THE NEW ZEALAND MEDICAL JOURNAL
Journal of the New Zealand Medical Association

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# This Issue in the Journal

**Stroke rehabilitation services in New Zealand: a survey of service configuration, capacity and guideline adherence**
Harry McNaughton, Anna McRae, Geoff Green, Ginny Abernethy, John Gommans

We surveyed all New Zealand stroke rehabilitation units in late 2013 and asked them to describe the set-up of the unit and whether they met NZ Stroke Guideline standards for stroke rehabilitation. Overall, improvements were noted from the last survey in 2007. Further improvements are required particularly in providing more contact time with therapists in hospital and early contact with rehabilitation clinicians once they are discharged from hospital.

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Katherine Gordon, Andrew Swain, Callum Thirkell, Mark Bailey, Dave Greenberg

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S John Sullivan, Steve La Grow, Sridhar Alla, Anthony G Schneiders

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The prevalence of iron deficiency in New Zealand women of child bearing age appears to be increasing. Iron deficiency is twice as prevalent in young New Zealand children (6 months to < 2 years old) than it is in children of the same age living in Australia, Europe or the United States. The prevalence of iron deficiency in NZ newborns is unknown. This study, conducted within the Growing Up in New Zealand child cohort study (www.gowingup.co.nz), shows that 7% of NZ newborns have iron deficiency. Newborns whose mothers consumed 3 or more servings of milk per day during pregnancy have lower iron stores at birth than newborns whose mothers who consumed fewer servings of milk.

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Veronica Boyle, Boaz Shulruf, Phillippa Poole

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Kim Frankish, Matthew Daly, Judy Greenslade, Sharron Denekamp, Anna Chapman, John Lainchbury, Iain Melton, Darren Hooks, Ian Crozier

Babies born with congenital cardiac anomalies “hole in the heart or blue babies” are now routinely saved by cardiac surgery and live to become productive adults. However many develop heart rhythm disturbances that can be severely disabling. Conventional drug treatments are rarely effective for these heart rhythm disturbances. However most can be effectively and safely treated by cauterising the critical parts of the heart causing the rhythm disturbance.

**Prognostic value and long-term variation of high sensitivity troponin T in clinically stable haemodialysis patients**
Stefanie Honegger Bloch, David Semple, Karishma Sidhu, Ralph Stewart, Helen Pilmore

High sensitivity troponin is more sensitive for predicting cardiac events but has not been looked at extensively in patients with kidney failure. We found that levels are higher in patients on dialysis with very high levels being a strong predictor of mortality.

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# Rehabilitation after stroke—is New Zealand making progress?

Alan Davis

There has been much written about the acute care of stroke. However, after the acute phase comes rehabilitation. Approximately 30% of all patients admitted for acute stroke receive inpatient rehabilitation and a further (unknown) number receives some type of ongoing rehabilitation in the community.

What do we know about stroke rehabilitation? We know that it has a strong effect,[1] that the more you give the better the result[2] and that its effect is considerable in the community as well as inpatient environment.[3] Overall, stroke victims who receive rehabilitation have reduced mortality, lower levels of dependence and are less likely to end up in institutional care.[1]

In this edition of the *Journal*, McNaughton et al report the findings of a survey of New Zealand stroke rehabilitation services conducted in late 2013.[4] This follows the audit of acute stroke services performed in 2009.[5] Both were based on the equivalent Australian studies performed in 2007 and 2012.

The Australian studies and the 2009 New Zealand acute stroke audit consisted of two parts: an organisational survey of structures and processes; and a retrospective clinical audit of consecutive stroke patients. The 2009 acute stroke audit identified significant service gaps across the country. At the time of that survey, only 8 district health boards (DHBs) had acute stroke units and even in those DHBs, only 62% of acute stroke patients were being managed in designated stroke beds. Today, almost all DHBs provide specialised acute stroke care.

The current paper covers only an organisational survey of stroke rehabilitation services. It includes a description of structure and processes from the service delivery perspective but in the absence of a clinical audit, does not describe treatments actually received by patients. This limits its value somewhat, however the authors have been able to provide comparisons with similar national surveys conducted in 2002 and 2007 and the 2012 Australian audit. They have also provided comment on adherence to national and international recommendations on stroke rehabilitation. The paper raises a number of important issues.

Firstly, compared to the substantial advances in acute stroke services that have occurred in the last 5 years, the improvements in stroke rehabilitation services across more than a decade are modest at best. Seven of the eight large DHBs who between them serve 62% of the country's population report that they provide stroke specific rehabilitation services. While this represents an increase from 49%, most, if not all, also manage stroke patients in general rehabilitation units. Thus, the proportion of New Zealand stroke rehabilitation patients receiving care in stroke specific units is likely to be well less than 62%.

 

The number of DHBs offering day hospital services has fallen dramatically since 2002. While this may well be appropriate there has been no substantial corresponding increase in outpatient rehabilitation and even a fall in the number of early supported discharge (ESD) programmes. As ESD services and community-based rehabilitation have been shown to have important benefits in terms of outcomes and hospital length of stay,[3] this seems an alarming lack of progress.

Secondly, the survey raises concerns over levels of expertise. Only one-third of services report providing regular stroke education to staff and there are glaring gaps in the routine use of guidelines (e.g. mood assessment, shoulder pain, bowel and bladder assessment). Only 29% have any leadership from rehabilitation physicians and most of these will be in the major centres.

Thirdly, intensity of therapy input reached guideline levels in only 50% of units. The New Zealand guideline levels of a total of 1 hour per day, 5 days a week[6] are low. International guidelines such as from the UK require 45 minutes per day of each therapy discipline.[7] It is concerning that half of our services cannot achieve even a lower level. It does, of course, beg the question of who is responsible for the therapeutic environment for the other 23 hours. The obvious answer is the nursing team. Anecdotally, most clinicians involved in rehabilitation will realise the enormous value of skilled rehabilitation nurses and the importance they have in ensuring good patient outcomes.

Although nurses are the largest professional group working with stroke survivors, there is limited understanding of nursing practice in stroke units and very little evidence in respect of nurses' involvement in post stroke rehabilitation.[8] There remains the tension between the traditional nursing values of caring for (or doing to) patients versus the rehabilitation approach of facilitating independent activity. Appropriate input from skilled rehabilitation nurses is at least as important as the other therapist resources.

Finally, and although the paper only briefly touches on such issues, there are the shortcomings of service-centred care provision based on tradition. In almost 30% of the country (and possibly more), rehabilitation patients are divided up on the basis of age. A number of DHBs have separate services depending on whether patients are under or over 65 years of age. The reasons for choosing 65 years as an age cut-off are buried in history. This is no longer appropriate in an era when 1 in 6 people over 65 (1 in 4 men) continue to be in paid employment[9] and have at least 15 years of healthy and active living ahead of them.

Also mentioned are the NZ stroke guidelines[6] including minimum stroke service specifications which vary depending on DHB size. These differences include "acceptable" departures from what is considered best practice—e.g. not requiring thrombolysis or dedicated stroke rehabilitation in smaller DHBs. While there are obvious logistical issues in service provision, it cannot be reasonable to accept lower levels of care on behalf of these communities.

The question in the title of this editorial is "is New Zealand making progress?" The answer appears to be—some, but not a lot. So what do we need to do?

Firstly we need to turn our service centred planning approach around to make it patient and family-centred. Instead of identifying primarily what appropriate service

structure and process should look like, we should define what a person who has experienced a stroke should expect to receive from high quality rehabilitation processes. If service quality is compromised by geography (or for any other reason), then the patient should be fully informed and alternatives considered.

Secondly, we need to look at how to support and develop expertise in stroke rehabilitation. The McNaughton paper mentions centralisation that is occurring in other countries such as the UK[10] as opposed to decentralisation and non-specialisation in New Zealand. However, the quoted centralised services are more about acute and hyper acute stroke care rather than rehabilitation and the evidence that stroke-specific rehabilitation is superior to general rehabilitation is relatively weak. Despite this, the variation in care across the country is glaring. New Zealand is a small country and it is important that patients have the opportunity to receive high quality and consistent care.

Rehabilitation services are led primarily by specialists in geriatric medicine in most DHBs. While geriatricians are skilled at managing complex older people, we also need better access to the expertise of specialist rehabilitation physicians. In New Zealand, these clinicians are employed only in a small number of main centres.

There needs to be national and regional coordination of staff education programmes provided in innovative ways. The use of telemedicine in stroke (telestroke) has shown evidence of benefit in the acute phase of care.[11] In countries such as Scotland and Canada, the use of this technology is expanding to include rehabilitation.[12]

Thirdly, we need to move to a more appropriate range of rehabilitation services. A recent review of rehabilitation services in the Northern Health Region (unpublished) stated principles that included the need for services to be based on need rather than age, and that services should be as close to the patients' communities as possible. This includes the delivery of community-based programmes.

Furthermore, we need to move to outcomes based monitoring of patient care. This will be assisted by the fact that New Zealand rehabilitation services are now routinely using the Functional Independence Measure (FIM) and the Australian Rehabilitation Outcomes Centre for benchmarking.

Pleasingly, the National Stroke Network (previously the National Stroke Leadership Group) has recognised many of these issues and has developed a work programme accordingly. It is in the process of seeking increased consumer input with one of the tasks being a review of stroke service specifications with a patient perspective. Working groups have been established to consider nursing issues and rehabilitation processes. The Ministry of Health has also given a clear indication that community based rehabilitation development will be an expectation in the coming years.

The McNaughton paper provides valuable information for a current baseline. The direction from the Ministry of Health and the establishment of processes to improve national and regional networking should support substantial change across the country. When stroke rehabilitation services are next reviewed, the answer to the question about progress should be “a great deal.”

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# Stroke rehabilitation services in New Zealand: a survey of service configuration, capacity and guideline adherence

Harry McNaughton, Anna McRae, Geoff Green, Ginny Abernethy, John Gommans

**Abstract**

**Aim** To provide an up-to-date account of stroke rehabilitation services in all District Health Boards (DHB) in New Zealand in 2013.

**Method** An online survey was completed by clinicians at all 38 facilities in New Zealand providing rehabilitation services following acute stroke.

**Results** There was some evidence of stroke rehabilitation specialisation, particularly in larger DHBs (seven of eight large DHBs provided a dedicated stroke rehabilitation unit or designated beds). Capacity was generally satisfactory with units accommodating all (68% of units) or most (further 29%) of stroke patients needing rehabilitation. Most units had guidelines for the management of common problems following stroke, apart from depression screening (7%), but intensity of therapy input remains below recommended levels. Post-discharge rehabilitation services are available in the majority of areas but significant delays (mean 14 days) are common in accessing these services. The results for New Zealand stroke rehabilitation services are broadly comparable with those from the recent Australian stroke rehabilitation service audit.

**Conclusion** Compared to previous surveys, New Zealand stroke rehabilitation services have shown progress. To maximise outcomes for stroke patients, improvements are still needed in provision of dedicated stroke rehabilitation units, rehabilitation intensity and access to prompt community rehabilitation in the community.

Stroke is the third highest cause of death,[1] and the single most important cause of disability[2] in New Zealand (NZ). Direct hospital costs for acute care and subsequent rehabilitation are considerable[3] and other ongoing costs, particularly for institutional care are substantial.

Around 20% of all new stroke patients are discharged to institutional care.[4] A further 30% are discharged home but dependent on others for activities of daily living, with associated costs of ongoing rehabilitation, unemployment, and carers' reduced ability to work plus less easily measured costs such as loss of social roles in the community and increased stress for carers.[5]

Successful rehabilitation via organised stroke care can reduce mortality, the discharge rate to institutional care and the level of dependence for those discharged home.[6] The United Kingdom (UK) stroke strategy states "Rehabilitation after stroke works. Specialist coordinated rehabilitation, started early after stroke, and provided with sufficient intensity, reduces mortality and long-term disability".[7]

 

Guidelines for stroke rehabilitation, from NZ and elsewhere recommend 'organised stroke care', expert stroke rehabilitation clinicians working in teams, and the use of guidelines for common problems following stroke.[8–10] The current NZ Stroke Management Guideline (NZSM Guideline) recommends the provision of a minimum of 1 hour per weekday physical therapy with the stroke person during inpatient rehabilitation.[8]

The UK National Institute of Clinical Excellence (NICE) guidelines recommend 45 minutes per day (5 days per week) of 'each relevant therapy', (within a dedicated stroke rehabilitation unit), but recognise that more intensive therapy may deliver better outcomes.[11] They further recommend that people with disability from stroke should subsequently receive rehabilitation in the community from a specialist stroke team.[12]

Previous surveys of stroke rehabilitation services in NZ in 2002,[13] and 2007[14] have shown variable adherence to guideline recommendations about stroke rehabilitation specialisation and specific aspects of stroke rehabilitation processes, including the use of guidelines in the management of common problems after stroke.

Since 2007, there has been ongoing development and networking of stroke rehabilitation services around NZ, with the aim of improving rehabilitation outcomes for people with stroke. Against this has been considerable pressure on hospital and community resources.

