Kupu Taurangi Hauora o Aotearoa – Health Quality & Safety Commission

AOTEAROA NEW ZEALAND

National point prevalence survey of healthcare-associated infections

Tiro whānui ā-motu mō te maimoa hauora – mate urutā

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Kupu Taurangi Hauora o Aotearoa

Contents

Ngā ihirangi

List of figures | Rārangi raraunga

List of tables | Rārangi ripanga

Acknowledgements | He mihi

We would like to acknowledge and thank those who contributed to and supported this project, including those individuals and departments that helped the survey team during the point prevalence survey district health board visits.

Abbreviations used in this report | Ngā whakapotonga

A&E	accident and emergency
ANOVA	analysis of variance
BSI	bloodstream infection
CI	confidence interval
CRO	carbapenem-resistant organism
CVC	central venous catheter
DHB	district health board
ECDC	European Centre for Disease Prevention and Control
ESBL	extended-spectrum beta-lactamase
HAI	healthcare-associated infection
IPC	infection prevention and control
IQR	interquartile range
IV	intravenous
MDRO	multidrug-resistant organism
MRSA	methicillin-resistant *Staphylococcus aureus*
OR	odds ratio
PIVC	peripheral intravenous catheter
PPS	point prevalence survey
REDCap	Research Electronic Data Capture
SSI	surgical site infection
UTI	urinary tract infection

Executive summary | He whakarāpopotonga matua

This report describes the approach to and findings of Aotearoa New Zealand's first national point prevalence survey (PPS) of healthcare-associated infections (HAIs). The infection prevention and control team of the Health Quality & Safety Commission (the Commission) led the survey, with the aim of estimating the total burden (prevalence) of HAIs among adult patients in Aotearoa New Zealand public hospitals. This information will help us identify targets for quality improvement.

Planning for the PPS began in July 2020. A team of trained surveyors then conducted the survey between February and June 2021. A total of 5,469 adult patients were included, representing 313 wards across 31 hospitals from all 20 district health boards (DHBs). The survey followed international methodology and used standard HAI definitions.

Results showed 361 patients had at least one HAI, and together had a total of 423 HAIs. The national point prevalence of HAIs was 6.6 percent and the HAI rate was 7.7 infections per 100 patients. The national rate is similar to rates reported in other countries and regions such as Wales, Switzerland and the European Union.

The following were key findings from the PPS:

- HAIs were more common in intensive care (23 percent) and surgical (8 percent) patients than in medical patients (4 percent) ($p < 0.001$).
- Four HAI types contributed 74 percent (rounded) of all HAIs: surgical site infections (SSIs) (25 percent); urinary tract infections (UTIs) (19 percent); pneumonia (18 percent); and bloodstream infections (BSIs) (13 percent).
- Of all patients in the survey, 66 percent had at least one invasive device in place. The most common types of devices were peripheral intravenous catheter (PIVC) (53 percent of all patients), central venous catheter (CVC) (10 percent) or urinary catheter (18 percent).
- Univariate analyses do not show any association between higher HAI rates and ethnicity, gender of patients or referral of patients from regional DHBs.
- Age, presence of a device and emergency admission were associated with higher HAI rates.
- *Clostridioides difficile (C. difficile)* infection was uncommon (1.7 percent).

Specific pathogens were identified in 301 of the 423 HAIs. The most common isolates were *Staphylococcus aureus* (*S. aureus*) (21 percent), *Escherichia coli* (20 percent) and *Enterococcus* species (12 percent). Of the isolates, 42 (14 percent) had antimicrobial resistance; 13 percent of *S. aureus* were methicillin-resistant *S. aureus* (MRSA) and 28 percent of enteric Gram-negative bacilli had cephalosporin or carbapenem resistance. No *Enterococcus* isolate was vancomycin resistant.

These findings will inform planning to reduce HAIs. Obvious focus areas include:

Reduce *S. aureus* infections associated with intravascular catheters

- Prevention of peripheral intravenous catheter infections
- Prevention of central venous catheter infections

Reduce SSI due to *S. aureus*

- Expand the use of the 'anti-staphylococcal' bundle across all clean surgery

Reduce all infections associated with medical devices

- Introduce care bundles for urinary catheter use
- Introduce care bundles for ventilator-associated and hospital-acquired pneumonia

Key findings | Ngā tino kitenga

Healthcare-associated infections (HAIs)

1 in 15 patients
(approximately) had an HAI

Of these:
60%
a microorganism was reported

14% were resistant organisms

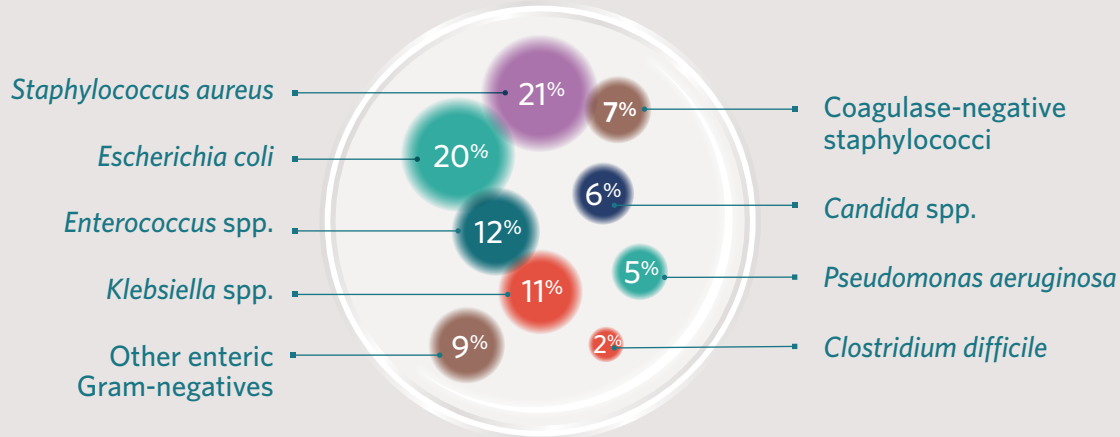
Antimicrobial usage

Approximately **1 in 3** of all patients were taking antimicrobials

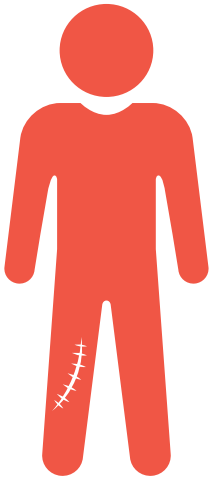
Types of HAIs

- Pneumonia/lower respiratory tract — 18%
- Urinary tract — 19%
- Surgical site — 25%
- Bloodstream — 13%
- Systemic — 4%
- Skin/soft tissue — 4%
- Other — 17%

The most frequently reported microorganisms in HAIs



Key findings – surgical site infection (SSI) | Ngā tino kitenga – mate wāhi kokoti



SSI accounted for **25% of all healthcare-associated infections**

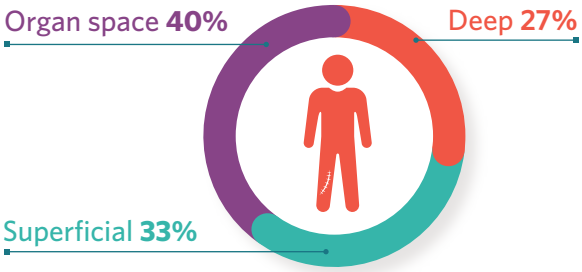
Proportion of surgical patients with an SSI

5.2% of surgical patients had an SSI (1:20)

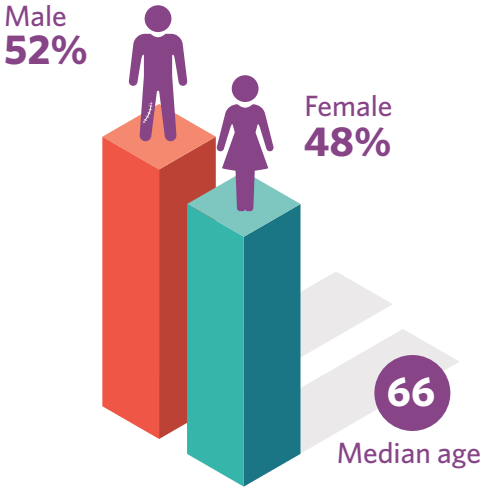
Surgical specialities

Speciality	%
General surgery	21
Orthopaedic	41
Cardiac	12
Obstetrics/gynaecology	7
Other	19

SSI type



SSI demographics



SSI causative microorganisms

Top 5	%
Staphylococcus aureus	31
Other enteric Gram-negatives	21
Escherichia coli	13
Enterococcus spp.	9
Klebsiella spp.	6

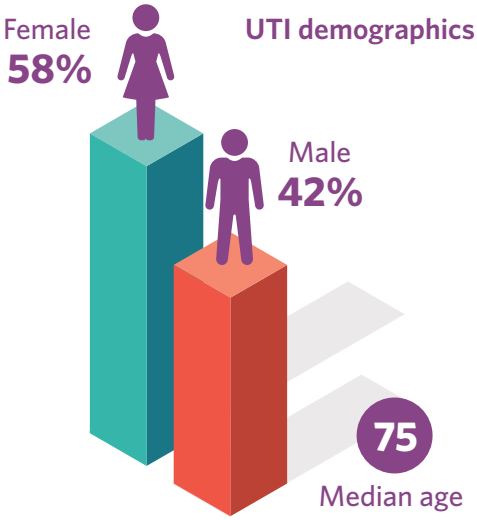
Key findings – urinary tract infection (UTI) | Ngā tino kitenga – mate roma mimi

