s	s	s	s	S	-
<b>M15.01 Dermatology</b>											
3214 Middlemore	s	s	0.02	s	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	0.00	-
3260 Auckland City Hospital	0.32	0.20	0.18	0.14	0.24	0.14	0.18	0.22	0.18	0.16	-50%
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M20.01 Endocrinology &amp; Diabetic</b>											
3214 Middlemore	s	0.55	0.48	0.51	0.52	0.51	0.42	0.44	0.35	0.45	-
3215 North Shore Hospital	s	s	s	s	s	s	s	-	s	s	-
3216 Waitakere Hospital	s	s	s	s	s	s	s	s	s	s	-

3260 Auckland City Hospital	0.73	0.97	0.80	0.59	0.79	0.73	0.80	0.65	0.61	0.66	-10%
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M24.01 Metabolic Services</b>											
3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	-	-	-	-	-	-	0.32	0.18	0.31	0.15	-
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M25.01 Gastroenterology</b>											
3214 Middlemore	0.79	0.74	0.77	1.02	1.06	0.98	1.02	0.92	0.83	0.77	-3%
3215 North Shore Hospital	0.57	0.59	s	0.49	0.54	0.38	0.51	0.31	0.17	0.16	-72%
3216 Waitakere Hospital	s	s	s	s	s	s	s	s	s	0.04	-
3260 Auckland City Hospital	0.56	0.48	0.43	0.52	0.38	0.39	0.46	0.39	0.36	0.38	-32%
4111 Whangarei Hospital	0.80	s	s	s	s	s	s	s	s	s	-
<b>M30.01 Haematology</b>											
3214 Middlemore	1.13	1.04	1.08	1.07	1.11	1.15	1.10	1.19	1.11	1.06	-6%
3215 North Shore Hospital	1.31	1.30	1.22	1.26	1.24	1.19	1.15	1.20	1.16	1.17	-11%
3216 Waitakere Hospital	s	s	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	1.37	1.37	1.29	1.26	1.19	1.05	1.05	1.05	1.14	1.11	-19%
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	s	s	-
<b>M40.01 Infectious Diseases</b>											
3214 Middlemore	s	s	s	s	s	s	s	s	s	s	-
3215 North Shore Hospital	s	-	-	s	s	-	-	s	-	s	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	0.43	0.46	0.47	0.48	0.55	0.61	0.46	0.48	0.49	0.35	-18%
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M45.01 Neurology</b>											
3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	-	-	-
3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	0.50	0.56	0.57	0.56	0.52	0.53	0.55	0.52	0.57	0.57	15%
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	-	-
<b>M50.01 Oncology</b>											
3214 Middlemore	-	-	-	-	-	-	-	-	-	-	-
3215 North Shore Hospital	-	-	-	-	-	-	-	-	-	-	-

3216 Waitakere Hospital	-	-	-	-	-	-	-	-	-	-	-	-
3260 Auckland City Hospital	2.81	2.80	2.76	2.46	2.27	2.21	2.26	2.37	2.43	2.41	-14%	
4111 Whangarei Hospital	-	-	s	-	-	-	-	s	-	-	-	
<b>M60.01 Renal Medicine</b>												
3214 Middlemore	0.74	0.70	0.72	0.80	0.80	0.78	0.72	0.69	0.68	0.67	-10%	
3215 North Shore Hospital	-	s	0.59	0.63	0.65	0.61	0.65	0.60	0.64	0.66		
3216 Waitakere Hospital	-	-	s	s	-	-	-	s	s	s	-	
3260 Auckland City Hospital	0.66	0.70	0.64	0.65	0.69	0.68	0.59	0.60	0.62	0.60	-9%	
4111 Whangarei Hospital	0.80	0.74	0.67	0.75	0.85	0.68	0.65	0.71	0.64	0.68	-16%	
<b>M65.01 Respiratory</b>												
3214 Middlemore	1.25	1.35	1.29	1.12	1.28	1.20	1.19	1.31	1.22	1.24	-1%	
3215 North Shore Hospital	s	s	s	s	s	s	s	s	s	s	-	
3216 Waitakere Hospital	-	-	s	-	s	s	s	-	s	s	-	
3260 Auckland City Hospital	0.93	1.08	0.78	0.69	0.66	0.70	0.69	0.68	0.66	0.63	-32%	
4111 Whangarei Hospital	-	-	-	-	-	-	-	-	-	s	-	
<b>M70.01 Rheumatology/ Immunology</b>												
3214 Middlemore	0.34	0.41	0.30	0.36	0.43	0.39	0.42	0.33	0.32	0.38	11%	
3215 North Shore Hospital	s	s	-	-	s	s	s	-	s	s	-	
3216 Waitakere Hospital	s	-	s	-	-	-	s	s	s	s	-	
3260 Auckland City Hospital	0.40	0.45	0.53	0.48	0.41	0.37	0.37	0.31	0.32	s	-	
4111 Whangarei Hospital	s	-	-	-	-	-	-	-	-	-	-	