The primary aim of this study was to provide an up-to-date account of stroke rehabilitation services in all DHBs, in terms of service configuration, capacity and adherence to guideline recommendations. A secondary aim was to compare this information to previous NZ surveys and a recent Australian survey.[15]

This study was performed under the auspices of the National Stroke Rehabilitation Working Group, a team set up by the Stroke Foundation of New Zealand to promote stroke rehabilitation according to guidelines.

## Method

The survey was developed using the survey component of the Australian National Stroke Audit of Rehabilitation Services (2012)[15] as the starting point, with modification and addition of questions relevant to the NZ setting (such as Maori and Pacific patient education). Other questions were also added to enable comparisons with the previous 2002 and 2007 NZ Stroke Rehabilitation surveys. Recommendations made in the NZSM Guideline for rehabilitation were reviewed and appropriate questions constructed to assess adherence to the recommendations.

Questions covered the provision of organised inpatient stroke rehabilitation, configuration of services, capacity, staff mix and equipment, process (including intensity of therapy input, goal setting and multidisciplinary working), the use of guidelines for assessment and management of common problems after stroke, audit, provision of education programmes to patients, family and staff, and the availability of rehabilitation services after discharge from hospital. Also added was an attempt at a ‘snapshot’ of stroke rehabilitation demand with each service asked “how many inpatients with stroke undergoing rehabilitation are in your hospital today?” It should be emphasised that no attempt was made to restrict this assessment to a particular day.

The survey was then formatted into an online tool using Survey Monkey (www.surveymonkey.com). Appropriate clinicians at all NZ public hospitals known to be managing stroke rehabilitation were contacted through the National Stroke Leadership Group and asked to complete the online survey. Follow up phone calls and emails ensured 100% of hospitals completed the survey, which was completed by each hospital between July and October 2013.

Survey results were collated electronically. Simple description of responses was considered appropriate for these data. An attempt to compare 2013 and earlier surveys using statistical methods was considered unwise given that the responses were self-reported and not verified, the questions were not identical across the three surveys, and multiple comparisons would be required. DHBs were grouped according to size of catchment population, in line with the NZSM Guideline recommendations viz: large (>200,000, n=8), medium (120-200,000, n=5), small (<120,000, n=7).

## Results

**Survey responses—**Thirty-eight responses were received representing 100% response from all public hospitals known to provide stroke rehabilitation in NZ. Rehabilitation services in each of the 20 DHBs responded. There were two responses from acute stroke units (Wellington Hospital and Christchurch Hospital) whose primary focus is not rehabilitation and these results were not included in the analysis. Of the remaining 36 responses, 28 were from 'primary' stroke rehabilitation units, defined as a unit that accepts patients for their initial period of inpatient stroke rehabilitation following acute stroke. Three DHBs (pop 1,288,000) had 'primary' units specifically for patients aged less than 65 years. These are included in the results for ‘primary’ units.

The eight 'secondary' units were generally small and/or rural centres that accepted patients after their initial period of stroke rehabilitation in a 'primary' unit. This report focuses on the results from the 28 'primary' stroke rehab units.

**Configuration, dedicated beds and capacity—**Most rehabilitation units (23, 82%) were on the same campus as an acute hospital. A dedicated stroke rehabilitation unit or designated area for stroke, with designated stroke beds was present in nine hospitals, representing seven DHBs, all large. One large DHB did not meet the NZSM Guideline requirement for a designated area for stroke. Compared to 2007, when seven DHBs (representing 49% of the NZ population) had a specific stroke rehabilitation unit or a designated stroke rehabilitation area, in 2013 seven DHBs (representing 62% of the NZ population) had these. In one large DHB and all the medium and small DHBs stroke rehabilitation occurred on general assessment treatment and rehabilitation wards. No stroke rehabilitation occurred on general medical wards.

Overall, only 32% of primary rehabilitation units had dedicated beds for stroke rehabilitation (Table 1). Of primary rehabilitation units, 19 (68%) were able to accommodate 100% of stroke patients needing inpatient rehabilitation and a further eight (29%) were able to accommodate at least 75% suggesting that capacity to admit people with stroke for rehabilitation is not a major problem for most services. No attempt was made to assess any delays in transferring patients once the need for inpatient rehabilitation was established.

**Table 1. Designated stroke beds and capacity in NZ rehabilitation units managing stroke, 2013**

| Variables | DHB (n=20; 8L, 5M, 7S) | Primary rehab unit (n=28; 15L, 6M, 7S) |
|---|---|---|
| **Designated stroke beds** | **Units combined if >1 per DHB** | |
| Nil | 13 (1 L, 5 M, 7 S) | 19 (6L, 6M, 7S) |
| 1 to 4 | 0 | 1 (1L) |
| 5 to 9 | 0 | 2 (2L) |
| 10 or more | 7 (7 L) | 6 (6L) |
| **Stroke rehab patients today** | **N=190 (plus 25 in secondary units)** | |
| Nil | 0 | 1 (1 L) |
| 1 to 4 | 7 (7 S) | 10 (3 L, 1 M, 6 S) |
| 5 to 9 | 4 (4 M) | 12 (6 L, 5 M, 1 S) |
| 10 or more | 9 (8 L, 1 M) | 5 (5 L) |
| **Capacity: % of all stroke patients requiring inpatient rehabilitation able to be accommodated** | | |
| 100% | | 19 (10 L, 4 M, 5 S) |
| 75–99% | | 8 (5 L, 1 M, 2 S) |
| 50–74% | | 1 (1 M) |

DHB=District Health Board, L=large, M=medium, S=small DHBs (see text for definitions)

Altogether, 190 patients were receiving inpatient rehabilitation following stroke in primary rehabilitation units and a further 25 patients in secondary units on the day the survey was completed. Eight large DHBs and one medium DHB had 10 or more stroke rehabilitation inpatients on that day and 17 of the 28 primary rehabilitation units had five or more stroke inpatients. However, in only eight of 28 primary units (29%) did stroke patients represent more than 50% of the workload for the rehabilitation team i.e. most units are not stroke-specific.

**Rehabilitation process and intensity—**The results are tabulated in Table 2. All units have regular formally documented multidisciplinary team meetings with 86% stating that they have a formal process for goal setting, 53% with a written guideline for goal setting.

**Table 2. Processes, guidelines and post-discharge services in NZ rehabilitation services managing stroke in 2013 compared to 2010 NZ Stroke Management Guideline recommendations and previous surveys in 2002 and 2007**

| Variables | Rec grade* | 2002** | 2007** | 2013 |
|---|---|---|---|---|
| | | n, (% of population) | | n (% of primary rehabilitation units) |
| **Multidisciplinary team working** | | | | |
| MDT meetings documented | A | | | 28 (100) |
| ≥1 hour therapy per day, >90% of the time | GP | | | 14 (50) |
| **Screening (with valid measure, >90% of the time) for problems with:** | | | | |
| Nutrition | B | | | 13 (46) |
| Communication | C | | | 13 (46) |
| Continence | B | | | 10 (36) |
| Mood | GP | | | 2 (7) |
| **Guidelines (assessment and/or management)** | | | | |
| Swallowing assessment | A | 20 (91) | 15 (83) | 27 (96) |
| Discharge planning | GP | 18 (87) | 12 (62) | 10 (36) |
| Pressure area | GP | 18 (81) | 14 (81) | 28 (100) |
| Goal setting | C | 14 (66) | 11 (54) | 24 (86) |
| Bladder & bowels | C | 16 (60) | 12 (74) | Bladder 12 (43)<br>Bowels 13 (46) |
| Nutritional support | C | 12 (50) | 13 (69) | 16 (57) |
| Shoulder pain | NR | 8 (32) | 11 (65) | 11 (39) |
| VTE prophylaxis | NR | 10 (31) | 13 (74) | 19 (68) |
| Mood assessment | NR | 6 (23) | 8 (45) | 12 (43) |
| **Audit and routine data collection** | | | | |
| Audit stroke service | C | 3 (28) | 10 (64) | 20 (71) |
| Discharge destination | NR | 12 (63) | 13 (76) | 23 (82) |
| ADL at discharge | NR | 10 (48) | 12 (75) | 28 (100) |
| **Post discharge rehabilitation services** | | | | |
| Written discharge rehab plan with patient and family | GP | | | 20 (71) |
| ESD service | A | 6 (25) | 7 (43) | 5 (18) |
| OP rehabilitation | B | 19 (86) | 18 (92) | 23 (82). Mean delay=14.1 days |
| Day hospital rehabilitation | NR | 14 (51) | 7 (31) | 4 (14) |
| Home or community-based rehabilitation | B | 14 (73) | 18 (97) | 23 (82). Mean delay=13.6 days |
| **Education sessions** | | | | |
| Staff | C | 17 (86) | 18 (85) | 9 (32) |
| Patients and families | C | 10 (42) | 14 (68) | 26 (93) |
| Patient education tailored for Maori and PI | GP | | | 14 (50) |

| | | | | |
|---|---|---|---|---|
| **Other services** | | | | |
| Driving assessment | NR | 18 (86) | 17 (79) | 25 (89) |
| Key contact person in community | GP | | | 12 (43) |

*Grades of recommendation are A, B, C or GP (good practice point). NR=no recommendation made, from NZ Stroke Management Guideline 2010. **Not all questions asked in all 3 surveys so some cells blank.

Screening processes for communication, vision, cognitive (including executive function), perceptual deficits and nutrition varied between 39% and 64% of units. Forty-three percent of units did not screen for depression, and only 7% of units screened for depression in >90% of patients, despite depression being a common problem following stroke. Written guidelines and processes were present as follows: falls prevention (96%), pressure injury prevention (100%), venous thromboembolism (68%), shoulder pain (39%), bladder function (43%) and bowel function (46%).

Only 50% of units achieved the recommended 1 hour per weekday of direct therapist-patient contact time at least 90% of the time. Group therapy is used by 89% of units. Speech language therapy is nearly always provided for dysphagia assessment (89%), but only 39% of units always provided as much as can be tolerated for communication difficulties.

**Rehabilitation services post-discharge—**Five units (18%) had an early supported discharge service (ESD) capable of providing a comparable service to inpatient rehabilitation within 24 hours of discharge. Most units provided outpatient (82%) and/or domiciliary/community rehabilitation (82%) services with a mean delay of around two weeks to the time of first therapist input (range from a few days to several weeks). More units provided education sessions for patients and carers (93%) than to their own staff (32%).

**Comparison with Australian survey in 2012—**A greater proportion of Australian rehabilitation units were configured as free-standing hospitals (31%, NZ 18%). More Australian stroke rehabilitation clinicians had over three years' experience (70%, NZ 48%) The Medical Leader was much more likely to be a rehabilitation physician in Australia (61%) than in NZ (29%) where geriatricians were Medical Leaders in 64% of rehabilitation units. Continuing education for staff in stroke management occurred in 68% of Australian units compared to only 32% in NZ.

Intensity of practice was similar for both countries with only half (51% Australia, 50% NZ) of patients with motor impairment undertaking at least 1 hour of active physical therapy per day (at least five times per week) at least 90% of the time.

Early Supported Discharge (ESD) was more available in Australia (27% of units, 18% NZ) and time to access community rehabilitation was shorter with 39% of units commencing rehabilitation within the first week (NZ mean wait time 14 days), increasing to 63% in the first week for ESD services.

## Discussion

The main emphasis of this and the earlier surveys was to try and establish the rate of adherence to NZSM Guidelines for rehabilitation. The implication is that improved

adherence to guidelines will translate into better outcomes for people with stroke. There is some uncertainty regarding this as the guideline recommendations are generally at the level of 'consensus' and/or based on indirect evidence for benefit. For example, the recommendation that protocols exist for management of swallowing or incontinence after stroke are based on a combination of common sense (these are common problems and a standardised approach makes sense), and that the original stroke unit trials (that confirmed a significant survival benefit for people with stroke) involved stroke rehabilitation units that usually had protocols for common problems unlike the general medical ward comparators.

This survey provides a picture of NZ stroke rehabilitation services in 2013. Seven of the eight large DHBs met the NZSM Guideline criterion for a designated stroke rehabilitation area although the one exception has a catchment population of over 400,000. None of the medium or small DHBs had designated stroke rehabilitation beds. The survey did not address waiting times for patients transferring from acute stroke services to rehabilitation.

Adherence to other guideline recommendations varied from excellent (MDT meeting documentation 100%, guidelines for common problems >80%) through to poor (screening for common problems <50% of the time, provision of ESD service in 18%).

There were changes in the provision of guidelines for the assessment and management of common stroke problems between 2007 and 2013; improved in the case of pressure area assessment and goal setting, but declined for discharge planning guidelines and bowel and bladder management guidelines. More units are auditing their stroke services in some way with all units measuring activities of daily living at discharge.

Direct comparison with the previous surveys is not straightforward. In the 2007 report, results were presented in terms of population coverage. We chose not to repeat this approach as the NZSM Guideline recommendations varied by size of DHB and we wished to report results in those terms, and some DHBs had more than one primary rehabilitation unit.

