



## The Auckland City Hospital Device Point Prevalence Survey 2005: utilisation and infectious complications of intravascular and urinary devices

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### Abstract

**Background** In November 2005 a point prevalence survey of all inpatients at Auckland City Hospital was conducted to define the utilisation of intravascular and urinary devices; to measure the prevalence of infectious complications from these devices; and to provide quality assurance information about the use of these devices.

**Methods** All 830 inpatients admitted on a single day under paediatric; adult medical; adult surgical, and women's health were visited by a member of the survey team and data regarding devices *in situ* was collected.

**Results** Intravenous (IV) devices were present in 376/830 patients (45%; 95%CI 42–49), and 25/830 (3%; CI 2–4) had either confirmed infection or showed signs of infection. 33/830 patients (4% CI 3–6) had intravascular devices *in situ* that were not required. Urinary devices were present in 93/830 patients (11%; CI 9–13), and 13/91 (14%; CI 8–23) had bacteriuria. A large proportion of urinary devices (19/91, 21%; CI 13–31) were found to have been inserted for inappropriate reasons.

**Conclusion** This study provides information on the current utilisation of devices in our hospital that can be extrapolated to other public hospitals in New Zealand. Healthcare workers require ongoing education to ensure prompt removal of devices that are not required for patient care.

Hospital-acquired infections (HAIs) are an important and often preventable cause of excess morbidity, mortality and cost.<sup>1–4</sup> A report from the office of the Controller and Auditor-General in 2003 made a number of recommendations regarding infection control practice in New Zealand hospitals.<sup>5</sup> Recommendations were also made about the surveillance of HAIs to “provide the Minister of Health, patients, and the general public, with information about rates and types of hospital-acquired infection that is necessary for reasonable assurance about the safety and quality of public health care”. Fundamental to this ideal is the reporting of surveillance data that can be generalised across different district health boards (DHBs).

HAI can be measured in a number of ways.<sup>5,6</sup> Perhaps the best method to determine HAI rates is to measure the cumulative incidence of infections over a defined time period, with the denominator of all admissions to hospital. This is beyond the resources of most district health boards; however targeted surveillance can be achieved. Using bloodstream infection (BSI) as an example; an estimate can be obtained by determining the rate per 1000 admissions by obtaining information only from patients with positive blood cultures. However, this method has limitations when

making comparison between hospitals as it does not measure important patient variables.

The most important risk factor for the development of HAI is the use of invasive devices: intravenous vascular catheters, urinary catheters and mechanical ventilation.<sup>7-10</sup> A device point prevalence survey can be utilised to provide information about these important variables and can assist in data comparisons between hospitals.

In November 2005 the Auckland District Health Board (ADHB) Infection Control Service performed a hospital-wide point prevalence survey focusing on intravenous (IV) devices and urinary catheters. The primary aim of this survey was to measure the prevalence of infectious complications from these devices and to complement available surveillance data regarding HAI. The secondary aim was to provide quality assurance regarding the use of these devices in the hospital and provide information about changes that have occurred since previous point prevalence surveys were carried out at ADHB in the late 1990s.<sup>4,11</sup>

## Methods

**Background and setting**—ADHB has a number of localities, but devices are predominantly used by inpatient medical and surgical services in two large tertiary hospitals (Auckland City Hospital and Starship Hospital) on a single site (Grafton, Auckland). These hospitals provide a full range of tertiary services and provide secondary medical and surgical care to a population of approximately 450,000 to 500,000. There are four intensive care units on the Grafton site: Department of Critical Care Medicine, Cardiovascular Intensive Care Unit, Neonatal Intensive Care Unit, and Paediatric Intensive Care Unit.

**Data collection and ethical considerations**—The Device Point Prevalence Survey was a survey of all inpatients on the Grafton site on 23 November 2005. A census list of all inpatients at 0600 hours was obtained from Decision Support Services. Patients admitted under ADHB services that are not on the Grafton Campus and inpatient psychiatry services, where devices are not routinely used, were excluded. The rapid patient turnover in the adult and children's emergency departments meant that the census data from 0600 hours was not valid when these departments were visited in the early afternoon. For this reason these data are not presented. None of the patients in the emergency departments had been in hospital for longer than 24 hours

All inpatients under emergency, medical, surgical, paediatric, and women's health services were surveyed. The survey team comprised of infection control nurse specialists, clinical microbiologists, and infectious diseases physicians; all experienced in the recognition of nosocomial infection from past surveillance studies at ADHB. To ensure that the mix of experience was adequate for the present study, practitioners reviewed patients in pairs.