UTI accounted for
19% of all healthcare-associated infections

UTI causative microorganisms

Top 5	%
Escherichia coli	41
Klebsiella spp.	15
Enterococcus spp.	14
Other Gram-negatives	13
Candida spp.	9

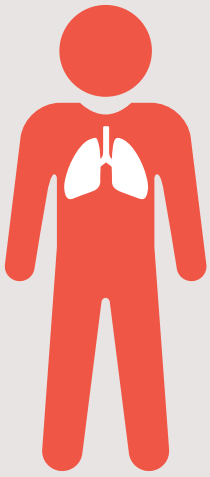
UTI demographics



Urinary catheterisation

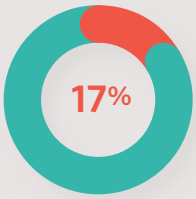
49% of patients with a UTI had a catheter in situ within 7 days before onset of infection

Key findings – pneumonia | Ngā tino kitenga – niumōnia



Proportion of pneumonia

Pneumonia accounted for **18% of all healthcare-associated infections**



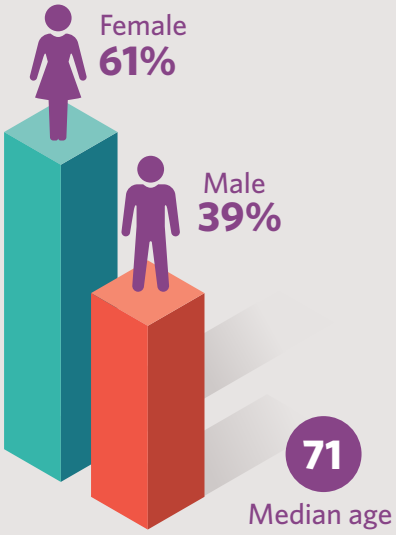
Intubation

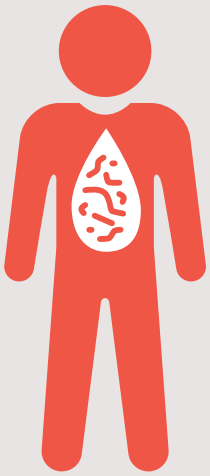
17% of patients with pneumonia were intubated within 48 hours before infection

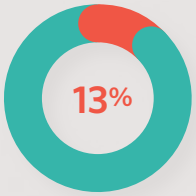
Pneumonia causative microorganisms (n = 17)

Top 3	%
Other Gram-negatives n=8	42
Staphylococcus aureus n=3	18
Klebsiella spp. n=3	18

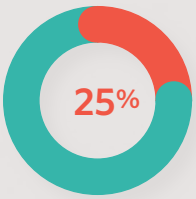
Pneumonia demographics







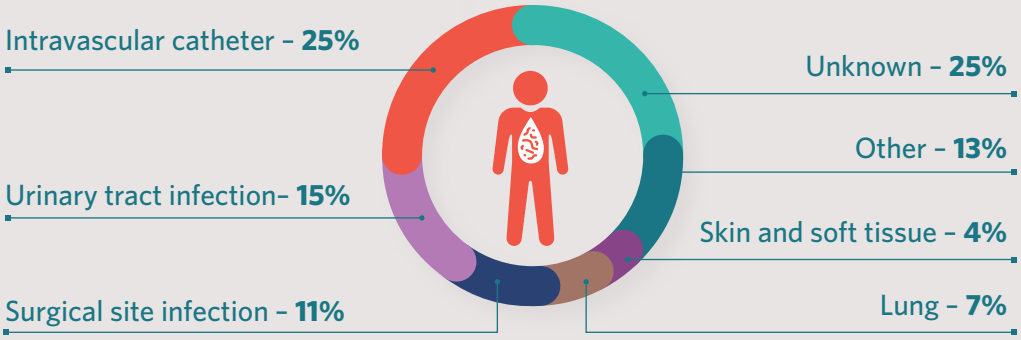
Healthcare-associated BSI accounted for **13% of all healthcare-associated infections**



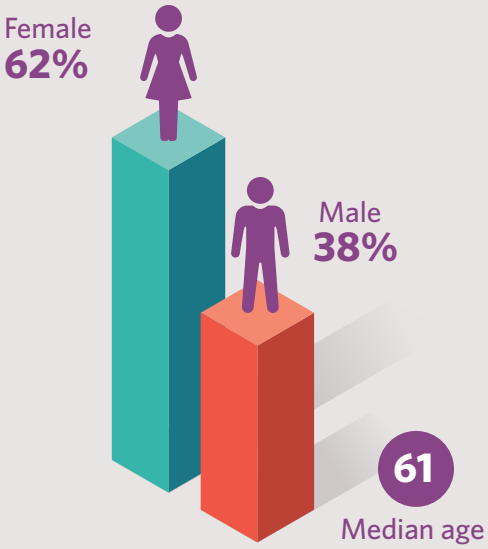
Vascular catheterisation

25% of patients with a BSI had a vascular catheter in-situ within 48 hours before infection

BSI source



BSI demographics



BSI causative microorganisms

Top 5	%
Staphylococcus aureus	25
Other enteric Gram-negatives	17
Escherichia coli	15
Enterococcus spp.	15
Klebsiella spp.	14

Patient perspectives | He kupu kōrero a ngā tūroro

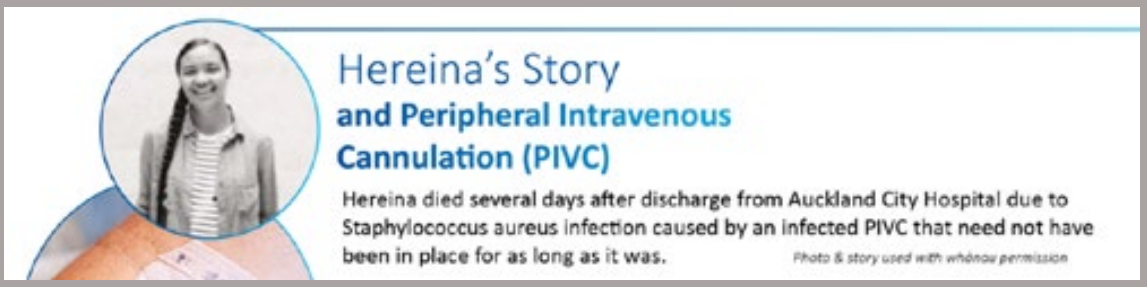
Healthcare-associated infections (HAIs) can negatively impact on the physical and mental health of patients and their whānau, resulting in a poorer quality of life. Patients with an HAI can suffer pain and anxiety, as well as being more at risk of secondary complications such as delayed wound healing or a bloodstream infection. In addition, an HAI can extend their length of stay in hospital, get them re-admitted to hospital or require multiple follow-up appointments. All of these experiences can result in significant disability, along with social, financial and emotional distress for the patient and their whānau.

It is important that we listen to our consumers and understand the effect HAIs have on their lives. The following stories and case studies provide consumer perspectives of having an HAI.

We are grateful to all those who have been generous in sharing their experience with us.

Hereina's story

Hereina Te Moana Matenga Searancke passed away on 21 January 2017 aged 20 years. She died from complications resulting from an infection associated with a peripheral intravenous catheter. Her family shared her story to help prevent other patients from getting an HAI. Hereina's story features in a poster that highlights the serious risk of morbidity and mortality associated with using peripheral intravenous cannulation. Her whānau gave their permission for us to include part of the poster here.



Hazel's story

In the video below, Hazel talks about the physical, emotional and financial impacts of having a surgical site infection following a total hip replacement. https://vimeo.com/241770442.

Case studies

The following case studies come from district health board (DHB) reports on adverse events that have resulted from HAIs. They provide a snapshot of the impact that an HAI can have on patients, including unexpected complications, longer treatment times, hospital re-admissions, unplanned surgery and intravenous antibiotics.

HAI requiring re-admissions to hospital

A 66-year-old man had an inpatient urological procedure and was discharged home two days later. He presented to hospital four days later with signs of sepsis. Three blood cultures were taken on the day of his re-admission; he was started on amoxicillin and discharged two days later. However, the blood culture grew *P. aeruginosa* so he was recalled to hospital for three days of intravenous (IV) antibiotics. He was then discharged to complete a seven-day course of antibiotics.

HAI resulting in clotting and longer treatment with IV antibiotics as an outpatient

A 66-year-old woman with a diagnosis of breast cancer had a portacath placed (implanted venous access device) to make it easier for her to have chemotherapy. Several months later, the hospital saw her as an acute patient because she had fever, swelling and pain associated with the portacath site. Blood cultures grew a methicillin-resistant *Staphylococcus aureus* (MRSA).

The planned treatment was two weeks of vancomycin given through a peripherally inserted central catheter (PICC). However, after six days of treatment she returned to hospital with fever again and further blood cultures grew MRSA. A computerised tomography (CT) scan showed a thrombus (clot) in the left internal jugular vein as well as a localised collection at the exit site of the portacath.

In total, the woman completed six weeks of intravenous (IV) antibiotic treatment with vancomycin, which the district nursing service administered daily. She also required six months of anticoagulation therapy to manage the thrombus.