The results of the current survey, whether considered by DHB size or population coverage (results not shown here), were broadly improved from those in 2007. For example, an area designated for stroke rehabilitation was available to around 62% of the population in 2013 (49% in 2007). Also, the number of primary units increased from 21 in 2007 to 28 in the current survey.

In comparison with stroke rehabilitation units in Australia, those in New Zealand have less experienced staff and undertake less continuing education in stroke for their staff. This, combined with a lack of stroke specialisation in many rehabilitation units, has significant implications for the development of high quality stroke rehabilitation teams in New Zealand.

Staff education programmes actually declined in the six years since the previous survey: 32% of units in 2013 vs units representing 85% of the NZ population in 2007. Although this possibly reflects different wording (in 2013 the requirement was that the programme was ‘at least monthly’), unless there is regular education of staff it is unlikely that highest quality stroke rehabilitation will result.

Two areas of particular concern identified from this survey are intensity of inpatient rehabilitation and delays (and perhaps intensity) of post-discharge rehabilitation. Despite an A grade recommendation in the NZSM Guideline that 'Rehabilitation should be structured to provide as much practice as possible within the first six months after stroke', less than 50% of primary rehabilitation units provide 1 hour active practice per day of physical therapy (at least 5 days a week).

For many people with stroke there is also a delay of over 2 weeks before the first therapy session in the community. This first session may then only be an assessment rather than implementation of a rehabilitation programme. If we accept that intensity of rehabilitation input has an effect on outcome, it seems wasteful to invest large amounts of time and money on inpatient rehabilitation and not follow this up with appropriate input in the community immediately following hospital discharge.

The Healthcare for London Stroke Rehabilitation Guide performance standards[16] require all patients to be contacted by a member of the community rehabilitation team within 24 hours and assessed within 3 days. Treatment programmes in the community must then commence within 24 hours of assessment for ESD patients and within 7 days for other patients. Further standards are that 90% of appropriate patients receive five sessions per week within the first two weeks (ESD) and/or three sessions per week for the first four weeks (non ESD/post ESD) of occupational therapy, physiotherapy and speech language therapy.

Studies show that similar outcomes to inpatient rehabilitation can be achieved in the community so long as the dose of ESD input is similar to that in hospital – at least once daily. Few services in NZ provide community or outpatient rehabilitation on more than 2 or 3 days per week. ESD services for stroke patients remain scant with only 18% of DHBs reporting that they offer such services.

In recent years, the trend in ‘Western’ countries, for example UK[16] and Canada, has been towards increased centralisation and specialisation of both acute and rehabilitation services for stroke.

In NZ, as seen in the current survey, decentralisation of stroke rehabilitation services and non-specialisation is the norm. There are five large DHBs and one medium DHB that have two ‘primary’ stroke rehabilitation units. Three DHBs segregate stroke patients for rehabilitation by age, preferring an age-appropriate environment rather than a stroke-specialist one. Some small DHBs will manage less than 100 acute stroke patients per year of which only 30 or so may receive inpatient stroke rehabilitation.

This survey has a number of strengths and weaknesses. Responses from 100% of stroke rehabilitation facilities ensures full coverage of the country. Nevertheless there is considerable variation in configuration and practice within rehabilitation units, hard to capture in a survey like this.

The snapshot of stroke rehabilitation bed utilisation was completed by individual hospitals on different days and thus may under or overestimate the actual usual bed utilisation in NZ. No attempt was made to verify responses to this survey. The exclusion of ‘secondary’ rehabilitation units removes information from the results but was felt necessary given the significant differences that exist between ‘primary’ and ‘secondary’ units.

Based on these data we suggest that three key messages from the NZSM Guideline should be considered carefully by all DHBs:

- All large DHBs should provide a dedicated stroke rehabilitation unit, with suitably trained rehabilitation staff,
- Stroke rehabilitation units should work to improve the intensity of rehabilitation, ensuring that therapist actual contact time with the patient is enhanced and
- Early supported discharge teams, which can commence prompt rehabilitation in the community, need to be provided for stroke patients after discharge, to optimise the gains from inpatient rehabilitation.

Specific clinical indicators (with targets) to monitor achievement would help optimise the content and dose of stroke rehabilitation in New Zealand. A recent review provides a set of targets and indicators that merit consideration and discussion.[17]

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# Awareness, acceptability and application of paracetamol overdose management guidelines in a New Zealand emergency department

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**Abstract**

**Aim** To measure emergency physicians' awareness, acceptance, access to and application of the Australasian Paracetamol Overdose Guidelines.

**Methods** A retrospective record review of 100 consecutive presentations with the complaint of paracetamol overdose to the Dunedin Hospital Emergency Department, New Zealand, from 1 December 2011 to 31 December 2012, with: comparison of management to that recommended by the Guidelines, analysis of access to both an Internet poisons information resource and the New Zealand National Poisons Centre, survey of clinical staff opinion of the Guidelines and, comparison of actual and recommended management costs at commercial laboratory rates and with application of the WHO-CHOICE unit cost estimates for service delivery.

**Results** Response rate to the survey was 92.9% with 96.2% of responders aware of or accessing the Guidelines when managing paracetamol overdose patients (0.28% of Emergency Department encounters). Record review identified adherence to the Guidelines in 19% of patients; the greatest deviation due to increased biochemical analysis (68% of patients) at a mean cost $59.32 per patient greater than recommended – junior doctors ordering twice the cost in investigations as their seniors. Mean cost of care was calculated at $686.89 per case.

**Conclusion** The application of poisons information guidelines by front-line medical staff is limited; innovative approaches to improve adherence to clinical management recommendations need to be considered.

Paracetamol is one of the most commonly used simple analgesic drugs; available via prescription, directly from pharmacies or even supermarket shelves. While an inexpensive and effective therapeutic agent for the management of mild to moderate pain and fever, paracetamol (as with any drug) is toxic in overdose and can lead to fatal hepatoxicity. In developed nations it is the principle subject of enquiries to Poisons Information Centers (PICs), the leading overdose presentation to Emergency Departments (EDs),[1,2] and a major contributor of admissions to liver transplant units.[1,4]

While tests to identify toxic paracetamol serum levels are widely available and timely treatment with the antidote N-acetylcysteine (NAC) highly effective, the management of paracetamol overdose is subject of much debate, variation, and a range of guidelines.[5,6]

This variance has caused confusion amongst medical practitioners and concerns over optimum care.[7] To address this situation within Australasia, a group of medical

toxicologists developed, and in 2008 published, flowchart based consensus guidelines for the management of paracetamol overdose.[8] These were subsequently promulgated via a range of mechanisms including: textbook publication;[9] poster distribution (to all Australasian EDs); Internet access (www.toxinz.com); Poisons Information Centre advice; and educational presentations at conferences, clinical toxicology workshops and EDs.

However, research has identified that despite wide promulgation, and a high level of physician-reported awareness and agreement, guidelines can have limited impact on clinical behaviour.[10] As no post-implementation review has been undertaken of these guidelines, it is unknown whether they are applied in clinical practice, or even accepted. Furthermore, while the economic implications of differing managements of paracetamol overdose have been highlighted,[11] no study has considered costs related to the Australasian Guidelines.

Finally, while there is recommendation that guidelines be reassessed for validity every three years,[12] no such review has been undertaken of these Guidelines since their publication.

This research aims to: identify physician's knowledge, acceptance, access to and application of the Australasian Paracetamol Overdose Guidelines; assess the application of the Guidelines; and, estimate costs related to patient management.

## Methods

The study was conducted within the Emergency Department of Dunedin Hospital, Dunedin: a 388 bed tertiary teaching hospital (affiliated with the University of Otago) located in the lower half of the South Island of New Zealand.

The ED records some 36,000 patient encounters per year from a population catchment for tertiary services of 300,000.[13] The department was staffed by 28 doctors: nine consultants – doctors qualified in the specialty of emergency medicine; 12 registrars – doctors undertaking specialist training; and 7 house officers – doctors in their first 2 years following medical graduation.

Ethical approval was provided by Health Research South (comprising the University of Otago, Dunedin School of Medicine and Southern District Health Board) – Project ID: 00843.

This ED was selected as it was known that a number of systems existed within the Department to raise awareness of, and provide access to, the Guidelines. These included: availability of the "Toxicology Handbook"[9] – an Australasian textbook featuring the Guidelines; a wall poster detailing Guideline flowcharts and recommendations; access to an Internet poisons information database (www.toxinz.com) which included the Guidelines; ability to contact a national Poisons Information Centre for Guideline-based advice; and, regular – at least yearly – teaching of the Guidelines to clinical staff by a medical toxicologist.

The study comprised a retrospective medical-record review, from 1 December 2011 to 31 December 2012, of 100 consecutive patient presentations to the study ED with complaint of paracetamol overdose as recorded on the Emergency Department Information System (EDIS version 9.46.1001 ER08 27 May 2009, Computer Services Corporation). The period chosen allowed opportunity for the Guidelines to be widely promulgated and accepted into routine clinical practice.

The patient records were identified, retrieved and reviewed by an Emergency Medicine Registrar, with controlled data collection into a bespoke database developed using Microsoft® Access 2010 software. The anonymised data included: patient demographics; paracetamol dose and timing; coingestants; investigations undertaken, their timing and results; antidote administration, dose and timing; periods and location of management; and, disposition.

To assess cost of care, commercial charges for biochemical investigations were obtained from the hospital laboratory services provider – Southern Community Laboratories;[14] and pharmaceutical prices

were obtained from the Pharmaceutical Management Agency (PHARMAC) Section H Schedule for hospital pharmaceuticals.[16]

Daily bed cost was identified using the WHO-CHOICE unit cost estimates for service delivery – a WHO estimate of the 'hotel' component of an hospital bed-day (i.e. the cost of personnel, capital and food but excluding drugs and investigations).[15] The currency is New Zealand dollars.

To gauge clinician's self-assessed awareness, opinion and use of the Guidelines, a survey tool was developed and – after initial trial, revision and validation with a subset of ED based doctors – conducted within the Dunedin ED during the period 24 May 2013 to 16 July 2013.

When assessing investigations, it was recognised that further tests were reasonable beyond those indicated in the Guidelines due to coingestants and/or comorbidities. To allow for coingestants, a medical toxicologist reviewed all cases and identified investigations that were indicated for the compound(s) involved, adding these to the total of indicated investigations.

To compensate for comorbidities, any biochemical analyses undertaken in patients aged 35 years or older were also added to the total of investigations indicated under the guidelines.

Records of logins and poisons information monographs accessed on the TOXINZ database were analysed, and National Poisons Centre telephone records reviewed, to identify Dunedin Hospital utilisation of these resources.

Summary statistics are presented as median (range) and hypothesis tests were performed using the Wilcoxon rank-sum test for unpaired data test using Stata® software.

## Results

During the study period 36,229 patient encounters were recorded into the EDIS system; 555 (1.53%) entered as poisoned / suffering overdose.

The 100 paracetamol encounters studied represented 18% of overdose presentations and 0.28% of all ED presentations. Eighty-two percent of study patients intended self-harm/suicide, 15% were unintentional overdoses (i.e. therapeutic misadventure or paediatric exploratory ingestion) with intent unknown in 3% (Table 1).