Data was collected on all patients who had a device *in situ*. A standardised collection form was used. We modified a form previously used at the Princess Alexandra Hospital, Brisbane, Australia (Personal Communication, J Shackelroth, 2005). This form was trialled by two members of the survey team prior to the study day and the other members of the survey team subsequently received instruction in its use.

To avoid differences in interpretation between pairs of survey team members, the data was collected as "tick boxes" wherever possible. Data collected included information about the type and number of devices, the duration the device had been *in situ*, the reason for insertion of the device, the type of practitioner who inserted the device, and whether any signs or symptoms attributable to the device itself were present. Information was obtained by patient interview, nursing staff, medical staff and from clinical records. All devices were inspected by a member of the survey team.

Urinary devices were considered to have been inserted for inappropriate reasons according to the criteria of Gokula et al.<sup>12</sup> Immobility and incontinence were considered to be appropriate reasons only if alternative measures were considered to be of risk to the patient—e.g. fracture or contamination of a wound or surgical site.

A study description was submitted to the Northern X Ethics committee, who advised that formal ethical approval was not required for a quality assurance audit.

**Measuring infectious complications**—Infectious complications were defined by the presence of positive microbiological cultures in patients with a device present on the day of the survey. This was performed by database matching between the patients with devices *in situ* and the microbiology laboratory database. The laboratory database provided a list of all positive cultures from blood and urine 4 days before and after the survey date, and from catheter tips 7 days following the survey date. All intravenous devices were inspected for signs of infection: pain, redness, swelling, and purulent discharge.

When a match was found between the databases, or if any signs of infection were identified on inspection, then the full clinical records were reviewed by the infection control team to determine the significance of each episode. Urinary infection was defined as a colony count  $\geq 10 \times 10^6$ /ml of a recognised pathogen.<sup>13</sup>

**Data analysis**—Data is presented by service according to the following groupings: adult medical, adult surgical, women’s health, paediatric (combined medical and surgical), adult intensive care, and paediatric intensive care. This survey was a descriptive study and data is presented numerically with proportions and 95% confidence intervals. Testing for statistical significance was performed by two-tailed Fisher’s exact test.

## Results

A total of 910 patients were present on the 0600 census. 830 patients met the criteria for inclusion after 18 patients who were not available for review were excluded. Intravenous (IV) devices were present in 376/830 (45%; 95%CI 42–49); urinary devices were present in 93/830 (11%; CI 9–13), and 74/830 (9%; CI 7–11) had both *in situ*.

**Intravenous devices**—A total of 490 IV devices were present in 376 patients; device utilisation by service is shown in Table 1 and the number of intravenous devices by type of device is shown in Table 2.

**Table 1. The number of patients in each service and the number and percentage with an intravenous (IV) or urinary device *in situ* by service**

Service	Number of patients	Number of patients with an IV device	Number of patients with a urinary device
Medical	306	111 (36%; 31-42)	22 (7%; 5-11)
Surgical	195	110 (56%; 49-63)	34 (17%; 12-23)
Paediatric	142	84 (59%; 51-67)	5 (4%; 1-8)
Women’s health	116	29 (25%; 17-33)	11 (10%; 5-16)
Adult ICU	19	19 (100%; 82-100)	17 (90%; 67-99)
Paediatric ICU	52	23 (44%; 31-59)	4 (8%; 2-19)
<b>Total</b>	<b>830</b>	<b>376</b>	<b>93</b>

Percentages and 95%CI are given in parentheses.

The majority of IV devices were inserted by doctors and nurses; only 14/490 (3%; CI 1–5) were inserted by phlebotomists or medical students. The reasons for the insertion and retention of the IV devices are shown in Table 3. No reason could be identified for 33/490 devices (7%; CI 5–9) in 33/830 patients (4%; CI 3–6); all of these were peripheral IV cannulae.

Greater than one device was present in 13/33 (39%; CI 23–58) patients when only one was required; 11/33 (33%; CI 18–52) had been *in situ* for longer than 72 hours and 4/33 (12%; CI 3–28) exhibited signs of infection.