HAI requiring lifelong antibiotics

A 75-year-old man was admitted for a neurosurgical procedure for a brain tumour. Five days after the operation, he developed fever and headache. Blood and cerebrospinal fluid grew *Serratia marcescens* and an organ space SSI was diagnosed. He required 21 days of intravenous antibiotics, leading him to spend one month in hospital in total. After he was discharged, he had to have lifelong oral antibiotics.

HAI requiring two additional operations

A 34-year-old man had an orthopaedic procedure on his left tibia (shinbone) at a private surgical hospital and returned two weeks later with an infected haematoma. He was admitted to the local DHB hospital for ongoing management. He grew *Staphylococcus aureus* in his blood and from pus and tissue collected in the operating theatre. He required two operations and 28 days of IV antibiotics to manage the infection. He remained on oral antibiotics for a further four months.

Introduction | He kupu whakataki

Healthcare-associated infections (HAIs) are a significant public health concern. They are associated with higher morbidity and mortality, longer hospital stays and increased health care costs.[1–4]

In the late 1990s, point prevalence surveys (PPS) in Auckland District Health Board (DHB) hospitals reported that the hospitals had a cumulative HAI incidence of 6.3 percent and an HAI prevalence of 9.5 percent.[3,5] The estimated costs of HAIs in 1999 were almost $19 million for Auckland DHB and $137 million for hospitals across the country.[3] A 2013 PPS of medical and rehabilitation patients in another public hospital found a prevalence of 5 percent and a cumulative prevalence of 10.7 percent.[6]

However, these findings from earlier PPS may not represent the current rate or distribution of HAIs. Medical care has changed over the past 20 years, including through immunosuppressive treatments, transplant programmes and greater use of medical devices. In addition, recently the Health Quality & Safety Commission (the Commission) has successfully introduced quality improvement programmes, such as the national hand hygiene and surgical site infection improvement programmes and Target CLAB Zero, with the aim of reducing HAIs.[7–10]

For these reasons, we undertook a PPS of all adults in DHB hospitals to gain updated data that can guide future choices of appropriate interventions to reduce HAIs.

Aims and objectives

The PPS used standardised methodology to gather national data on HAI prevalence. The aim was to provide reliable HAI estimates to identify priority areas for action and to inform policy for infection prevention.

The objectives of the PPS were to:

- estimate the burden (prevalence) of HAI among adult patients in public hospitals in Aotearoa New Zealand
- describe patients, invasive procedures and types of HAIs
- share results to raise awareness of infection, identify training needs and guide policies for future action
- use a standardised tool to identify national targets for quality improvement.

Ethics and privacy

This project met the requirements of a quality improvement project so ethical approval was not considered necessary. However, we submitted an 'out of scope' application to the Health and Disability Ethics Committee, which confirmed we did not need to submit the study to the Committee. We used this confirmation to reassure participating hospitals that this project had followed the appropriate approval process.

After the team completed a privacy impact assessment, the Northern Region Information Governance and Privacy Group approved it. We also gave each DHB a copy of the privacy impact assessment to review and endorse as part of the full implementation.

Project overview | Tirohanga whānui

The planning for the PPS project began in July 2020. For a diagram of the stages and key aspects of implementation, see Appendix 1.

Pilot PPS

Between September and November 2020, the PPS was piloted at Counties Manukau, Auckland, Nelson Marlborough and Lakes DHBs. Pilot visits included medical wards, surgical wards and intensive care units. The Commission's infection prevention and control (IPC) team undertook the survey with support from local IPC personnel.

Following the pilot, the team reviewed and refined the project budget, methodology and training materials.

In December 2020 the team formally invited DHBs to participate. All 20 DHBs accepted the invitation.

DHB engagement

The PPS project was promoted at meetings of the DHBs' chief executive officers, chief operating officers, chief medical officers and directors of nursing and received support from all. The PPS was also promoted to local stakeholder groups who met regularly with the Commission's project team. These groups included representation of roles in quality and risk, IPC, business intelligence, communications, wards/units and others.

Delivery of PPS

The Commission's project team managed the logistics required to organise and implement the PPS. Logistics included regular meetings with the DHB stakeholders (which totalled more than 100 hours), scheduling survey visits, arranging accommodation and transport for the surveyors, coordinating the process for uploading patient lists (.csv files) with local information technology support teams and scheduling local feedback meetings at the end of each survey.

PPS surveyor training

The PPS survey team members were three registered nurses (two with over 20 years of IPC experience) and the clinical leads for the IPC programme. Surveyors had a three-week training programme, which involved self-directed learning and face-to-face classroom work. An IPC expert experienced in adult education was contracted to develop training materials and deliver the education, which covered the PPS data collection methodology, data validation and the data collection tool. The surveyors went through competency assessments before they conducted the national PPS.

A PPS data collection manual was created to provide information and a practical guide for the surveyors.

Scheduling for DHB visits

Under the schedule, one to five members of the PPS team visited each DHB to collect data, with the number of team members depending on the size and number of hospitals. The team spent a total of 148 surveyor days on site in the hospitals.

The PPS took place from 22 February to 23 June 2021. Each DHB visit was scheduled for one to four consecutive days, depending on the number of patients to be surveyed. Scheduling of DHBs considered local requests. Small scheduling changes were made during the survey in response to the New Zealand Nurses Organisation nurses' strike and Auckland COVID-19 lockdown. An extra week was required for data collection as a result.

The PPS timing meant it avoided the usual winter peak period of respiratory illness. In addition, due to COVID-19 border restrictions and 14 days of managed isolation for returnees, the amount of circulating respiratory viruses was very low.

Methodology | Te tukanga

The PPS followed the European Centre for Disease Prevention and Control (ECDC) protocol.[11] This standardised methodology for HAI PPS has been tested extensively with reliable outcomes and administered since 2010 across 29 European Union countries. Singapore and more recently Australia have also adapted the methodology for national PPS HAI surveillance.[2,4]

The New Zealand/Australian protocol has one major difference from the ECDC protocol, in that it uses two 'trigger' criteria (fever and current antimicrobial therapy) to identify patients for HAI review. In contrast, the ECDC protocol assesses all patients as to whether they have a HAI.

Sample

The survey covered all eligible hospitals (those with more than 25 beds) within each DHB.

It included eligible patients who were on the ward or unit at 8.00 am and still present at the time of the survey.

Eligible patients were:

- inpatients aged 18 years and over
- patients in short-stay inpatient units
- postnatal patients on maternity wards
- short-stay rehabilitation patients.

Patients who were not eligible were:

- patients in day-stay units
- patients using outpatient services (including dialysis services)
- patients in neonatal intensive care units
- paediatric patients
- newborn babies in maternity services
- mental health (acute and non-acute) patients
- patients in long-term rehabilitation wards
- patients in accident and emergency (A&E) departments (except for wards attached to A&E departments where patients are admitted and monitored for more than 24 hours).

Data collection

A DHB staff member worked alongside each of the surveyors to help them access electronic records and find paper records. These staff coordinated a census conducted by local ward staff to gather data on the number and types of invasive devices present in the patients at 8.00 am on the survey day.

In total, 98 DHB staff helped with the survey. In most DHBs, the local IPC teams sourced and/or provided these staff. Clinical staff who accompanied the surveyors received a certificate in recognition of their professional development training hours.

At the end of each DHB visit, the surveyors and local stakeholders gave each other verbal feedback. Where data collection was incomplete, the Commission's surveyors project team followed up with the local IPC teams in the following weeks. The project team sent a formal interim report of the DHB's results to each DHB three weeks later.

Data entry

A secure online web-based survey tool Research Electronic Data Capture (REDCap) [12] was used for data collection. The REDCap tool included branching logics based on the ECDC HAI definitions used.[11] The REDCap PPS tool was sourced and adapted from the Australian PPS study.[13]

Surveyors entered data directly through a tablet or laptop. Each DHB provided basic patient demographics to the Commission through a secure file transfer software on the day of the survey. The Commission uploaded this data into REDCap to create a list of patients for each ward the surveyors visited on the day.

Surveyors completed data entry for each patient using their mobile device into the REDCap PPS programme through a virtual private network (VPN) connection. The VPN enabled secure data storage in a database hosted on a local server at the Commission. The mobile devices did not store any data.

Data validation and verification

An inter-rater reliability co-efficient was used to assess how consistently the PPS surveyors judged the HAI status of patients.

The survey team discussed all HAI cases at the end of each day and the project clinical leads verified them.

Data fields

In addition to hospital and ward data, patient admission details and patient demographic information, the survey teams collected information on:

- **invasive devices:**
  - peripheral vascular access present
  - central vascular access present
  - indwelling urinary catheter present
- **undergoing ventilation:**
  - invasive involving an endotracheal tube or tracheostomy
  - non-invasive, for example, continuous positive airway pressure
- **surgical history:**
  - surgery without implants within 30 days from current admission
  - surgery with implants within 90 days of current admission
- **active alert for multidrug-resistant organism (MDRO) on the national medical warning system**
- **trigger information for further investigation:**
  - receiving antimicrobial therapy excluding surgical and medical prophylaxis
  - documented fever of more than 38.0°C in the last 24 hours.

Data analysis

The Commission's health quality intelligence team undertook the data analysis. It estimated the prevalence of HAI from the proportion of patients with an HAI. Percentages and rates per 100 patients have been rounded and may not total to 100 percent. The team calculated confidence intervals (CIs) using the Wilson method for proportions and Poisson exact for rates. It calculated the funnel limits in Figure 7 using the binomial exact method with Spiegelhalter's interpolation.[14]

For some patients, information was unavailable for certain demographic and/or clinical characteristics. Patients with missing values for a given characteristic were excluded from all counts, numerators and denominators, derived statistics, tables and figures involving that particular data.