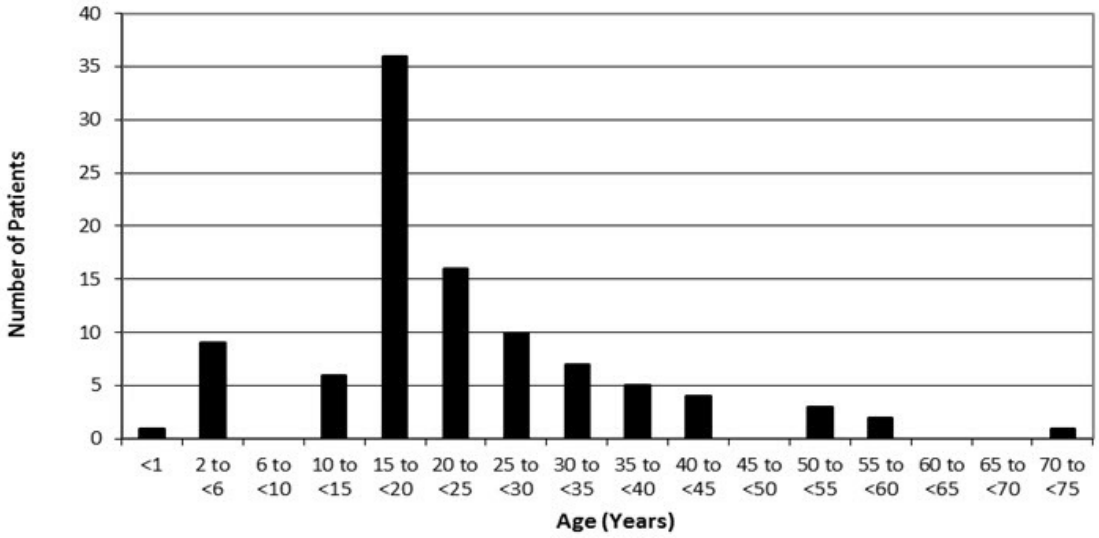
### Table 1. Patient characteristics by intent

| Characteristics | Intent | | | |
|---|---|---|---|---|
| | **Self-harm (n=82)** | **Unintentional (n=15)** | **Unknown (n=3)** | **All intents (n=100)** |
| Male (%) | 11 (13.4) | 11 (73.3) | 3 (100.0) | 25 (25.0) |
| Female (%) | 71 (86.6) | 4 (26.7) | 0 (0.0) | 75 (75.0) |
| Median Age (range) years | 19.5 (13–72) | 19 ( 0.92–72) | 2 (2–4) | 19 (0.92–72) |
| Discharged Well (%) | 0 (0.0) | 10 (66.7) | 3 (100.0) | 13 (13.0) |
| Discharged to EPS (%) | 48 (58.5) | 0 (0.0) | 0 (0.0) | 48 (48.0) |
| Discharged to Ward (%) | 34 (41.5) | 5 (33.3) | 0 (0.0) | 39 (39.0) |
| Median time in ED (range) | 4:54 (1:11–14:14) | 4:03 (0:25–5:50) | 4:16 (4:07–5:21) | 4:37 (0:25–14:14) |
| Total ED Time (hrs:min) | 434:32 | 51:02 | 13:44 | 499:18 |
| Median hours in ward (range) | 31:15 (10:30–99:59) | 19:30 (2:30–28:30) | 0 | 28:30 (2:30–99:59) |
| Total Ward Time (hrs:min) | 1,190:24 | 75:00 | 0 | 1265:24 |
| Median hours in Hospital (range) | 7:03 (1:11–104:46) | 4:05 (0:25–32:50) | 0 | 5:59 (0:25–104:46) |
| Total Hospital Time (hrs:min) | 1624:56 | 126:02 | 13:44 | 1764:42 |

ED = Emergency Department; EPS = Emergency Psychiatric Service.

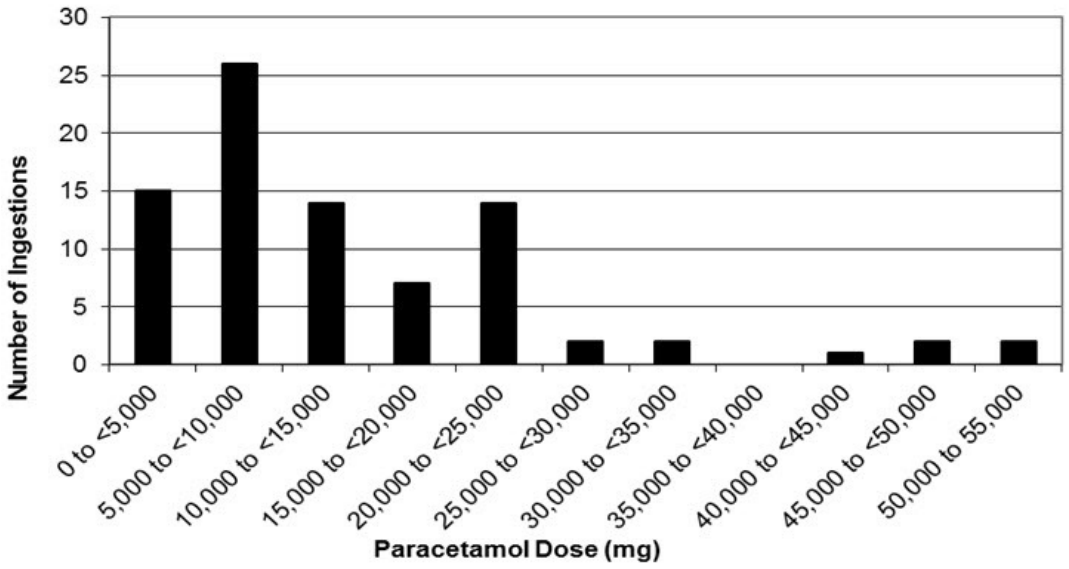
Ages ranged from 11 months to 72 years with a median of 19 years and a bimodal distribution (Figure 1).

**Figure 1. Patient age distribution**




Five patients (aged from 11 months to 3 years) ingested liquid formulations, all remaining ingestions were of solid standard-release forms. Ninety presentations were for acute overdose, nine for repeated supratherapeutic ingestions, with the exposure unknown in one case. A history of dose ingested was recorded in 85 (85%) of acute overdoses, with a median of 10,000 mg (range 1,000 mg to 55,000 mg). See Figure 2.

**Figure 2. Estimated acute single dose of paracetamol ingested**



Twenty-seven percent of patients were managed by consultants, 58% by registrars, house officers accounting for the remaining 15%; there was no statistically significant difference in the characteristics of the patients seen by these doctor groups (Table 2).

**Table 2. Patient characteristics by primary treating doctor position**

| Characteristics | Consultant | Registrar | House Officer | Total | p-value |
|---|---|---|---|---|---|
| Median Age (range) yrs | 20.5 (2–52) | 19 (2–56) | 20 (0.92–72) | 19 (0.92–72) | 0.8398 |
| Median Weight (range) kg | 65 (13–97) | 60.5 (13–90) | 59 (46–98) | 63 (13–98) | 0.9904 |
| Median Time (range) hrs | 4.15 (1.25–17.3) | 4.14 (1.4–98.35) | 4.15 (2–13.1) | 4.15 (1.25–98.35) | 0.5650 |
| Coingested * | 11 (42.3%) | 21 (37.5%) | 7 (46.6%) | 39 (40.2%) | 0.775 |
| Female gender * | 18 (66.7%) | 45 (77.6%) | 12 (80%) | 75 (75%) | 0.495 |
| Above nomogram | 2 (8.3%) | 9 (16.1%) | 3 (21.4%) | 14 (14.8%) | 0.495 |
| *Intent* | | | | | |
| Self-harm | 19 (40.4%) | 51 (87.9%) | 12 (80%) | 82 (82%) | 0.263 |
| Not self-harm | 6 (22.2%) | 6 (10.3%) | 3 (20%) | 15 (15%) | |
| Unknown | 2 (7.4%) | 1 (1.7%) | 0 (0%) | 3 (3%) | |
| *Ingestion type* | | | | | |
| Acute | 26 (96.3%) | 52 (89.7%) | 13 (86.7%) | 91 (91%) | 0.497 |
| Repeated | 1 (3.7%) | 6 (10.3%) | 2 (13.3%) | 9 (9%) | |

**Note:** Median (range) Kruskall-Wallis test, except for * n (%) Chi squared; Fisher exact test.

Thirty-nine (39%) patients coingested a median of 1.77 compounds (range 1 to 5); 38 (97.4%) of whom intended self-harm. Of the 69 coingested substances, the most common classes were: NSAIDs, 23 (33.33%); opioids, 10 (14.49%); and, ethanol, 8 (11.59%).

The survey enjoyed a 92.9% (26 of 28) response rate comprising: eight (30.8%) consultants, 11 (42.3%) registrars, and seven (26.9%) house officers. Seventeen (65%) responders were aware of the Guidelines, 16 (94%) of whom viewed them as best practice (one individual was unsure).

While not all responders were aware of the Guidelines *per se*, 96.2% considered they either directly applied the Guidelines in 90% or more of patients seen, or, referred to sources based on the Guidelines "often" or "always" when treating patients.

Sources utilised were reported as: PIC 3.8%, text book 3.8%, original journal article 3.8%, poster 23.0%, ED protocol 23.0%, Internet poisons information database 77.0% (responders referring to more than one resource).

Review of National Poisons Centre records for the study period identified that Dunedin Hospital staff viewed 2,903 poisons information monographs, 363 (17.3%) relating to paracetamol; and rang the National Poisons Centre on three occasions regarding paracetamol overdose (20% of all calls from this ED).

Two patients had no biochemical investigation, and in one otherwise investigated case no paracetamol level was assessed. In all 1,085 blood analyses were undertaken – 829 (75.85%) in the ED and 256 (24.15%) on the ward. The mean number of investigations of untreated patients was 7.33, while a mean 16.83 investigations were conducted in those receiving the antidote NAC.

Total cost of investigations was $10,153; a median cost per patient of $95 (range $0 to $270) – registrars and house officers spending twice that of consultants (Table 3).

**Table 3. Cost of emergency department investigations by clinical position**

| Position | Patients (n) | Investigations (n) | Cost ($) | Investigations/Patient Median (Range) | Cost/Patient ($) Median (Range) |
|---|---|---|---|---|---|
| House Officer | 15 | 154 | 1439 | 11 (1 to 14)* | 102 (19 to 132)† |
| Registrar | 58 | 509 | 4826 | 10 (0 to 13)* | 96 (0 to 144)† |
| Consultant | 27 | 160 | 1546 | 5 (0 to 11)* | 47 (0 to 107)† |
| Department | 100 | 823 | 7811 | 10 (0 to 14) | 88 (0 to 144) |

Kruskall-Wallis p=0.0005; †Kruskall-Wallis p=0.0002.

By applying the Australasian guidelines, it was identified that 184 biochemical tests were indicated for the 100 encounters. Following assessment of coingestants and potential for comorbidities, a further 53 and 155 investigations respectively were added, reaching a total of 392 investigations at a cost of $4,221; a median cost per patient of $25 (range $0 to $384) (Table 4).

This $5,932 difference identified 140.5% more was spent on blood tests than proposed by the guidelines, a mean difference of $59.32 per patient.

**Table 4. Cost of paracetamol overdose investigation and N-acetylcysteine treatment (100 patient encounters)**

| Variables | Actual | Guideline | Significance |
|---|---|---|---|
| Investigations | | | |
| Patients Investigated | 98 | 99 | <0.05 † |
| No. of Investigations | 1085 | 392 | |
| Median (range) | 10 (0–31) | 2 (0–41) | <0.0001 * |
| Total Cost | $10 153 | $4221 | |
| Median Cost (range) | $95.00 ($0.00–$270) | $25.00 ($0.00–$384.00) | <0.0000 * |
| N-acetylcysteine | | | |
| Patients Treated | 38 | 36 | <0.001 † |
| Total Cost | $7867.60 | $7209 | |
| Median Cost (range) | $178.00 ($106.80–$480.60) | $195.50 ($53.40–$284.80) | 0.8695 * |

* Wilcoxon signed-rank test; † Chi-squared, Fisher's exact test.

This level of investigation changed management in one case: where a full course of NAC was administered to a patient without recorded history of repeated paracetamol exposure or coingestant and an initial serum paracetamol level of 659 mcmol/L at 4 hours post-ingestion (below the 1,000 mcmol/L treatment level used by the Guidelines). Treatment started when a second (non-recommended) level taken at 5 hours 45 minutes returned a result (808 mcmol/L) above the treatment line.

Overall, the Australasian Guidelines were fully applied in 19 (19%) encounters; ten (53%) involving paracetamol ingestions of 6,000 mg or less and discharge following a single non-toxic paracetamol level.

Thirty-eight patients (38%) were treated with NAC, compared with the guideline's recommendation of 36 (36%). The guideline advises NAC if the paracetamol level is above the published nomogram line following an acute single overdose. There were 14 such patients in this series. However, the nomogram cannot be applied in cases of repeated paracetamol ingestion or when the time of ingestion is unknown. In these cases other criteria including total ingested dose and ALT level are applied. The remaining 24 patients receiving treatment fell into these categories.

Biochemical investigation beyond those recommended contributed the majority of deviations from the Guidelines, occurring in 68 (68%) patients. This included 16 (16%) patients from whom paracetamol levels were obtained prior to 4 hours post-ingestion – a period when levels are considered non-interpretable. Notably four (20%) were not then further tested.

A total of 73 days, 12 hours and 42 minutes were recorded as spent in the hospital at a cost of $50,611 using the WHO-CHOICE criteria ($688.40 per hospital day). Total cost of hospital stay, drug cost and investigations were calculated at $68,688.97, a mean of $686.89 per patient.

Management by strictly following the guidelines was estimated at $62,098.37 ($620.98 per patient). Judging length in hospital was impracticable and the same time cost was applied in each group. Comparing cost of antidote and investigation between groups revealed a mean $65.91 per patient was spent over Guideline recommendations, $59.32 (90%) due to additional biochemical investigations alone.

## Discussion

Despite wide dissemination by a variety of media, a high level of awareness, and a high level of self-reported access to the Australasian Paracetamol Overdose Guidelines, it appears that the group of physicians studied did not manage the majority of their patients strictly according to the Guidelines.

The accuracy of reported access to Guideline-based resources is corroborated by National Poisons Centre records. A striking correlation was seen between the proportion of total documents viewed on the online poisons information database relating to paracetamol, and the proportion of paracetamol overdoses seen in the ED – 17.3% and 18% respectively. The low use of the telephone poisons information service is also confirmed, reflecting previously reported findings from Australasian EDs.[17]

The major source of variation from the Guidelines was the ordering of biochemical analyses beyond those recommended, with an associated increased cost of care. With the exception of one instance where a repeat paracetamol level was taken when a history was doubtful, this practice did not benefit this group, and appeared to reflect a recipe approach.