**Table 2. The numbers of different intravenous (IV) devices used in 376 patients; percentages are expressed as a proportion of the total number of IV devices (490) used.**

Type of IV device	Number (%; 95% CI)
Peripheral cannula	345 (70%; 66–74)
Non-tunnelled CVL*	56 (11%; 9–14)
PICC^	26 (5%; 4–8)
Arterial	24 (5%; 3–7)
Other, e.g. umbilical	12 (2%; 1–4)
Tunnelled CVL*	10 (2%; 1–4)
Port-a-Cath	10 (2%; 1–4)
Haemodialysis catheter	7 (1%; 1–3)
<b>Total</b>	<b>490</b>

Percentages and 95%CI are given in parentheses; \*CVL = central venous line; ^PICC = peripherally inserted central catheter.

**Table 3. The reasons for insertion and retention of 490 intravenous (IV) devices in 376 patients**

Reason for IV device	Number (%; 95% CI)
Antibiotics	156 (32%; 28–36)
Hydration	134 (27%; 23–31)
Other IV medication	109 (22%; 19–26)
Surgery / anaesthesia	62 (13%; 10–16)
No reason identified	33 (7%; 5–9)
TPN*	23 (5%; 3–7)
Transfusion	22 (5%; 3–7)
Chemotherapy	16 (3%; 2–5)
Other (e.g. blood pressure monitoring)	14 (3%; 2–5)

The percentages are expressed as a proportion of the number of devices and more than one reason could be given for each device; \*TPN = total parenteral nutrition.

**Peripheral IV cannulae**—Overall, 345 peripheral IV cannulae were present in 305/830 patients (37%; CI 34–40); only paediatric patients had peripheral IV cannulae sited in the lower limb. Most of the peripheral IV cannulae had been *in situ* for 24 to 48 hours but 42/345 (12%; CI 9–16) of these had been *in situ* for longer than 72 hours. Determining the duration that a peripheral IV cannula had been *in situ* was greatly facilitated by the presence of the date of insertion recorded on the IV dressing of 149/345 cannulae (43%; CI 38–48). Phlebotomists were more likely to date cannulae they had inserted (13/13, 100%; CI 75–100) compared to all others (136/332, 41%; CI 36–46)  $p < 0.001$ ; and nurses were more likely to date cannulae they had inserted (46/86, 54%; CI 42–64) when compared to doctors (90/232, 39%; CI 33–45)  $p = 0.022$ . The remaining peripheral cannulae were inserted by midwives and medical students.

Recording the date of insertion on dressings did not help to ensure that cannulae remained *in situ* less than 72 hours: when the date was recorded 19/149 devices

remained *in situ* for more than 72 hours (13% CI 7–18) compared to 23/196 devices without the date recorded (12% CI 7–16)  $p=0.87$ . This is inclusive of the paediatric service where the date is not routinely recorded as cannulae are not changed unless they are not working or if signs of infection are present.

**Infection of intravenous devices**—Signs of infection (pain, swelling, erythema and/or purulent discharge) were found in 22/345 (6%; CI 4–10) peripheral IV cannulae. Only one of these had microbiological assessment (an exit site swab) yet this device was retained. There was an increase in signs of infection if the device had been *in situ* longer than 72 hours (6/44; 14%) compared with those *in situ* less than 72 hours (16/301; 5%);  $p=0.047$ .

There were three microbiologically confirmed infections of devices *in situ* on the day of the survey. The first was an infection of a non tunnelled central venous line (CVL) caused by *Acinetobacter calcoaceticus* isolated from blood cultures and catheter tip culture. The second and third were caused by *Staphylococcus aureus* infection of an umbilical venous line and of a Hickman’s CVL. All three patients had their lines removed and received appropriate antibiotic therapy.

Confirmed infection of an IV device was seen in 3/376 patients with vascular devices *in situ* on the day of the survey (0.8%; CI 0.1–2); when suspected infection of peripheral cannulae is included this rose to 25/376 (7%; CI 4–10) as shown in Table 4.

**Table 4. The prevalence of microbiologically confirmed infection and suspected peripheral intravenous (IV) cannula infection per inpatient, device, and patient with device *in situ***

Infection prevalence	Peripheral IV cannula with signs of infection present (%; 95% CI)	Microbiologically proven infection (%; 95% CI)	Total
Per total inpatients	22/830 (3%; 2–4)	3/830 (0.3%; 0.07–1)	25/830 (3%; 2–4)
Per device	22/345 (6%; 4–10)	3/490 (0.6%; 0.1–2)	25/490 (5%; 3–7)
Per patient with device <i>in situ</i>	22/305 (7%; 5–10)	3/376 (0.8%; 0.1–2)	25/376 (7%; 4–10)

Percentages and CI are given in parentheses.