The team used two sources of ethnicity data: the survey itself and linked data from the Ministry of Health. Where the two differed and the Ministry data identified an ethnicity, the team used the Ministry data. However, if the Ministry data had no or unknown ethnicity, the team used the data from the survey.

Future reporting will include multivariable analysis of factors associated with higher HAI risk, with the aim of identifying independent risk factors for HAI.

Characteristics of survey patients | Ngā āhua o ngā tūroro

Patients by DHB

In total, the survey included 5,469 adult patients in 313 wards across 31 hospitals. Table 1 shows the total number of hospitals, wards and patients in the national survey sample.

Table 1: Number of hospitals, wards and patients surveyed by DHB

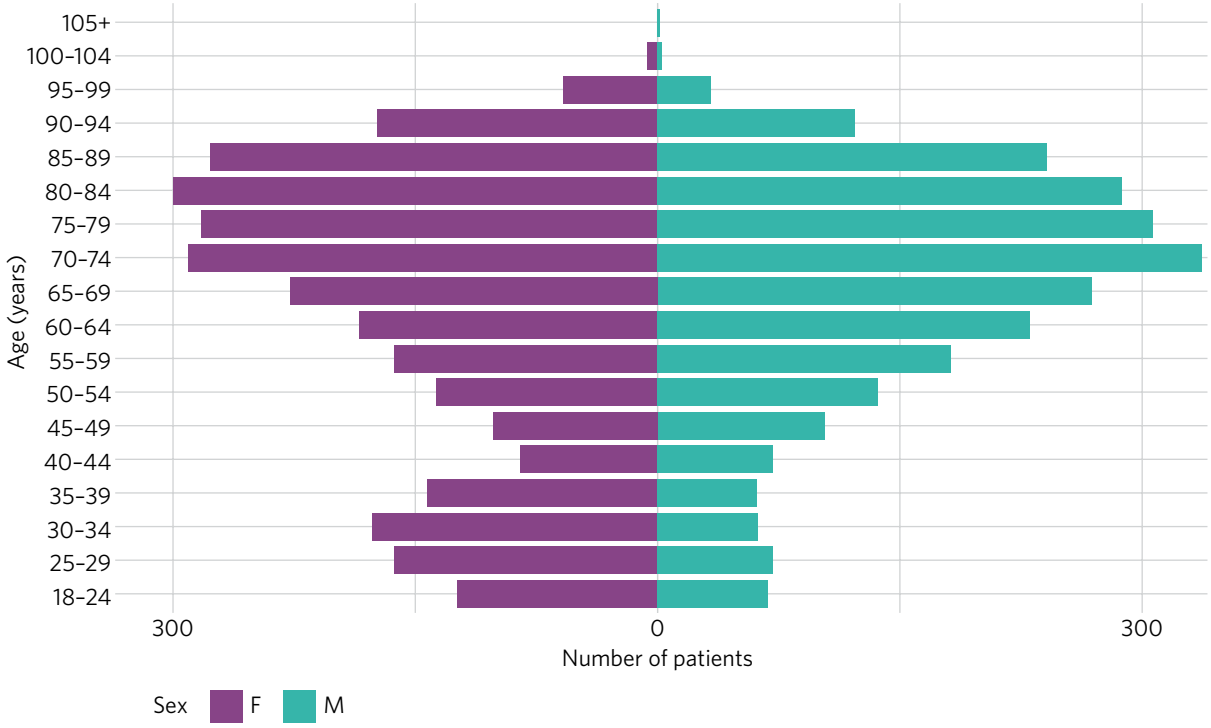
DHB	Hospitals	Wards	Patients
Auckland DHB	2	34	700
Bay of Plenty DHB	2	18	271
Canterbury DHB	3	39	661
Capital & Coast DHB	2	17	301
Counties Manukau DHB	2	32	642
Hauora Tairāwhiti	1	4	54
Hawke's Bay DHB	1	12	209
Hutt Valley DHB	1	9	167
Lakes DHB	1	7	99
MidCentral DHB	1	12	203
Northland DHB	1	11	175
Nelson Marlborough DHB	2	12	149
South Canterbury DHB	1	5	76
Southern DHB	2	20	315
Taranaki DHB	1	8	136
Waikato DHB	2	30	550
Wairarapa DHB	1	7	50
Waitematā DHB	3	28	594
West Coast DHB	1	3	31
Whanganui DHB	1	5	86
Total	**31**	**313**	**5,469**

DHB = district health board.

Patients by age, sex and ethnicity

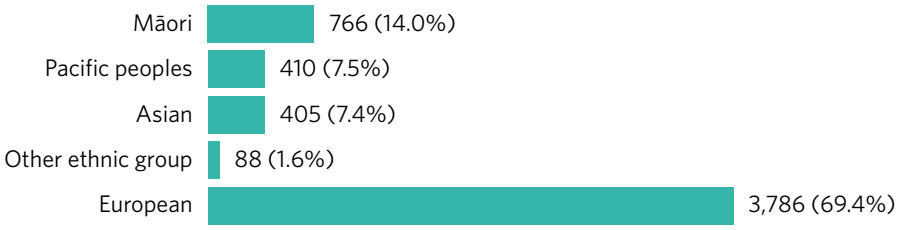
Patients had a median age of 69.9 years (interquartile range (IQR) 52.9–81.1 years) and 52.8 percent of patients (2,889) were female. Analysis of variance (ANOVA) indicated a statistically significant difference in mean age between women (63.8 years) and men (67.2 years) ($p < 0.001$).

Figure 1: Distribution of patients by age and sex



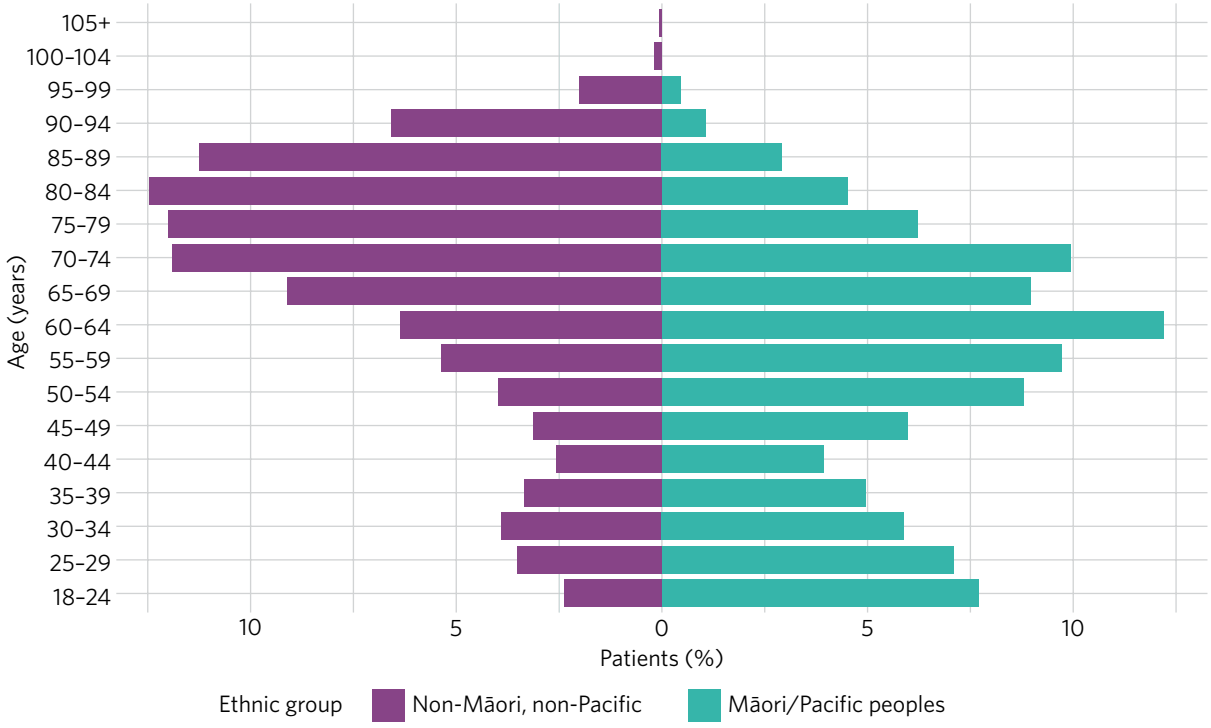
Fourteen percent of patients were Māori, 7.5 percent Pacific peoples, 7.4 percent Asian and 69.4 percent European (Figure 2). ANOVA indicated a statistically significant difference in mean age between grouped Māori and Pacific patients (55.3 years) and non-Māori, non-Pacific patients (68.2 years) ($p < 0.001$) (Figure 3).

Figure 2: Number and percentage of patients by prioritised ethnic group



Note: Denominator excludes 14 patients for whom ethnicity information was unavailable. 'Other ethnic group' includes Middle Eastern/Latin America/African (MELAA; 54 patients).