That junior doctors (house officers and registrars) ordered twice the cost of tests as their seniors, and quadruple that of the Guideline, was notable and may indicate that clinical experience or authority influences ordering patterns. It is also possible that the Guidelines do not well model the realities of clinical practice.

This assessment of actual management of paracetamol overdose is useful for informing review of the Australasian Guidelines. It is reasonably said that "Physicians who do not follow guidelines are not always wrong",[18] and that "Monitoring of what physicians actually do, as compared with what guidelines suggest, might facilitate updating of guidelines and avoid outdated recommendations".[12]

This study has highlighted routine divergence of practice away from frequently accessed recommendations, particularly in the area of biochemical testing. This may reflect a generally high level of investigation of patients for any indication, a recognised phenomenon; disagreement with the Guidelines, though this was not reflected in the survey; or, clinicians applying alternate recommendations.

Indeed, it is possible that changes promulgated in the United Kingdom for the management of paracetamol overdose (with more thorough biochemical investigation) may be influencing physicians in New Zealand.[19] This is informative as the cost-benefit of this new approach has been questioned,[11] and a considered review of any adoption of these recommendations within Australasia would seem appropriate.

The finding that a widely disseminated and accepted guideline was poorly applied is not novel. Assessment of a consensus statement released nationally in Canada recommending decreased use of caesarean section revealed that while most physicians (87 to 94 %) were aware of the guidelines, and most (82.5 to 85%) agreed with them, there was little change in actual practice.[20]

A study in The Netherlands of guidelines for use of laboratory tests concluded that general practitioners applied these recommendations as a minimum level of investigation – extra tests ordered in 77.2% of rheumatoid arthritis cases.[21] And review of the difficulties related to guideline implementation has identified a range of barriers to adherence.[10] However, despite these difficulties, a novel "marketing paradigm" approach to the national promotion of biochemical testing in New Zealand created a sustained – 2 year – decline in test ordering amongst general practitioners, offering hope that guidelines can be successfully implemented.[22]

Innovative informatics-based approaches to the generation and dissemination of guidelines for the management of poisoning may therefore provide a solution to the difficulties identified by this study.

A limitation of this study is small sample size and an absence of less common events (e.g. severe toxicity requiring transfer to a liver transplant unit) making generalisation difficult. However, this approach does provide a detailed view of paracetamol overdose management in the group studied, and its retrospective nature negates impact from a Hawthorne effect.

Data entry errors into both the EDIS system and the study database may have occurred and influenced findings; however, any such errors would be few and considered unlikely to significantly affect overall findings.

Data on comorbidities were not collected, which may have indicated a need for further investigation. To compensate, all biochemical tests undertaken in patients aged 35 years or older were added to the recommended investigations, as were those considered due to coingestants. While this approach may not recognise all reasonable investigations, the tests ordered were generally similar and appeared to reflect rote

ordering practice rather than focused assessment of specific complaint(s). It is also considered that all investigations undertaken were not recorded in the clinical notes, producing a reduced assessment of total investigation cost.

Unfortunately, the expense of psychiatric care could not be evaluated, adding to a conservative calculation of cost of care. It should also be noted that the group of doctors responding to the survey were not identical to those providing management during the study period. An unavoidable result of normal work rotation of junior doctors (i.e. registrars and house officers).

Despite the best intentions of both the authors of the guidelines and practising physicians, it appears that the Australasian Paracetamol Overdose Guidelines are not applied to the majority of patients. Reasons for this are likely complex and have not been explored. While these findings cannot be generalised to other hospitals throughout the Australasian region, they raise questions regarding similar practises and related opportunity cost.

Importantly, consideration needs to be given to the development of systems and support for medical staff on how best to apply complex interventions when only pertinent for a small minority of patients encountered in a busy, resource constrained and often stressful clinical environment.

## Conclusion

Despite accessibility via multiple media forms and a high level of self-assessed use and regard for the Australasian Paracetamol Overdose Guidelines, clinicians routinely deviated from these recommendations when treating patients.

Biochemical analyses in excess of those advised comprised the most notable variance, and carried a significant opportunity cost. Novel approaches to improve adherence to clinical practice guidelines need to be considered to better support front-line clinical staff.

**Competing interests:** Nil.

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# The Wellington Life Flight Helicopter Emergency Medical Service (HEMS): a retrospective audit against new Ministry of Health criteria

Katherine Gordon, Andrew Swain, Callum Thirkell, Mark Bailey, Dave Greenberg

**Abstract**

**Aim** To analyse the clinical and operational indications for activating the Wellington Life Flight helicopter emergency medical service (HEMS) against draft Ministry of Health (MOH) criteria.

**Method** Wellington HEMS records for 3 years were reviewed. Details of mission location, timings, medical procedures, patient demographics, and primary reasons for dispatch were analysed.

**Results** 471 missions were reviewed. The main reasons for helicopter dispatch were anticipated time savings (47%), geographical access (36%), provision of skills (7%), or a combination (10%). In 62% of total missions, a road ambulance and helicopter were both dispatched. The helicopter was dispatched after the road ambulance had arrived at the scene in 52% of these cases, with a median lag time of 11 minutes and 12 seconds, and median waiting on scene time of 27 minutes 28 seconds. The road ambulance arrived first in 77% of cases. The median arrival time by air was 26 minutes compared to 11 minutes 45 seconds by road. In contrast, the transfer to hospital by helicopter was quicker in 99% of cases, with a median flight time of 15 minutes compared to 49 minutes by road.

**Conclusion** Wellington HEMS offers advantage over the road ambulance when dispatched and utilised appropriately. The majority of missions satisfied the MOH activation criteria but time-saving issues became apparent. Changes to the Helicopter Dispatch Flowchart have been proposed as a result. Further studies are required to assess any improvement in HEMS response times as the service develops. This data provides a benchmark for audits of future operational and clinical performance.

The Wellington Life Flight helicopter emergency medical service (HEMS) is an important healthcare service provided to the Greater Wellington Region (including the Wairarapa).

When a patient is critically ill or injured, and/or in a remote location, the emergency helicopter can be dispatched to deliver aid. Helicopters offer advantage over road ambulance as they travel at higher speed (190–290 kph), follow more direct routes, and avoid traffic and other road conditions that can slow land transport.[1] Additionally, advanced paramedic care can be delivered as the intensive care flight paramedics (ICPs) are trained to carry out advanced airway management, rapid sequence intubation (RSI), chest decompression, as well as the administration of additional medications.[2,3]

Appropriate use of HEMS is vital to maximize the patient benefit from this limited and expensive resource.[4] Saving time transporting the patient to hospital, or bringing more advanced medical skills than that provided by ground services, has been found to maximise patient benefit in trauma situations.[5] Additionally, it is important that the dispatch system clearly differentiates the more severely sick or injured from the less severely sick or injured, so that the service is primarily activated for patients with critical conditions.[6] It is clear that well-defined criteria are required to appropriately and effectively dispatch the Wellington HEMS to an incident.

The Clinical Advisory Group (CAG) constituted by the National Ambulance Sector Office (NASO) of the Ministry of Health (NZ) have summarised these criteria by means of the acronym ANTS, standing for Access, Number, Time and Skill.[7]

The aim of this study was to retrospectively analyse the clinical and operational activation of the Life Flight HEMS and audit this against the draft Helicopter Dispatch Protocols produced by NASO.

The response times of the helicopter compared to road ambulance, as well as the spectrum of work and the application of advanced clinical skills, were analysed for the first 3 years of the service. This information is critical for assessing the impact and efficiency of this potentially life-saving service and the benefits to the patient and the emergency services. The results will also provide a benchmark for further analyses and comparison against similar services.

## Method

**Study design—**All missions undertaken by the Wellington HEMS during the 3-year period from 28 October 2010 to 27 October 2013 inclusive were reviewed retrospectively. Data from helicopter flights were entered into an Excel spreadsheet (Microsoft Corporation, Redmond, WA) by the duty ICP.

Data recorded included the date, name of treating ICP, incident number, location, ambulance status of the patient at the scene and on arrival at the destination, ICP-level clinical interventions, case description and outcome.

Basic demographics for each patient (age and gender) were recorded. The following times were documented: 111 phone call received by the ambulance communication centre, helicopter activation, lift-off, arrival on scene, departure from the scene and arrival at the destination hospital. The cause of any delay was also documented.

The times from lift-off to arrival at the scene were taken from TracPlus software (TracPlus Global Ltd, Dunedin, NZ) which monitors and tracks the helicopter in real time. Other times (e.g. call received, activation time) were taken from Opus (3tc Software, Desford, UK) which logs them to the nearest second. From these absolute times, differences were calculated to establish intervals such as activation-to-liftoff, activation-to-arrival time, scene time, patient transport time etc.

Inclusion criteria were emergency flights in which a patient was transported and/or treated. Exclusion criteria were flights which were cancelled, or instances in which the patient was not transported or treated (e.g. police search missions).

One author (CT) who is both an ICP and a Communications Centre clinician experienced in helicopter dispatch, also analysed data from computerised Incident Detail Reports (VisiNet, Tritech Software Systems, San Diego, CA) to determine for each mission whether the helicopter was dispatched for reasons of access, number of patients, time factors, or skill requirements (ANTS criteria), or a combination of these, as detailed in Table 1 below.

**Table 1. ANTS criteria**

| | |
|---|---|
| **A – access:** | Where road access is difficult to the extent that a helicopter is the only feasible means of access to the patient (e.g. remote areas, areas without roads). |
| **N – number:** | Where the estimated number and condition of patients is such that sufficient personnel cannot reach the scene in a reasonable time by road. |
| **T – time:** | Where the patient has what is considered to be a "time-dependent" problem and use of a helicopter will significantly shorten:<br>The time for clinical personnel to first reach the scene, OR<br>The time for the patient to be transported to an appropriate hospital<br>Time-saving targets are:<br>Status 1 (time-critical) patient: the helicopter will transport more than 15 minutes faster than a road ambulance<br>Status 2 (time-urgent) patient: the helicopter will transport more than 30 minutes faster than a road ambulance<br>Status 3/4 (time-sensitive) patient: the helicopter will transport more than 2 hours faster than a road ambulance. |
| **S – skill:** | Where the patient appears to have a 'skill-dependent' problem (e.g. requires rapid sequence intubation (RSI), or specialised medications such as ketamine) and use of a helicopter with an appropriate paramedic will:<br>Significantly shorten the time for that skill to be delivered to the patient in accordance with the status code (see above) OR<br>b) Decrease the clinical risk to the patient during transport. |

**Response times—**The response times to the incident for helicopter and road ambulance were calculated and compared. Helicopter response times were taken from the database generated by the ICPs using TracPlus, whereas road ambulance data was obtained from VisiNet. In order to be comparable to the helicopter, response times for the closest ambulance capable of treating and transporting the patient were recorded. "Time saved" for transporting Status 1, 2, and 3 patients to hospital were compared against the NASO draft Helicopter Dispatch targets.

**Retrieval times—**In all cases analysed it was the helicopter that delivered the patient to the medical destination. The equivalent road transport times, if no helicopter had been available, were calculated from the exact patient address to the destination hospital using Google Maps (Google Inc, Mountain View, CA) to provide an estimated road transport time.

Definitions for the time intervals calculated are:

- **Time-to-liftoff** = interval between helicopter activation and being airborne.
- **Lag time** = time between road ambulance dispatch and helicopter dispatch.
- **Waiting time** = delay between road ambulance arrival and subsequent helicopter arrival at the scene.

Night missions were also compared with day missions.

The study was approved by the University of Otago Ethics Committee (H13/046).

## Results

Of 623 missions over the 3-year period, 471 matched the inclusion criteria. Of these, there were 126 in 2010-2011, 173 in 2011-2012, and 172 in 2012-2013.

**Demographics (Table 2)—**157 females and 314 (66.7%) males were rescued by the helicopter over the 3 year period. The peak age group was 55–64 years for females (20% of females) and 45–55 years for males (17% of males). The most common locations for rescue were Kapiti Coast (38%), South Wairarapa (12%), Wellington area (9%), and Masterton/North Wairarapa (9%). The most common clinical reasons

for rescue were trauma (54%), cardiac illness (13%), general medical conditions (8%), and collapse (6%).