**Urinary devices**—Urinary drainage devices were utilised in 93/830 patients (11%; CI 9–13); the utilisation by Service is shown in Table 1. Two patients had suprapubic catheters and the remaining 91 had per-urethral indwelling catheters (IDC). The majority of the IDCs had been *in situ* for less than 1 week (64/91 (70%; CI 60–79) and only 3/91 (3%; CI 0.6–9) had been *in situ* for greater than 1 month.

Documentation regarding IDC insertion was only found in 56/91 (62% CI 51–72); in the remainder the reasons for insertion were obtained from nursing or medical staff and are shown in Table 6. One in five IDCs were considered to have been inserted for inappropriate reasons (19/91, 21%; CI 13–31). In 4 cases, no reason for insertion could be identified; 3 were inserted for incontinence; and 12 were inserted for immobility.

**Table 6. The reason for insertion and retention of per urethral indwelling urinary catheters (IDC) in 91 patients**

Reason for IDC	Number (%; 95% CI)
Perioperative	34 (37%, 27-48)
Urine output measurement	24 (26%, 18-37)
Urinary retention	20 (22%, 14-32)
Immobility	15 (17%, 10-26)
Incontinence	5 (6%, 2-12)
Unknown	4 (4%, 1-11)
Palliative care	1 (1%, 0.3-6)

The percentages are expressed as a proportion of the number of IDCs and more than one reason could be given for each IDC. 19/91 (21% CI 13-31) were considered to have been inserted for inappropriate reasons.

**Complications of urinary devices**—One in five patients had the urinary drainage bag level with or above the level of the IDC (18/91, 20%; CI 12–29) which allows reflux of urine back into the bladder. Five patients had symptoms related to their IDC (6%; CI 2–12) but only one had microbiological assessment performed.

None of the patients with urinary devices *in situ* had bacteraemia, but 13/91 (14%; CI 8–23) had bacteriuria. Even though none of these patients had symptoms, eight patients received treatment in response to these culture results, and only one had their IDC removed.

## Discussion

This survey, conducted at Auckland City Hospital in November 2005, has documented the point prevalence of device related infections in context of the utilisation of IV and urinary devices. Of concern, 7% of patients with a vascular device *in situ* had evidence of infection associated with the device and 6% of patients with IDC had symptoms suggestive of infection.

Whilst only one of five patients with an IDC with symptoms suggestive of infection was investigated, 8 of 13 patients with asymptomatic bacteruria received antibiotics unnecessarily. The present study has also raised a number of important issues regarding infection control and minimisation of device related infection.

When compared to surveys performed yearly between 1996 and 2001 at ADHB, the prevalence of peripheral IV cannula and IDC usage has not changed; yet the use of central venous lines was approximately 1.6 times higher than in any of those years.<sup>11</sup> Hospital-acquired bloodstream infection is more likely to complicate central venous lines than peripheral IV cannula, yet peripheral cannula do need to be inspected frequently. There is a clear association between clinical signs of intravascular device infection and microbiologically confirmed infection.<sup>14,15</sup>

The current policy at ADHB is to remove peripheral cannulae after 96 hours; we plan to review this policy as the present study found that peripheral IV cannulae that had been *in situ* for more than 3 days were more likely to exhibit signs of infection: pain, erythema, swelling and/or pus.

The majority of peripheral IV devices did not have the date recorded on them when inserted, however, in the present survey, recording the date of insertion on the IV dressing did not appear to influence the duration that the device remained *in situ*.

Regardless, recording the date of insertion on the dressing is simple and with further education will facilitate the timely removal of peripheral cannulae.

We were able to identify a number of patients who had peripheral cannulae *in situ* which were not in use. In most cases this appears to have occurred when a cannula that had been in use was no longer required. The prevalence of unnecessary IDCs was also high, but not as high as other reports.<sup>12</sup> Alternatives to placement of IDCs should be employed whenever possible; the use of non-invasive urinary drainage devices have been shown to reduce adverse events and death.<sup>16</sup>

The present study has identified that doctors and nurses are equally responsible for the placement and maintenance of invasive devices and should be targeted for education strategies.

Our education strategies will highlight the following recommendations:

- Devices that are not required should be promptly removed;
- In adult services, peripheral cannulae should be exchanged after 3 days;
- All IV lines should be inspected twice each day;
- Peripheral cannulae should be removed if signs of infection are present;
- The date of insertion should be clearly recorded on the dressing of all peripheral cannulae;
- Non-invasive means of urinary drainage should be utilised whenever possible;
- The reason and time of placement of urinary devices should be clearly indicated in the clinical record;
- Urine specimens should only be obtained if infection is suspected;
- In most cases, prompt removal of urinary catheters will provide sufficient treatment.<sup>13</sup>

This point prevalence survey has complemented other surveillance data collected at our institution and has highlighted a number of areas for improvement. We believe that the results from adult medical, surgical, and women's health services may be able to be generalised to other secondary care facilities in New Zealand, where the patient mix and provision of care are likely to be very similar.