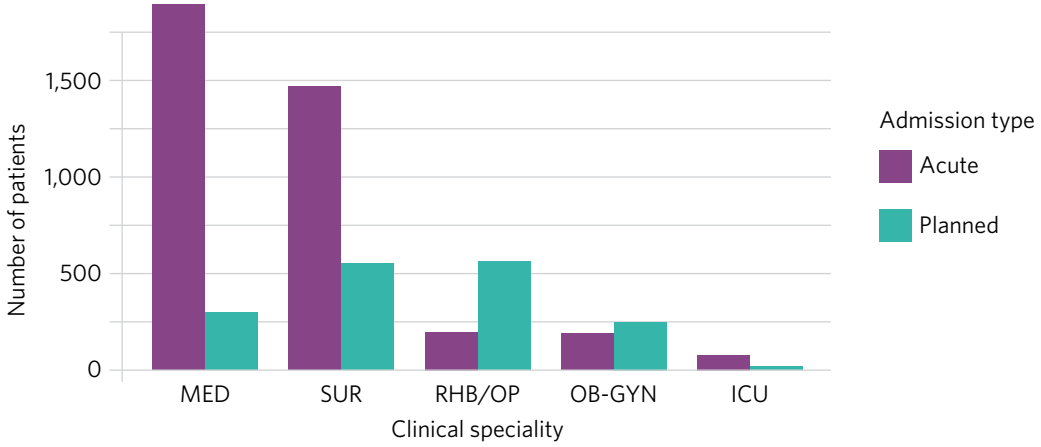
Figure 3: Distribution of patients by ethnic group and age



Patients by clinical specialty

Medical specialties provided care for 40 percent of patients (2,189); surgical specialties for 36.8 percent (2,013); rehabilitation and older persons' care for 13.8 percent (755); obstetrics and gynaecology for 7.8 percent (424); and intensive care for 1.6 percent (87). Most patient admissions were acute (69.8 percent, 3,816) while 30.2 percent (1,653) were planned. Planned admissions were more frequent in surgical (27.1 percent) than in medical (13.4 percent) specialties ($p < 0.001$).

Figure 4: Number of patients by clinical specialty and admission type



ICU = intensive care unit; MED = medical; OB-GYN = obstetrics and gynaecology; RHB/OP = rehabilitation/older persons' care; SUR = surgical.

Patients by invasive device use

A total of 3,586 (65.6 percent) patients had at least one invasive device. Table 2 shows the prevalence of vascular access devices, indwelling urinary catheters and endotracheal tubes. Figure 5 shows the prevalence of different combinations of vascular catheters and urinary catheters. Overall, 4,761 devices were in place (251 patients had more than one central and/or peripheral intravenous catheter).

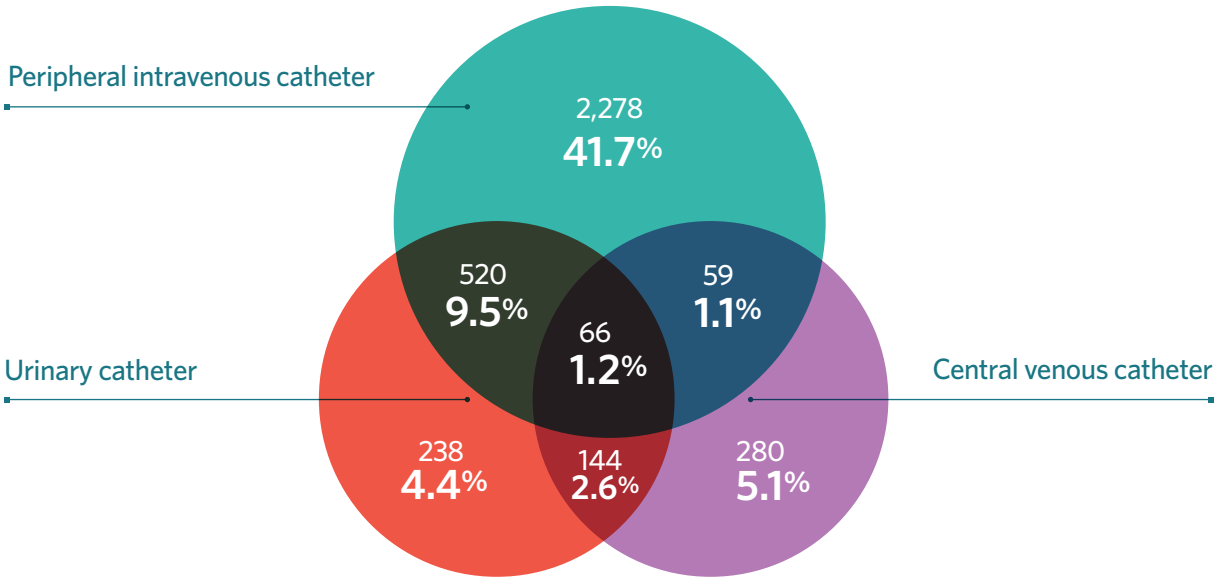
Device utilisation

Approximately **13 in 20** patients had a device in situ

Table 2: Number and prevalence of patients with at least one invasive device, by device type

Device type	Number	Prevalence % (95% CI)
Peripheral intravenous catheter	2,923	53.4 (52.1–54.8)
Central venous catheter	549	10.0 (9.3–10.9)
Urinary catheter	968	17.7 (16.7–18.7)
Endotracheal tube	52	1.0 (0.7–1.2)
Any device	3,586	65.6 (64.3–66.8)

Figure 5: Number and percentage of patients using the three most common invasive devices



Patients by multidrug-resistant organisms and *Clostridioides difficile* infection

The survey looked into whether the patient had a multidrug-resistant organism (MDRO) alert or *Clostridioides difficile (C. difficile)* infection in their medical record. It found 421 patients (7.7 percent) had such an alert; the most common were extended-spectrum beta-lactamase (ESBL) and methicillin-resistant *Staphylococcus aureus* (MRSA) (Table 3). In addition, 35 patients had more than one type of MDRO alert.

It is important to note that DHBs have different practices for coding and retaining alerts, so the data does not represent a complete national picture.

Table 3: Number and percentage of patients who had a multidrug-resistant organism alert or *C. difficile* infection

Alert type	Number (%)
Extended-spectrum beta-lactamase (ESBL)	244 (4.5)
Methicillin-resistant *Staphylococcus aureus* (MRSA)	188 (3.4)
Vancomycin-resistant *Enterococcus* species (VRE)	6 (0.1)
Carbapenem-resistant organism (CRO)	4 (0.07)
Other resistance alert	13 (0.2)
C. difficile	6 (0.1)
Any multidrug-resistant organism (MDRO) alert or *C. difficile*	421 (7.7)

Patients by screening triggers

Patient notes were reviewed in depth if the patient:

- was receiving antimicrobial therapy, other than surgical and medical prophylaxis, or
- had documented fever of more than 38.0°C in the last 24 hours.

A total of 2,008 patients (36.6 percent) met one or both criteria. Analysis showed 1,966 patients were on antimicrobial treatment, a prevalence of 35.9 percent (95 percent CI 34.7–37.2). Table 4 shows the relationship between trigger type and HAI status.

Table 4: Relationship between type of screening trigger and HAI status

Trigger type	Number (%)		Total
	Patients without HAI	Patients with HAI	
Antimicrobial treatment	1,478 (82.7)	309 (17.3)	1,787
Fever	36 (85.7)	6 (14.3)	42
Both screening triggers	133 (74.3)	46 (25.7)	179
No screening trigger	3,461 (100.0)	0 (0.0)	3,461
Total	**5,108 (93.4)**	**361 (6.6)**	**5,469**

HAI = healthcare-associated infection.

HAI results | Ngā hua HAI

In total, the survey identified 423 active HAIs in 361 patients. The national point prevalence was 6.6 percent (95 percent CI 5.9–7.3 percent). The HAI rate per 100 patients was 7.7 (95 percent CI 7.0–8.5 percent). The majority of patients had one HAI, but 53 had two or more HAIs at the same time (Table 5). A total of 132 patients were admitted to hospital with their HAI.

Table 5: Number and percentage of patients with HAIs by number of HAIs

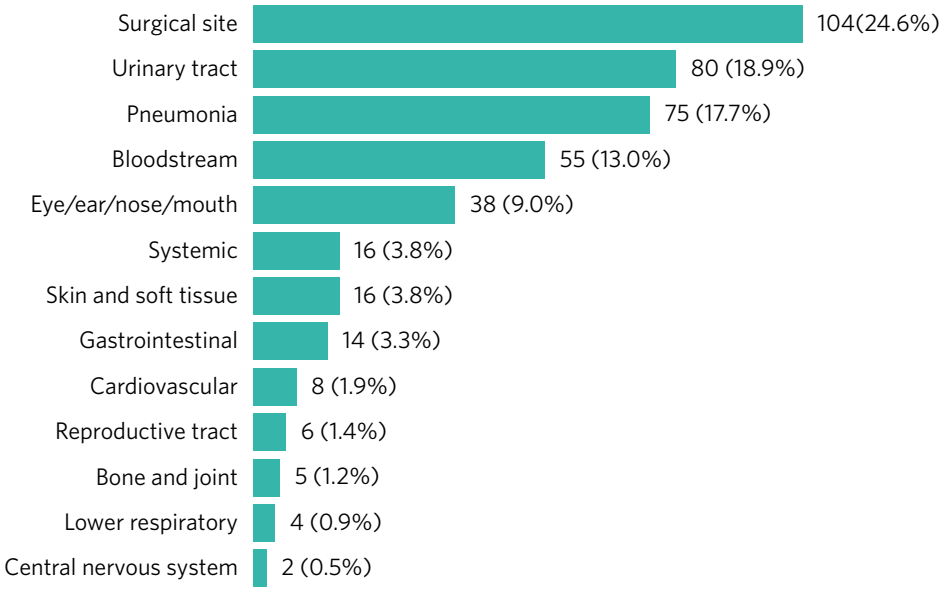
Number of HAIs	Number (%) of patients
1	308 (85.3)
2	45 (12.5)
3	7 (1.9)
4	1 (0.3)

HAI = healthcare-associated infection.