**Table 2. Demographics of patients**

| Gender | | Age range | | Location | |
|---|---|---|---|---|---|
| Female | 33% | <6 months | 0.4% | Carterton | 2.5% |
| Male | 67% | 6–12 months | 1.1% | Horowhenua | 0.6% |
| | | 1–9yrs | 3.8% | Kaikoura | 0.8% |
| | | 10–14yrs | 3.0% | Kapiti Coast | 38% |
| | | 15–24yrs | 13.0% | Lower Hutt | 5.1% |
| | | 25–34yrs | 8.7% | Manawatu | 0.2% |
| | | 35–44yrs | 12.7% | Marlborough | 7.9% |
| | | 45–54yrs | 16.1% | Masterton | 8.9% |
| | | 55–64yrs | 14.6% | Nelson | 0.8% |
| | | 65–74yrs | 12.5% | Offshore | 0.8% |
| | | 75–84yrs | 10.4% | Other | 0.2% |
| | | 85–94yrs | 3.2% | Palmerston North | 0.2% |
| | | | | Porirua | 3.8% |
| | | | | South Wairarapa | 11.9% |
| | | | | Tararua | 1.7% |
| | | | | Upper Hutt | 7.4% |
| | | | | Wellington | 8.9% |

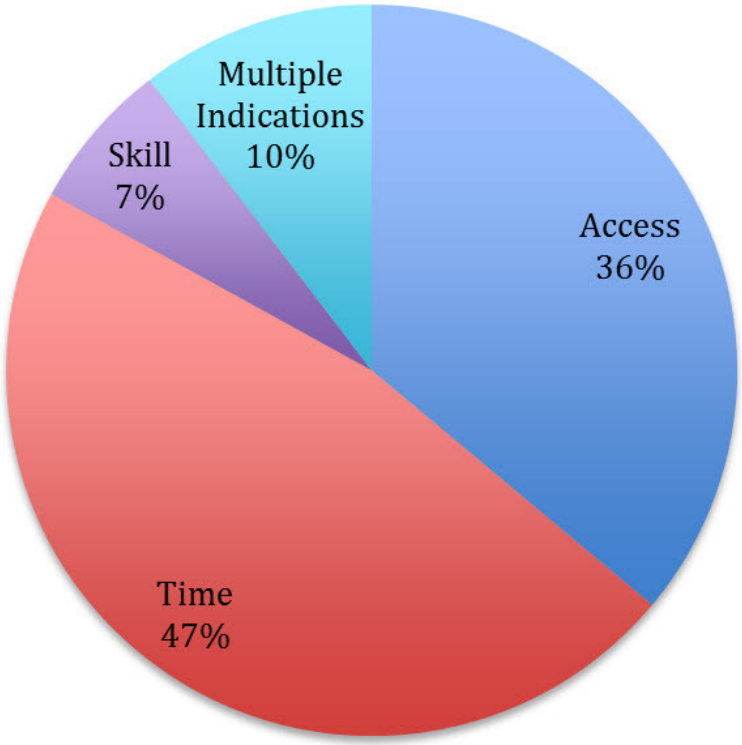
**Patient care—**Of the 471 flights analysed, the patient's condition on arrival was deceased (Status 0) in 1%, immediately life-threatening (Status 1) in 14%, potentially life-threatening (Status 2) in 38%, unlikely to be life-threatening (Status 3) in 31%, or of no threat to life (Status 4) in 14%. ICP procedures were used in 222 out of 471 missions, with 32 of these being RSI.

Advanced analgesia (ketamine or intravenous morphine with or without midazolam) was used in 133 missions (28%). Other ICP interventions were used in 29 missions and these included cardiac arrhythmia treatment, asthma medication, intravenous ceftriaxone, chest decompression, post-intubation sedation and/or paralysis, pulmonary oedema treatment, and thrombolysis.

Of the 69 Status 1 patients, 41% required RSI, 11% required ICP analgesia, 14% required other ICP interventions, 19% required multiple interventions, and 14% required no intervention.

**Application of ANTS criteria (Figure 1)—**Across the 3 years, the main indications for helicopter dispatch (Figure 1) were time (47%), access (36%), skills (7%), or a combination of these (10%). There were 18 occasions (4%) when the helicopter was dispatched because of a temporary lack of appropriately situated ambulance resources. On 18 separate occasions (4%), the reason for dispatching the helicopter was deemed "inappropriate".

**Figure 1. Primary reasons for helicopter dispatch**

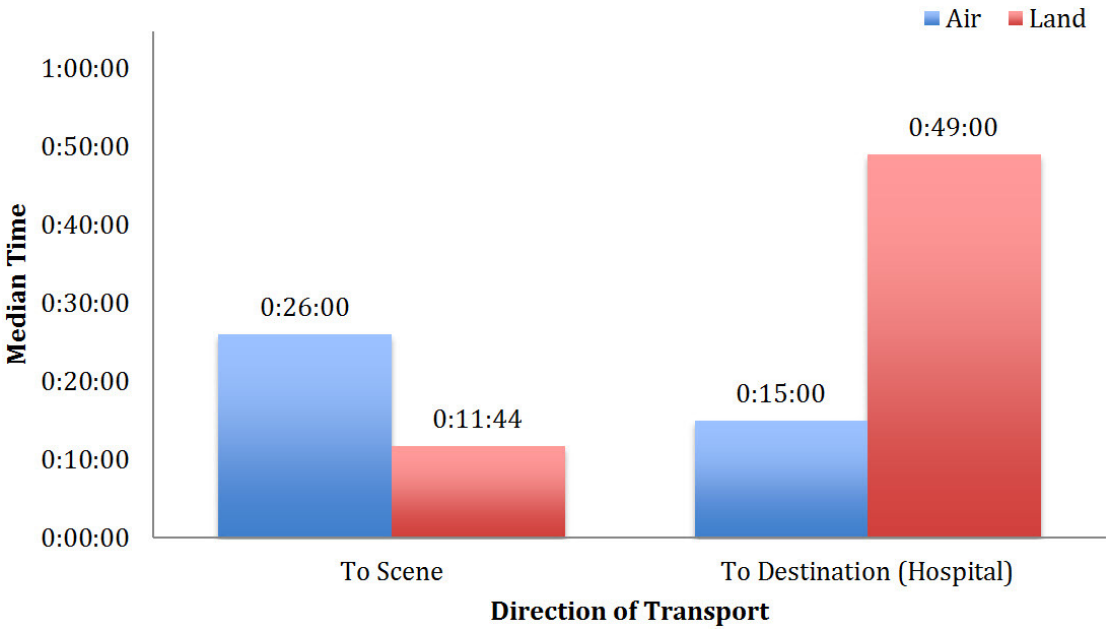



**Night missions—**Analysed separately from the 471 day missions, 32 missions were undertaken at night. ICP interventions in this group included RSI (2), ICP analgesia (5), and multiple interventions (1). The most common locations for night missions were Kapiti (28%), South Wairarapa (22%), Marlborough (13%) and Masterton (13%), with none in the Wellington area. The patients were therefore located in more distant or remote areas.

**Time intervals—**The median time-to-liftoff interval for day missions was 8 minutes (IQR 5m to 11m9s), compared to 18 minutes and 32 seconds (IQR 12m36s to 26m46s) for night missions. Median times from activation to arrival at the scene, as well as median time to destination from the scene were calculated, for both air and road transport (**Figure 2**).

From activation to arrival at scene, the median time was 26 minutes (IQR 20m50s to 36m28s) by helicopter and 11 minutes and 44 seconds (IQR 6m59s to 23m52s) by road. Therefore land transport, on average, reached the patient more quickly. In contrast, the median time from the scene to destination by helicopter was 15 minutes (IQR 11m24s to 19m53s), whereas median road time was 49 minutes (IQR 42m to 55m30s). Therefore air transport, on average, transferred the patient to the regional hospital more rapidly.

**Figure 2. Air versus land: median speeds for transport**




The helicopter spent a median time at the scene of 28 minutes (IQR 15m34s to 40m). In 292 of 471 (62%) helicopter missions, a road ambulance was also dispatched to the scene. When both helicopter and road ambulance were dispatched, in 154 out of 292 cases (53%) the helicopter was only dispatched after the road ambulance had arrived at the scene. In these cases, the median activation "lag time" was 11 minutes and 14 seconds (IQR 5m25s to 19m14s).

The median "waiting time" on scene for the helicopter was 27 minutes and 37 seconds (IQR 15m46s to 38m36s). Of the 292 cases when both helicopter and road ambulance were dispatched to the scene, 277 cases (95%) had complete outward and return time data for both air and road transport. From this data, the time saved in the return trip for each flight was calculated. In 259 of these 277 cases (94%) the helicopter saved time on the return trip.

When looking at missions where the primary reason for activation was "time", missions were categorised as to whether the patient was Status 1, 2 or 3/4 on paramedic arrival. To satisfy the targets listed in the NASO draft Helicopter Dispatch Protocol, the time saved in either direction by using the helicopter (i.e. either to reach the patient or to transfer the patient to hospital) must be 15 minutes for Status 1 patients; 30 minutes for Status 2 patients; and 2 hours for Status 3/4 patients.

When analysed, the median time saved by the helicopter was 35 minutes and 45 seconds for Status 1 patients, with 95% of incidents saving at least 15 minutes. The median time saved for Status 2 patients was 35 minutes, with 78% of incidents saving at least 30 minutes. The median time saved for Status 3/4 patients was 37 minutes and 15 seconds, with only 6% of patients benefiting from a time saving of at least 2 hours. However 8 of these patients (10%) had a secondary reason for helicopter activation, which provided justification for those trips.

The draft Helicopter Dispatch Protocol Flowchart (Appendix 1) was also considered. Author CT, who analysed the data in relation to the ANTS criteria, proposed ways in which the flowchart could be improved. The recommendations for both day & night dispatches, and the changes incorporated, are included in Appendix 2.

It should also be mentioned that the helicopter is occasionally used for interhospital transfers (18% of all transfers) and during this time, it is unavailable for emergency services.[8] The helicopter was used for 177 medical transfers during our study period.

# Discussion

The rational and appropriate use of Wellington HEMS is vital to ensure maximum benefit to patients while minimising potential costs and safety concerns. We can find no other published analysis of missions carried out by HEMS in New Zealand and this is the first to characterise reasons for helicopter dispatch in the Greater Wellington Region.

Sixty-six percent of Wellington HEMS patients were male, mainly in the age range of 45–55 years, and the common clinical indications were trauma (54%) and cardiac causes (13%). Most were retrieved from the Kapiti Coast (37%) or South Wairarapa (12%) which is consistent with our findings that "time" (47%) and "access" (36%) were the main reasons for helicopter dispatch.

Most patients were classified on arrival at the scene as Status 2 (38%) or Status 3 (31%), which was unexpected considering that the helicopter service is primarily intended for critically ill or injured patients. However, the "time" factor includes occasional situations in which a temporary lack of appropriately situated ambulance resources warranted use of the helicopter for patients with lower acuity conditions (18 instances in this study).

Interestingly, our expert found that 18 flights were dispatched for "inappropriate" reasons. We expect that with a clearer dispatch protocol, inappropriate activation should be reduced in the future.

Wellington HEMS is most often activated to reduce the time taken to transfer the patient to hospital and allow better access to the location. However, time saved is only beneficial if it includes both the outward and return helicopter journeys, especially as road ambulances usually respond from locations much closer to the patient.

In 53% of cases when both helicopter and road ambulances were used, the helicopter was dispatched 11 minutes after the ambulance had reached the scene. In these instances, it seems that the helicopter was dispatched more as an after-thought, rather than as a primary clinical resource. Furthermore, the median time the road ambulance spent waiting for the helicopter to arrive was 27 minutes. This has a significant impact on the total time taken by the helicopter to transfer the patient to the treating hospital. Despite these delays, use of the helicopter failed to save time in only 6% of cases.

When the primary reason for helicopter activation was "time", the majority of Status 1 and 2 patients met the NASO targets for time-saving (15 and 30 minutes respectively). However, 94% of missions involving Status 3 patients failed to save 2 hours.

The helicopter dispatch lag time and lack of time-savings for Status 3 patients highlight the need for clearer helicopter activation criteria for communication centre personnel responding to 111 calls. To try and achieve this, we have proposed changes to the draft Helicopter Dispatch Flowchart (Appendix 2).

Although only 32 night missions were completed during the study period, the availability of HEMS at night is still an essential service, particularly to more distant or remote areas. However, it does takes longer to respond at night when the crew are located off base. This is evident from the median time-to-liftoff of 18 minutes at night compared to 8 minutes during the day.

On average, road ambulances reached the patient 14 minutes faster than the helicopter, and were first to reach the scene 77% of the time. This finding is consistent with those reported in another study.[9] However, the Wellington Life Flight helicopter transferred the patient to hospital 34 minutes quicker, and achieved this faster than a road ambulance 99% of the time. This finding is consistent with that reported by Svenson et al[1] and it illustrates the need in critical cases for road and helicopter resources to be dispatched simultaneously to enable the fastest clinical response to the scene and the most rapid transfer to hospital.

By road and air transport working together, maximum patient benefit may be achieved. Although the helicopter spent 28 minutes at the scene with the patient, this could be reduced if the patient is stabilised and prepared for any ICP procedures and transport when the helicopter arrives. Scene times can be reduced by good coordination between helicopter and road ambulance personnel.[10]

Advanced clinical procedures such as RSI, specialised analgesia or medication, and chest decompression are vital skills provided by the ICPs on HEMS, and these were used in 47% of missions analysed in this study. These skills are expected to have a significantly beneficial effect on patient outcomes, particularly for Status 1 patients requiring RSI. Although RSI training has increased over the three-year period, we did not see a corresponding increase in the number of RSI cases. This suggests that the ICPs only use these skills when the situation demands it.