It is highly likely that the issues identified in this study, that is, the retention of IV devices *in situ* beyond the recommended length of time and the placement of IDC's for inappropriate reasons, occur at other hospitals in New Zealand.

The cost of HAI for the ADHB was estimated in 1999 at \$23 million.<sup>4</sup> Most of this additional cost falls on the hospital sector and relates to increased length of stay. Recent estimates from the UK suggest that about 15% of all HAI can be avoided.<sup>17</sup>

The prompt removal of invasive devices when they are no longer required or when early signs of infection are present are important manoeuvres to reduce both the incidence and significant cost of HAI. Healthcare workers require ongoing education to ensure they undertake infection control practices such as hand hygiene, as well as simple measures aimed at reducing device related infections.

Put simply: for any invasive device, if it is not needed, remove it.

**Competing interests:** None.

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### References:

1. Thomas MG, Morris AJ. Cannula-associated *Staphylococcus aureus* bacteraemia: outcome in relation to treatment. *Int Med J*. 2005;35:319–30.
2. Upton A, Smith P, Roberts S. Excess cost associated with *Staphylococcus aureus* poststernotomy mediastinitis. *N Z Med J*. 2005;118(1210). <http://www.nzma.org.nz/journal/118-1210/1316/>
3. Chu VH, Crosslin DR, Friedman JY, et al. *Staphylococcus aureus* bacteremia in patients with prosthetic devices: Costs and outcomes. *Am J Med*. 2005;118:1416.e19–e24.
4. Graves N, Nicolls T, Morris A. Modeling the Costs of Hospital-acquired Infections in New Zealand. *Infect Control Hosp Epidemiol*. 2003; 24: 56–61.
5. Controller and Auditor General. Management of hospital-acquired infection. Monograph on the internet. <http://www.oag.govt.nz/2003/hospital-infections/default.htm>
6. The Australian Council on Healthcare Standards. Infection Control Indicators: clinical indicators users' manual v. 3. Australia; 2005.
7. Saint S, Kaufman SR, Rogers MA, et al. Risk factors for nosocomial urinary tract-related bacteremia: a case-control study. *Am J Infect Control*. 2006;34:401–7.
8. Trilla A, Gatell JM, Mensa J, et al. Risk factors for nosocomial bacteremia in a large Spanish teaching hospital: a case-control study. *Infect Control Hosp Epidemiol*. 1991;12:150–6.
9. Richardson JP, Hricz L. Risk factors for the development of bacteremia in nursing home patients. *Arch Fam Med*. 1995;4:785–9.
10. Suljagic V, Cobeljic M, Jankovic S, et al. Nosocomial bloodstream infections in ICU and non-ICU patients. *Am J Infect Control*. 2005;33:333–40.
11. Graves N, Nicholls TM, Wong CGS, Morris AJ. The prevalence and estimates of the cumulative incidence of hospital-acquired infections among patients admitted to Auckland District Health Board hospitals in New Zealand. *Infect Control Hosp Epidemiol*. 2003;24:56–61.
12. Gokula R, Hickner J, Smith M. Inappropriate use of urinary catheters in elderly patients at a Midwestern community teaching hospital. *Am J Infect Control*. 2004;32:196–9.
13. Burke J, Yeo TW. Nosocomial urinary tract infections. In: Mayhall CG editor. *Hospital Epidemiology and Infection Control*. 3<sup>rd</sup> ed. Philadelphia: Lippincott Williams & Wilkins 2004. p67–86.
14. Bentley D, Lepper M. Septicaemia related to indwelling venous catheter. *JAMA*. 1968;206:1749–52.
15. Maki D, Weise C, Sarafin H. A semiquantitative culture method for identifying intravenous-catheter related infection. *N Engl J Med*. 1977;296:1305–9.
16. Saint S, Kaufman S, Rogers M, et al. Condom Versus Indwelling Urinary Catheters: A Randomized Trial. *J Am Geriatr Soc*. 2006;54:1055–61.
17. National Audit Office. The management and control of hospital acquired infection in acute NHS trusts in England: executive summary and recommendations. London: HSMO; 2000.