Type and source of HAI

Figure 6 shows the number and percentage of HAIs by type of infection. The most common HAIs were surgical site infection (SSI), urinary tract infection (UTI), pneumonia, bloodstream infection (BSI) and infections of the eye, ear, nose or mouth. Of the 104 SSIs, 34 (32.7 percent) were superficial, 28 (26.9 percent) were deep and 42 (40.4 percent) were organ space.

Figure 6: Number and percentage of HAIs by type of infection



Note: Lower respiratory includes infectious bronchitis, tracheobronchitis etc without evidence of pneumonia.
HAI = healthcare-associated infection.

Table 6 lists the sources of BSIs. Intravenous catheters, SSIs and UTIs were the most common sources for BSIs.

Table 6: Number and percentage of BSIs by source of infection

Source of BSI	Number (%)
Intravenous catheter	14 (25.5)
Urinary tract infection	8 (14.5)
Surgical site infection	6 (10.9)
Pulmonary infection	4 (7.3)
Digestive tract infection	3 (5.5)
Skin/soft tissue infection	2 (3.6)
Other infection	4 (7.3)
Unknown origin	14 (25.5)

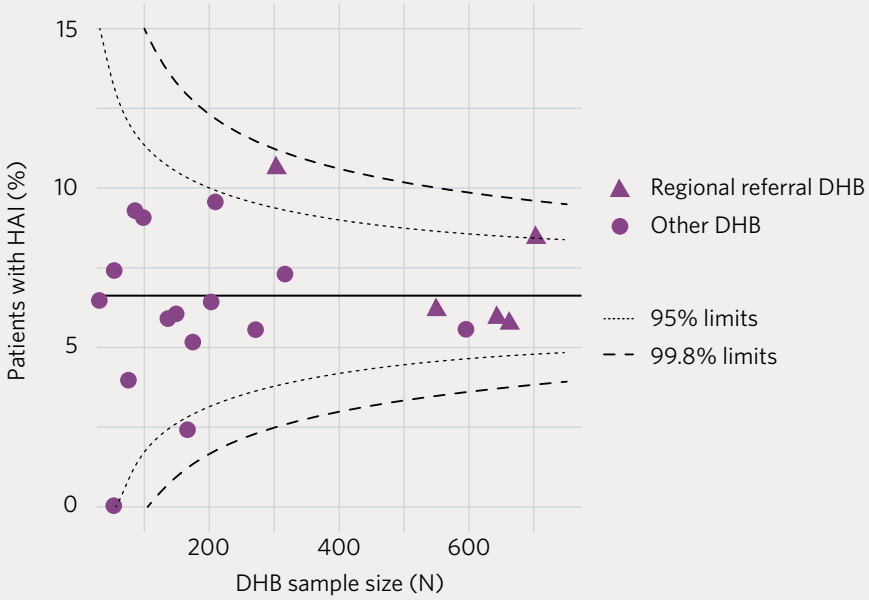
BSI = bloodstream infection.

Of the 16 skin and soft tissue infections, three (18.8 percent) were local infections related to a central venous catheter (CVC). Among the UTIs, 39 (48.8 percent) were related to a urinary catheter, and 13 pneumonia events (17.3 percent) were associated with invasive ventilation.

HAI by DHB

Among DHBs, estimated HAI point prevalence ranged from 0 to 10.6 percent (median 6.2 percent, IQR 5.6–7.4 percent). Figure 7 is a funnel plot showing the point prevalence for individual DHBs in two categories: regional referral DHBs and others. It also compares the DHB prevalence with the national point prevalence of 6.6 percent, which is the solid central line. The curved dotted control limits show the expected variation around the central line given the sample size and desired statistical confidence limits. Table 7 reports the point prevalence for each DHB by name.

Figure 7: Funnel plot showing HAI prevalence by DHB sample size



Note: National point prevalence (6.6 percent) is the solid central line.
DHB = district health board; HAI = healthcare-associated infection.

All DHBs fall within the 99.8 percent control limits. Two DHBs are above the 95 percent limits.

Table 7: HAI point prevalence by DHB

DHB	Number of patients		% with HAI (95% CI)
	Total	With HAI	
Auckland DHB[1]	700	59	8.4 (6.6–10.7)
Bay of Plenty DHB	271	15	5.5 (3.4–8.9)
Canterbury DHB[1]	661	38	5.7 (4.2–7.8)
Capital & Coast DHB[1]	301	32	10.6 (7.6–14.6)
Counties Manukau DHB[1]	642	38	5.9 (4.3–8)
Hauora Tairāwhiti	54	4	7.4 (2.9–17.6)
Hawke's Bay DHB	209	20	9.6 (6.3–14.3)
Hutt Valley DHB	167	4	2.4 (0.9–6)
Lakes DHB	99	9	9.1 (4.9–16.4)
MidCentral DHB	203	13	6.4 (3.8–10.6)
Nelson Marlborough DHB	149	9	6 (3.2–11.1)
Northland DHB	175	9	5.1 (2.7–9.5)
South Canterbury DHB	76	3	3.9 (1.4–11)
Southern DHB	315	23	7.3 (4.9–10.7)
Taranaki DHB	136	8	5.9 (3–11.2)
Waikato DHB[1]	550	34	6.2 (4.5–8.5)
Wairarapa DHB	50	0	0 (0–7.1)
Waitematā DHB	594	33	5.6 (4–7.7)
West Coast DHB	31	2	6.5 (1.8–20.7)
Whanganui DHB	86	8	9.3 (4.8–17.3)
National	**5,469**	**361**	**6.6 (6–7.3)**

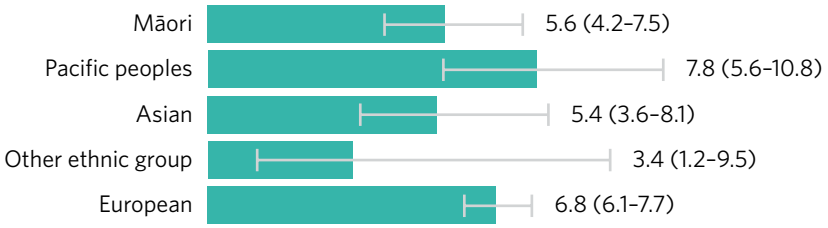
[1] Regional referral DHB.

CI = confidence interval; DHB = district health board; HAI = healthcare-associated infection.

Risk factors for HAI

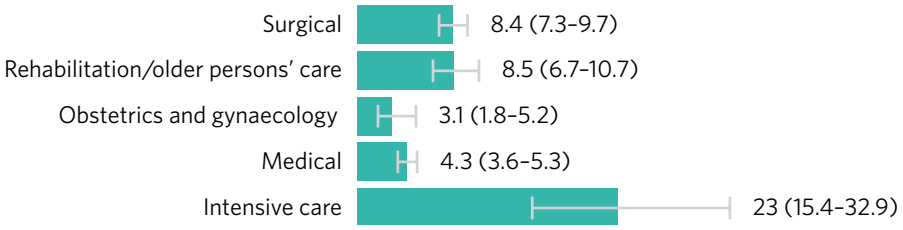
Ethnic group (unadjusted for age or other risk factors) was not associated with variation in HAI risk (Figure 8). Patients under intensive care, rehabilitation, older persons' care and surgical specialties were more likely to have an HAI than those under medical specialties (Figure 9).

Figure 8: HAI prevalence by ethnic group, percentage (95% CI)



CI = confidence interval; HAI = healthcare-associated infection.

Figure 9: HAI point prevalence by clinical specialty, percentage (95% CI)



CI = confidence interval; HAI = healthcare-associated infection.

Other factors associated with differences in HAI risk included age group, admission type, length of stay, surgery within the last month and presence of a device (other than a peripheral intravenous catheter (PIVC) (Table 8 and Table 9). Future reporting will include multivariable analysis of factors associated with HAI risk to identify independent risk factors for HAI.

Table 8: Patient demographic risk factors for HAI

Characteristic	Patients without HAI N = 5,108[1]	Patients with HAI N = 361[1]	N	OR	95% CI	*p*-value
Age group			5,469			
18–40	856 (95.7)	38 (4.3)		—	—	
41–64	1,255 (92.1)	107 (7.9)		1.92	1.33–2.84	< 0.001
65+	2,997 (93.3)	216 (6.7)		1.62	1.15–2.34	0.007
Age (median, IQR)	70 (53, 81)	70 (57, 80)	5,469	1.00	1.00–1.01	0.11
Sex			5,468			
F	2,715 (94.0)	174 (6.0)		—	—	
M	2,392 (92.7)	187 (7.3)		1.22	0.99–1.51	0.068
Ethnic group			5,455			
European	3,527 (93.2)	259 (6.8)		—	—	
Māori	723 (94.4)	43 (5.6)		0.81	0.57–1.12	0.2
Pacific peoples	378 (92.2)	32 (7.8)		1.15	0.77–1.66	0.5
Asian	383 (94.6)	22 (5.4)		0.78	0.49–1.20	0.3
Other ethnic group	85 (96.6)	3 (3.4)		0.48	0.12–1.29	0.2

[1] N (%); median (IQR).