As a resulted of this study, some changes to the original helicopter dispatch flow chart have been proposed (see appendices 1 and 2). The specific skill set of the flight paramedic, in addition to the ICP skills possessed by this group, should be considered by the dispatcher. There are also situations in which local hospitals should be by-passed to enable a patient needing treatment in a regional or supraregional unit to be flown there directly. Finally, at night the dispatcher should take advice from the duty team manager if the senior paramedic advisor on the Clinical Desk (CD) is unavailable.

Limitations of this study include firstly its retrospective nature and reliance on administrative data. However, all timings and clinical details were cross-checked for accuracy against other databases.

Secondly, although data was missing or inadequate in some fields, this amounted to less than 5% in any category. With a sample size of 472, we did not consider this to be a major limiting factor.

Thirdly, although Google Maps were used to estimate the road transport time from the patient's location to the destination hospital, the time used was that quoted for traffic-free conditions. Bearing in mind that ambulances achieve their advantage mainly by cutting through traffic congestion, and that they are limited to only 30 kph above the speed limit for any section of road, it is believed that the calculations for time to hospital are accurate and do not favour the helicopter to any significant extent.

Fourthly, the classification of flights into the different ANTS criteria was not undertaken by an independent expert but relied on the expertise of a senior and experienced paramedic who was still employed by Wellington Free Ambulance at the end of the study.

Fifthly, the study did not explore patient outcomes in any depth. Therefore the results of this study cannot determine the efficacy of the service in terms of patient benefit nor cost-benefit. However, the data does highlight the need for clear helicopter activation criteria for communications personnel.

This study has significant implications for the future activation of Wellington HEMS. It has been proposed that NZ adopts an 'air desk' system, which allocates the role of helicopter dispatch to a specific control centre operated by flight-trained ICPs with more specialised knowledge. Similar systems are used in Nova Scotia[4] and the UK[11].

## Conclusion

The Wellington Life Flight helicopter is an essential life-saving service, and offers advantages over road ambulance when dispatched and utilised appropriately. When compared against the MOH draft dispatch protocol, the majority of missions meet the NASO time-saving criteria for Status 1 and 2 patients, but not for Status 3/4 patients.

This highlights the need for clear helicopter activation criteria for communication centre personnel responding to 111 calls. Potential changes to the draft national Helicopter Dispatch Flowchart have been proposed to try and achieve this. Further studies are required to assess whether there is any improvement in response times and times on scene as the HEMS service develops beyond its first 3 years. However, the data in this paper will serve as a benchmark for audits of future operational and clinical performance.

**Competing interests:** Nil.

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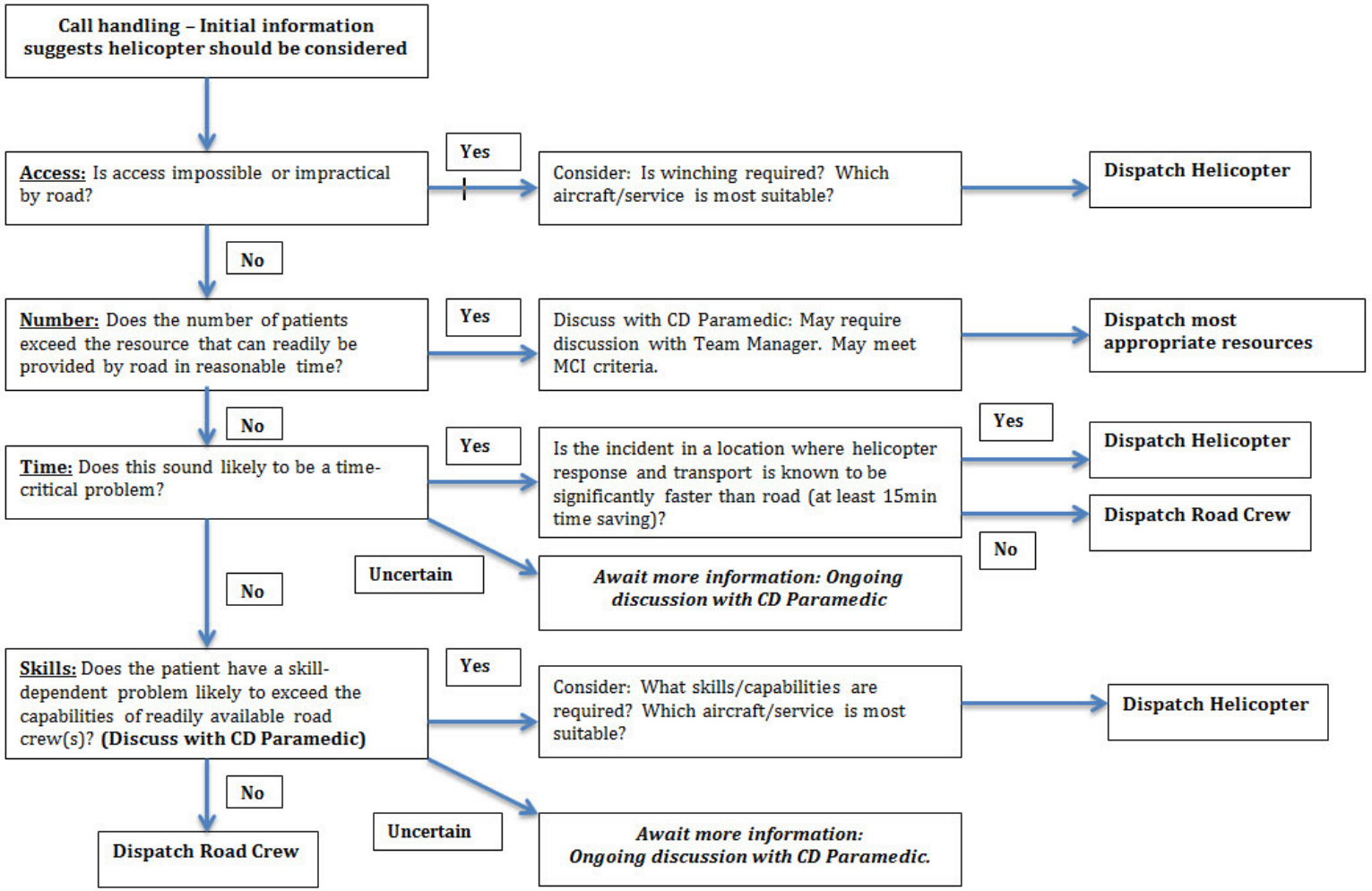
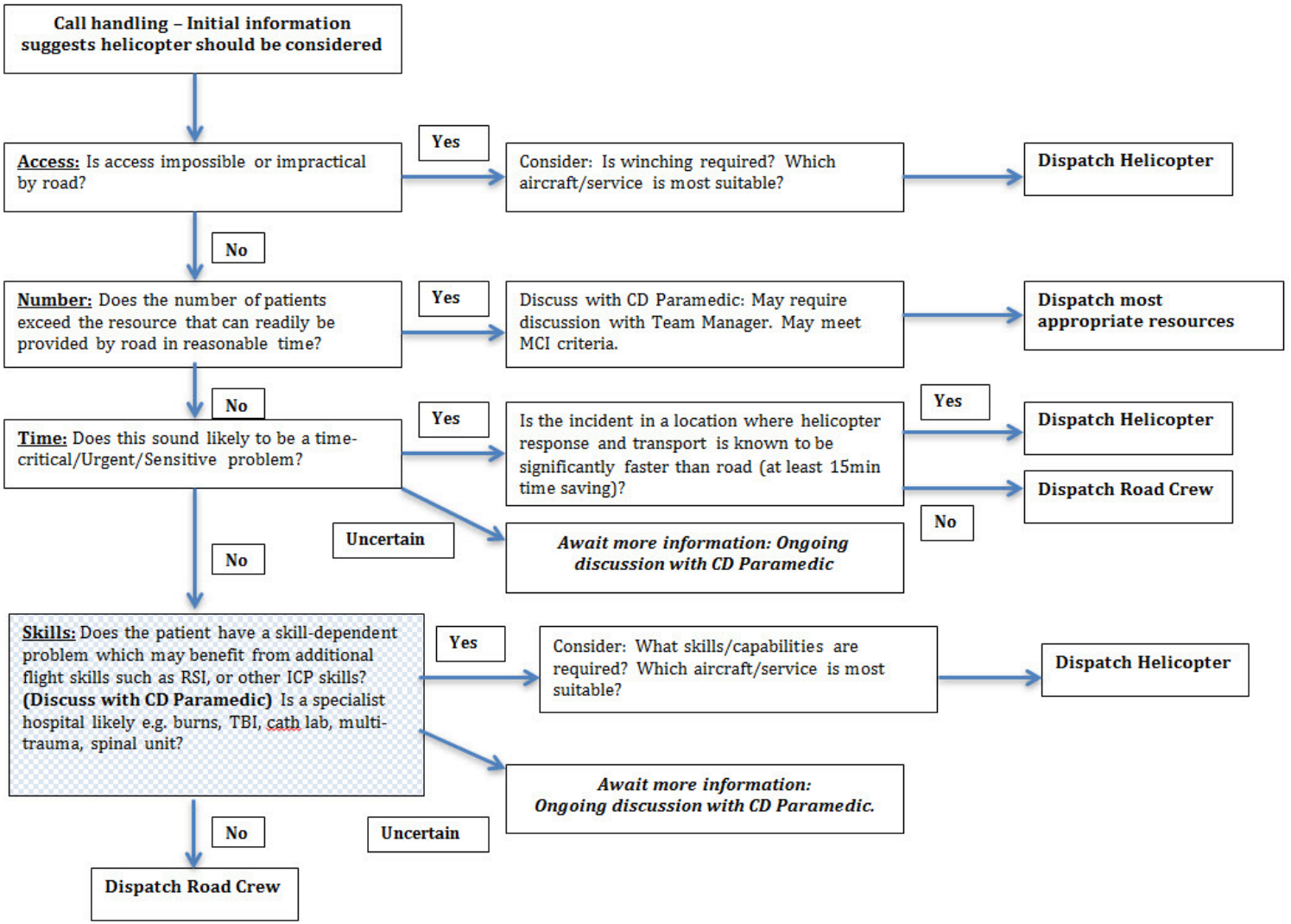
**APPENDIX 1:**

*Flow Chart:*
*Immediate (Dispatcher-initiated) Helicopter Dispatch (CD=Clinical Desk)*



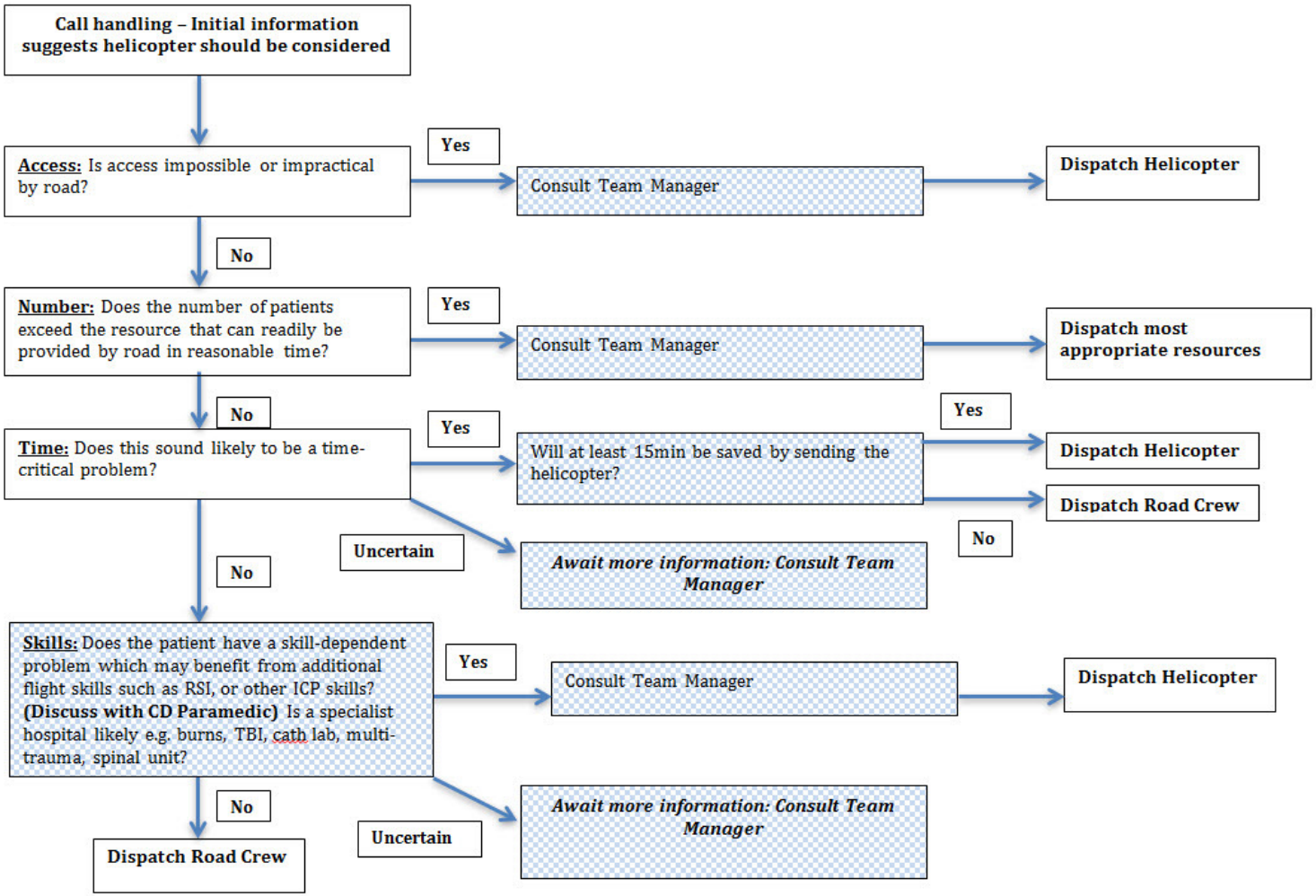
**APPENDIX 2:**

*Proposed changes to original flowchart – for day missions (see shaded boxes)*



**APPENDIX 2 (contd.):**

*Proposed changes to original flowchart – for night missions (see shaded boxes)*



THE NEW ZEALAND MEDICAL JOURNAL
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# Riding into the future: a snapshot of elderly mobility scooter riders and how they use their scooters