CI = confidence interval; HAI = healthcare-associated infection; IQR = interquartile range; N = total number in sample; OR = odds ratio.

Table 9: Clinical risk factors for HAI

Characteristic	Patients without HAI N = 5,108[1]	Patients with HAI N = 361[1]	N	OR	95% CI	*p*-value
Regional referral DHB			5,469			
No	2,455 (93.9)	160 (6.1)		—	—	
Yes	2,653 (93.0)	201 (7.0)		1.16	0.94–1.44	0.2
Admission type			5,469			
Acute	3,583 (93.9)	233 (6.1)		—	—	
Planned	1,525 (92.3)	128 (7.7)		1.29	1.03–1.61	0.025
Clinical specialty			5,468			
Medical	2,094 (95.7)	95 (4.3)		—	—	
Surgical	1,844 (91.6)	169 (8.4)		2.02	1.56–2.63	< 0.001
Rehabilitation/older persons' care	691 (91.5)	64 (8.5)		2.04	1.46–2.83	< 0.001
Obstetrics and gynaecology	411 (96.9)	13 (3.1)		0.70	0.37–1.21	0.2
ICU	67 (77.0)	20 (23.0)		6.58	3.75–11.1	< 0.001

Characteristic	Patients without HAI N = 5,108[1]	Patients with HAI N = 361[1]	N	OR	95% CI	*p*-value
Time in days from (ward) admission to survey date	4 (2, 8)	9 (5, 18)	5,468	1.02	1.01–1.02	< 0.001
Presence of MDRO alert			5,468			
No	4,724 (93.6)	323 (6.4)		—	—	
Yes	383 (91.0)	38 (9.0)		1.45	1.01–2.04	0.038
Surgery within last 30 days			5,421			
No	4,088 (95.2)	207 (4.8)		—	—	
Yes	979 (86.9)	147 (13.1)		2.97	2.37–3.70	< 0.001
Presence of PIVC			5,469			
No	2,381 (93.5)	165 (6.5)		—	—	
Yes	2,727 (93.3)	196 (6.7)		1.04	0.84–1.29	0.7
Presence of CVC			5,469			
No	4,675 (95.0)	245 (5.0)		—	—	
Yes	433 (78.9)	116 (21.1)		5.11	4.00–6.50	< 0.001
Presence of IDC			5,469			
No	4,249 (94.4)	252 (5.6)		—	—	
Yes	859 (88.7)	109 (11.3)		2.14	1.68–2.70	< 0.001
Undergoing invasive ventilation			5,469			
No	5,069 (93.6)	348 (6.4)		—	—	
Yes	39 (75.0)	13 (25.0)		4.86	2.47–8.94	< 0.001
Presence of any PIVC, CVC, IDC and/or invasive ventilation			5,469			
No	1,817 (96.5)	66 (3.5)		—	—	
Yes	3,291 (91.8)	295 (8.2)		2.47	1.89–3.27	< 0.001

[1] N (%); median (IQR).

CI = confidence interval; CVC = central venous catheter; DHB = district health board; HAI = healthcare-associated infection; IDC = indwelling urinary catheter; IQR = interquartile range; MDRO = multidrug-resistant organism; N = total number in sample; OR = odds ratio; PIVC = peripheral intravenous catheter.

Microbiology of HAI

A specific pathogen was identified in 301 of 423 HAIs. The most common pathogens were *Staphylococcus aureus (S. aureus)*, which accounted for 21 percent of the isolated HAI, and *Escherichia coli* at 20 percent. Other members of the Enterobacterales order (enteric Gram-negative bacilli) together accounted for 20 percent and *Enterococcus* species for 12 percent.

Of the 301 pathogens isolated, 42 (14 percent) met the criteria for MDRO. These were MRSA (8), ESBL-positive Enterobacterales (28), carbapenem-resistant Enterobacterales (5) and one *P. aeruginosa* which was carbapenem-resistant.

Table 10: Pathogens isolated as cause among 423 HAI, by HAI type[1]

	Number isolated from 423 HAIs		Type of HAI				
			Surgical site (N = 104)	Urinary tract (N = 80)	Pneumonia (N = 75)	Blood-stream (N = 55)	Other HAIs (N = 109)
Pathogens overall	301 isolates		87 isolates	80 isolates	17 isolates	65 isolates	52 isolates
Type of pathogen	Number (%)	Rank	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)
Staphylococcus aureus[2]	63 (21)	1	27 (31)	3 (4)	3 (18)	16 (25)	14 (27)
Escherichia coli[3]	61 (20)	2	11 (13)	33 (41)	1 (6)	8 (15)	8 (15)
Enterococcus species[4]	36 (12)	3	9 (9)	11 (14)	1 (6)	8 (15)	7 (13)
Klebsiella species[5]	32 (11)	4	5 (6)	12 (15)	3 (18)	9 (14)	3 (6)
Other Enterobacterales[6]	27 (9)	5	12 (14)	6 (8)	1 (6)	6 (9)	2 (4)
Other staphylococci	20 (7)	6	9 (9)	2 (3)	—	6 (9)	3 (6)
Candida species[7]	17 (6)	7	3 (3)	7 (9)	1 (6)	3 (5)	3 (6)
Pseudomonas aeruginosa[8]	15 (5)	8	5 (6)	4 (5)	2 (6)	2 (3)	2 (4)
Other Gram-negatives[9]	8 (3)	9	1	—	4 (24)	3 (5)	—
Clostridioides difficile	7 (2)	10	—	—	—	—	7 (13)
Streptococcus species	5		1	2 (3)	—	2 (3)	—

	Number isolated from 423 HAIs	Type of HAI				
		Surgical site (N = 104)	Urinary tract (N = 80)	Pneumonia (N = 75)	Blood-stream (N = 55)	Other HAIs (N = 109)
Other Gram-positives	4	3 (3)	—	—	1 (2)	—
Other anaerobes	4	1	—	—	1 (2)	2 (4)
Aspergillus fumigatus	1	—	—	1 (6)	—	—
Herpes simplex virus	1	—	—	—	—	1 (2)
Multidrug-resistant organism[10]	42 (14)	14 (16)	15 (19)	2 (12)	7 (11)	4 (8)
No pathogen isolated[11]	172 (41)	35 (34)	9 (11)	62 (83)	0 (0)	66 (61)

[1] Out of the total of 301 pathogens isolated, one was identified in 208 HAIs, two in 37, three in 3 and four in 1 HAI.

[2] Eight (13%) methicillin-resistant *S. aureus* (MRSA).

[3] Eleven (18%) extended-spectrum beta-lactamase (ESBL) positive, 1 (1.6%) carbapenem-resistant organism (CRO).

[4] No isolate was vancomycin resistant.

[5] Ten (31%) ESBL positive, 1 (3%) CRO.

[6] Seven (26%) ESBL positive, 3 (11%) CRO.

[7] *C. albicans* (10), *C. glabrata* (3), *C. parapsilosis* (1), non-speciated (3).

[8] One (7%) CRO.

[9] None was drug resistant.

[10] Eight (19%) MRSA, 28 (67%) ESBL, 6 (14%) CRO.

[11] Total number of HAIs used as the denominator.

HAI = healthcare-associated infection; N = total number in sample.

Comparing New Zealand HAI data with international findings

Table 11 compares findings from the national PPS with recent data from other countries and the European Union.

Table 11: Prevalence of HAIs in New Zealand, Australia, European Union, Singapore, Wales and Switzerland

Study context and findings	Country or region					
	New Zealand	Australia [4]	European Union [11]	Singapore [2]	Wales [15]	Switzerland [16]
Year(s)	2021	2018	2016–17	2015–16	2017	2018
Sample type	All public hospitals	Sample of principal referral and Group A hospitals	Sample	Sample (86% of all beds)	All acute care hospitals	Sample
Number of patients in study	5,469	2,767	310,755	5,415	6,400	2,421
Prevalence, % (95% CI)	6.6 (5.9–7.2)	9.9 (8.8–11.0)	6.5 (5.4–7.8)	11.9 (11.1–12.8)	5.5 (4.9–6.1)	5.6 (4.7–6.5)
HAI per 100 patients	7.7 (7.0–8.4)	13.1	6.3	13.4	5.7	6.3
Most common HAIs, %	[top 4 = 74.2% of 423 HAIs]	[top 4 = 75%]	[top 4 = 69.4%]	[top 4 = 76.3%]	[top 4 = 56.3%]	[top 4 = 77.7%]
Surgical site	24.6	27.5	18.3	17.3	11.3	22.2
Pneumonia	17.7	18.5	21.4	24.8	19.2	24.8
Urinary tract	18.9	18.5	18.9	6.7	15.9	13.7
Bloodstream	13.0	10.5	10.8	8.7	9.9	17.0
Systemic	3.8	1.7	5.4	25.5	7.7	3.5
Clostridioides difficile infection	1.7	ns	4.8	3.8	9.6	3.7

Study context and findings	Country or region					
	New Zealand	Australia [4]	European Union [11]	Singapore [2]	Wales [15]	Switzerland [16]
Device use, %						
Peripheral intravenous catheter	53.5	55.2	ns	75.1	35.8	43.4
Central venous catheter	10.0	14.8	ns	12.7	4.2	12.0
Urinary catheter	17.7	20.7	ns	24.0	16.2	18.0
Ventilation, intubated	1.6	2.0	ns	1.9	1.6	2.1

CI = confidence interval; HAI = healthcare-associated infection; ns = not stated.

Summary | He whakarāpopotonga

This report describes the first national HAI PPS among adult inpatients in Aotearoa New Zealand. All 20 DHBs participated in the survey, which took place in 2021.

In summary, the findings indicate a national HAI prevalence rate of 6.6 percent and the HAI rate was 7.7 infections per 100 patients. Two-thirds of patients had one or more devices in place on the day of the survey. Also, 36 percent were receiving at least one antimicrobial agent.

Similar to the ECDC and Australian HAI prevalence studies, the most common HAIs were SSIs (26.4 percent), UTIs (18.9 percent), pneumonia (17.7 percent) and BSIs (13 percent). The overall infection rate is similar to Wales, Switzerland and the European Union. [11,15,16]

Gender and ethnicity were not associated with a higher risk of HAI. However, the presence of an invasive device was a significant risk for infection. The rate of *C. difficile* infection was low compared with the reported rates overseas.

The PPS has demonstrated the burden of HAI in DHB hospitals is significant, despite current national IPC programmes and initiatives such as the hand hygiene and surgical site infection improvement programmes. Individual DHBs may use this information to review their internal surveillance programmes. The new information and insights from the PPS are critical for the Commission's work planning in the future and will inform potential HAI surveillance and improvement initiatives.

This study has several strengths. The survey used an established methodology from the ECDC,[11] which the recent Australian study[4] has validated further. All DHBs participated, giving a complete picture of HAI prevalence in acute care in Aotearoa New Zealand. The reliability of the study was strengthened through the use of a small, dedicated team of trained surveyors with IPC expertise. As a result, data collection was consistent across all sites and there was no potential for bias from local surveyors. As a national approach to getting HAI prevalence rates both nationally and for individual DHBs, the PPS was cost-effective and came in under the projected budget.

One of the limitations of the PPS was that it did not collect data on patient risk factors such as co-morbidities, so the analysis could only adjust for individual patient risk to a limited extent. A further limitation was that the PPS only captured HAIs in hospital and did not record an HAI managed in primary care.

The delivery of the PPS had its challenges. The process of collecting data on device use on the day of PPS was resource-intensive for ward/unit staff and in many hospitals the local DHB support people had to collect this data. Delays in accessing paper-based clinical records were common due to competing requirements from clinicians, such as doctors' rounds, and note writing. Variable information technology platforms within DHBs caused problems for accessing information. Where patients had received their original treatment in a private surgical hospital, information on HAIs that resulted from that treatment was not always available. Similarly, some inter-DHB transfer notes did not have all the information required to identify an HAI.

The WHO Core Components of Infection Prevention and Control Programmes[17] require that countries have national IPC programmes and within that is a strategic plan for HAI and antimicrobial resistance (AMR) surveillance. Also the New Zealand Standard NZS8134:2021, Part 5 Infection Prevention and Antimicrobial Stewardship,[18] requires service providers to undertake HAI surveillance. This activity should be based on national recommendations and standardised definitions. National HAI and AMR surveillance requires the full support and engagement of all key central health agencies with appropriate human and financial resourcing. This will ensure the surveillance data is of high quality and can inform and guide national IPC policy and quality improvement activities.

Next steps | He mahi hei whai

Following on from this PPS, next steps will involve:

conducting a multivariable analysis to examine if age and/or ethnicity are related to risk factors for an HAI

identifying the economic burden of HAI in Aotearoa New Zealand based on the findings of the PPS

performing an in-depth review of the published evidence to reduce the most significant HAIs, which will inform future HAI initiatives.

The Commission will also seek sector feedback on proposed surveillance or improvement projects that it develops based on the findings from the PPS. The areas of focus will include:

Reduce *S. aureus* infections associated with intravascular catheters

- Prevention of peripheral intravenous catheter infections
- Prevention of central venous catheter infections

Reduce SSI due to *S. aureus*

- Expand the use of the 'anti-staphylococcal' bundle across all clean surgery

Reduce all infections associated with medical devices

- Introduce care bundles for urinary catheter use
- Introduce care bundles for ventilator-associated and hospital-acquired pneumonia

Conclusion | He whakakapinga

Almost 7 percent of adults in DHB hospitals have an HAI. The results highlight the need for further investment in IPC strategies at local and national levels. The Commission will use the information from the PPS to choose interventions to reduce HAIs. In particular, in making our choice we will consider which HAIs are most likely to decrease through interventions and the estimated cost-effectiveness of individual interventions.

Endnotes | Kupu āpiti

1. Magill SS, Edwards JR, Bamberg W, et al. 2014. Multistate point-prevalence survey of health care-associated infections. *New England Journal of Medicine* 370(13): 1198–208. DOI: 10.1056/NEJMoa1306801 (accessed 21 April 2018).
2. Cai Y, Venkatachalam I, Tee NW, et al. 2017. Prevalence of healthcare-associated infections and antimicrobial use among adult inpatients in Singapore acute-care hospitals: results from the first national point prevalence survey. *Clinical Infectious Diseases* 64(Suppl 2): S61–7.
3. Graves N, Nicholls TM, Morris AJ. 2003. Modeling the costs of hospital-acquired infections in New Zealand. *Infection Control and Hospital Epidemiology* 24(3): 214–23.
4. Russo PL, Stewardson AJ, Cheng AC, et al. 2019. The prevalence of healthcare associated infections among adult inpatients at nineteen large Australian acute-care public hospitals: a point prevalence survey. *Antimicrobial Resistance and Infection Control* 8(1): 1–8. DOI: 10.1186/s13756-019-0570-y (accessed 24 January 2022).
5. Nicholls TM, Morgan AS, Morris AJ. 2000. Nosocomial blood stream infection in Auckland healthcare hospitals. *New Zealand Medical Journal* 113(1106): 96–8.
6. Read K, Bhally H, Sapsford S, et al. 2015. 'Real-time' burden of community and healthcare-related infections in medical and rehabilitation patients in a public hospital in Auckland, New Zealand. *New Zealand Medical Journal* 128(1426): 69–74.
7. Roberts S, Jowitt D. 2015. New Zealand Health Quality & Safety Commission infection prevention and control programmes: evidence for sustained improvement in infection prevention interventions. *Antimicrobial Resistance and Infection Control* 4(Suppl 1): 58. doi: 10.1186/2047-2994-4-S1-P58.
8. Gray J, Proudfoot S, Power M, et al. 2015. Target CLAB Zero: a national improvement collaborative to reduce central line-associated bacteraemia in New Zealand intensive care units. *New Zealand Medical Journal 128*(1421): 13–21.
9. Grae N, Morris A, Roberts S. 2019. Reduction in national orthopaedic and cardiac surgical site infection rates following sustained improvement in process measures. *Infection Disease & Health* 24: S5.
10. Morris AJ, Roberts SA, Grae N, et al. 2018. The New Zealand Surgical Site Infection Improvement (SSII) Programme: a national quality improvement programme reducing orthopaedic surgical site infections. *New Zealand Medical Journal* 131(1479): 45–56.
11. ECDC. 2019. *Point Prevalence Survey of Healthcare-associated Infections and Antimicrobial Use in European Acute Care Hospitals: ECDC PPS validation protocol version 3.1.2.* Stockholm: European Centre for Disease Prevention and Control. URL: www.ecdc.europa.eu/en/publications-data/point-prevalence-survey-healthcare-associated-infections-and-antimicrobial-use-4 (accessed 23 December 2021).
12. Harris PA, Taylor R, Minor BL, et al. 2019. The REDCap consortium: building an international community of software platform partners. *Journal of Biomedical Informatics* 95: 103208. DOI: 10.1016/j.jbi.2019.103208 (accessed 21 January 2020).
13. Russo PL, Stewardson A, Cheng AC, et al. 2018. Establishing the prevalence of healthcare-associated infections in Australian hospitals: protocol for the Comprehensive Healthcare Associated Infection National Surveillance (CHAINS) study. *BMJ Open* 8(11): e024924.

14. Spiegelhalter DJ. 2005. Funnel plots for comparing institutional performance. *Statistics in Medicine* 24(8): 1185–202.

15. Public Health Wales NHS Trust. National Point Prevalence Survey of Healthcare Associated Infection, Device Usage and Antimicrobial Prescribing 2017, Wales. URL: www.publichealthwales.wales.nhs.uk.

16. Walter Z, Aliki M, Carlo B, on behalf of the Swissnoso Network. 2019. National point prevalence survey on healthcare-associated infections in acute care hospitals, Switzerland, 2017. *Euro Surveill* 24(32): pii=1800603. URL: https://doi.org/10.2807/1560-7917.ES.2019.24.32.1800603.

17. World Health Organization. 2016. *Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level.* Geneva: World Health Organization. URL: www.who.int/publications-detail-redirect/9789241549929.

18. Standards New Zealand. 2021. Ngā Paeraewa Health and Disability Services Standard, NZS 8134:2021 [online]. URL: www.standards.govt.nz/shop/nzs-81342021.

Appendix 1: Stages and key aspects of point prevalence survey implementation | Āpitihanga 1: Ngā wāhanga me ngā tino āhuata

Te Kāwanatanga o Aotearoa
New Zealand Government

Health Quality & Safety Commission New Zealand
Kupu Taurangi Hauora o Aotearoa