S John Sullivan, Steve La Grow, Sridhar Alla, Anthony G Schneiders

**Abstract**

**Aim** The purpose of the study was to understand the typical mobility scooter rider, how they use their scooter and the role it plays in their lives.

**Method** A 30-item purpose designed questionnaire was used to collect data on rider demographics and mobility status, reasons for purchasing and using a mobility scooter, patterns of scooter use, and the role it plays in the individual's life. Riders aged 65 years and older were recruited from the wider Dunedin community.

**Results** Thirty persons (15 males and 15 females) aged 65 to 90 years participated. Most experienced walking limitations with only 5 participants able to walk further than one block. The majority (80%) purchased their scooter to address their walking limitations. They had owned a scooter for a mean of 4.4 (range 1–19) years and most had purchased it privately without the input of a health professional. The majority of the group used their scooter 2–3 days per week.

**Conclusion** This study provides a snapshot profile of mobility scooter riders and how they use their scooters to increase their mobility within the community. This information is useful for service providers and planners working towards providing services and infrastructures for the aging population.

Mobility scooters, or 'powered mobility devices',[1] have become more visible on our footpaths and in our shopping precincts in recent years. This reflects the growing use of mobility scooters as both a mobility aid and as a form of personal transport, particularly among those older New Zealanders who experience mobility difficulties.

Almost 50% of people aged 65 and over have some form of disability and mobility-restricting physical and sensory disabilities are the most common.[2] Mobility scooters provide a way to facilitate an independent lifestyle for their owners and promote "aging in place" and participation in the community.

The proportion of the New Zealand population aged 65+ is rapidly increasing and expected to constitute 23% of the population by 2036 and 26% by 2061.[3] This group are likely to experience high levels of mobility limitations and are likely to turn to mobility scooters as a primary solution; yet, at present, little is known about the extent of mobility scooter use in New Zealand.[4] However, it is clear that sales and marketing (magazines and television) of scooters is increasing. This suggests the need for a greater understanding of the pressure on services and infrastructure in order to provide a safer operating environment and to reduce accidents.[5]

Studies from Australia,[6,7] Canada,[8,9] Netherlands,[10] Scandinavia,[11,12] the United Kingdom,[13,14] and the United States,[15,16] have provided insight into the acquisition and prescription, patterns of and barriers to use, and safety of mobility scooters. However,

these studies are specific to those countries and their respective built environments and socioeconomic and healthcare systems.

This study, part of a larger programme of research examining mobility and mobility scooter use in the aging population, seeks to provide an initial understanding of mobility scooter use in a typical New Zealand city.

As such it will provide information to inform planners, social policy developers, service agencies and health professionals of the mobility needs of our aging population so that they may be more adequately understood and prepared for.

Specifically, this exploratory descriptive study sought to gain an initial understanding of the typical mobility scooter rider, how they use their scooter and the role their scooter plays in their lives.

## Method

The study sought to recruit mobility scooter riders living in the wider Dunedin (New Zealand) area. The convenience sample was drawn primarily from the suburbs of Mosgiel and South Dunedin, which are well known for their gentle terrain, generally wide footpaths and higher than average density of elderly residents. Mobility scooters are frequently observed in these areas.

Persons who met the inclusion criteria of being aged 65 years or older and a self-reported regular mobility scooter rider were recruited via public notices, referrals from mobility scooter sales and service agents and via word of mouth.

The study was approved by the University of Otago Human Ethics committee and all participants provided written informed consent before participating. The study was conducted during August 2011.

A 30-item questionnaire sought information on: the demographics of the riders and their mobility status; why they purchased their scooter; how they used it and barriers to its use. The questionnaire was developed specifically for this study and was based on; established questionnaires,[17] questions used elsewhere and adapted for the goals of this study,[6,7] and questions constructed based on the findings of a series of focus groups[18] conducted by the research team to better understand the phenomenon of mobility scooter use. Collectively, this assured the face validity of the contents of the questionnaire.

Generally a closed-question format was used, while others required participants to provide a short written response or complete a visual analogue scale. The wording was carefully chosen and reviewed to be age appropriate and presented in an easy to read manner, to facilitate completion.

Participants who expressed an interest in participating were contacted by phone and a time and place, usually their homes, to complete the questionnaire was established.

A member of the research team met with the participant and explained the requirements for participation and provided assistance in answering questions when needed. Participants were informed that they could complete all or some of the questions. The time to complete the questionnaire varied but was generally completed in approximately 30 minutes.

On completion of the questionnaire all participants were offered a grocery voucher as compensation for their time and contribution to the project.

The data were coded where necessary and entered into an Excel spreadsheet. Descriptive statistics including means and frequencies were computed using IBM SPSS Statistics for Windows, Version 20.0 (Armonk, NY: IBM Corp).

## Results

Equal numbers (N=15) of males and females were recruited with ages ranging from 65 to 90 years (Mean=78.2). Twenty-nine persons reported their ethnicity as being New Zealand European and one as Australian. Less than half (40%, 12/30) lived alone, while 60% (18/30) reported having two or more chronic health conditions.

The majority reported difficulties in walking: with 90% (27/30) able to walk inside the home; 73% (22 /30) around the home or garden; 43% (13/30) able to walk a block and only five persons (17%) reported that they could walk further than one block.

Participants used a number of mobility aids including; a cane (N=17), a crutch (N=7) and a walking frame (N=6). Participants had owned a mobility scooter from between 1 and 19 years (Mean=4.4).

The reasons they purchased a scooter are shown in Table 1. Most (22/30, 73%) purchased their scooter with private funds with a smaller group (N=6) obtaining funding support from the New Zealand Lottery Grants Board.

**Table 1. Participants' reasons for purchasing their mobility scooter**

| Reasons for purchasing | Persons reporting – n (%) |
|---|---|
| Inability or difficulty with walking | 24 (80%) |
| Stopped driving | 12 (40%) |
| Observed others | 10 (33%) |
| Poor health or serious illness | 9 (30%) |
| Felt isolated | 8 (27%) |
| Partner stopped driving | 3 (10%) |

**Note:** Participants could indicate as many reasons as applied, therefore, the percentage of responses do not add up to 100.

Approximately one-half (14/30, 47%) of the participants purchased their scooter of the own accord, while 10 (33%) did so on the recommendation of a family member or friends, and only 5 persons (17%) on the advice of a health professional.

Twenty-three persons (77%) indicated that they received a demonstration and/or instruction on how to operate their scooter with only 3 (10%) stating that this was provided by a health professional.

Scooter use varied in a typical week with 17% (N=5) indicating they used their scooters on a daily basis, 33% (N=10) between 4-5 days per week, 43% (N=13) 2–3 days per week and two persons reporting they used their scooters just 1 day per week. It was estimated that the average trip length as 7.2 (±0.51) km. The purpose of these trips are presented in Table 2. On these excursions participants reported a range of barriers to their mobility scooter use, these are presented in Table 3.

**Table 2. Participants' reasons for using their mobility scooter**

| Reason for travel | Persons reporting – n (%)* |
|---|---|
| Shopping | 27 (90%) |
| Visit a doctor | 23 (77%) |
| Bank | 20 (66%) |
| Post shop | 19 (63%) |
| Visit friends/family | 14 (47%) |
| Recreation | 9 (30%) |
| Volunteer/paid work | 4 (13%) |

*Participants could provide multiple responses.

**Table 3. Barriers to mobility scooter use**

| Identified barrier | Persons reporting – n (%)* |
|---|---|
| Uneven footpaths | 22 (73%) |
| Kerb height | 21 (70%) |
| Pedestrians | 21 (70%) |
| Potholes | 11 (37%) |
| Street crossings | 10 (33%) |
| Limited accessibility to buildings/shops | 9 (30%) |
| Motorists | 6 (20%) |
| Hills and slopes | 6 (20%) |
| Other scooter users | 3 (10%) |

*Participants could provide multiple reasons.

In general, participants were very satisfied (90%) with their scooter as a means to getting around. Not only did it increase their mobility, and independence (90%) they also reported that the best part of owning a scooter was that it increased their ability to participate in their community (14/30, 47%) and afforded them great recreation and leisure opportunities (24/30, 80%).

Participants were asked to rate their ability to get around on a 1 to 10 visual analogue scale as they perceived it to be before and after they obtained a mobility scooter. The mean score for ability to get around increased from 3.3 to 9.3 from before to after the scooter was obtained.

## Discussion

This snapshot of a small group of mobility scooter rides provides insight into the reasons they purchased their scooter and how they use it to overcome their mobility limitations and maintain their independence in their communities. These data are similar to those reported in other countries,[6-8 13] and confirm the emerging importance of mobility scooters within New Zealand's aging population.

With the projected rise in the number of persons aged 65 and over it is reasonable to assume that there will be an increasing number of persons using mobility scooters in the immediate future. This should highlight to both healthcare professionals and planners the need to consider the specific demands of this emerging group when developing and forecasting services for the aging population.

The riders reported severe mobility limitations which challenged their ability to walk even short distances. Yet, all rated their ability to get around as either very good or excellent due to the availability of their mobility scooter.

Their mobility limitation was often accompanied with other comorbidities reinforcing the central role scooters play in keeping them active and connected in their communities. The inability to walk several blocks is a severe limitation for a person living in the community and creates a dependence on others in the form of a support person or taxi service to complete regular errands or to visit a doctor.

For the participants in this study their scooter was their prime form of transport and in several instances the scooter replaced the ownership of a car following the loss of a

drivers licence. Their regular use of the scooter suggests that ownership facilitated their independence in a wide range of activities including shopping, socializing and for recreational purposes.

The independence gained by scooter ownership clearly enhanced their ability to "get around" in their community. While the use of a mobility scooter can facilitate geographical mobility it also has the potential in those who have minimum mobility restrictions to reduce the actual amount of walking an individual may do. This may in turn impact on their overall health status.

Providing an infrastructure conducive to the safe use of mobility scooters is primarily the responsibility of local authorities who maintain the footpaths, roads and signage. The state of the footpaths, kerbs and crossings all presented as barriers to the safe use of mobility scooters, and are potentially able to be fixed through regular maintenance or in some situations as part of planning exercises.

The recognition of the needs of mobility scooter users is only just beginning to appear in key policy documents which noted "we could also focus on the safety of mobility devices" as an area of future focus in discussing the older driver.[19] Clearly, there is still considerable work to be done to ensure adequate planning is taking place to serve the needs of this emerging group of footpath (and road) users.

Individuals are able to gain funding assistance from the Lottery Individuals with Disabilities programme[20] to purchase a scooter, and thus most probably had professional advice as to whether they need a mobility scooter and what was the most appropriate scooter for their needs. However, the majority of the participants in this study purchased their scooter privately. This raises the issue of whether they received any advice when purchasing their scooter or not. Very few participants (n=5, 17%) obtained the advice of a healthcare professional in the choice of their scooter or in learning how to operate it safely. This is a similar finding to that reported (10.9%) in a recent Australian study.[6]

Scooters can be purchased from dedicated dealers and distributors, internet sales sites or secondhand traders, thus the level of advice and instruction can vary considerably. This applies equally to whether the scooter is suitable for the client and their needs, and for instruction in the safe operation of machine.

While sales staff are well positioned to provide information and training they are also working in a commercial environment and may or may not have the time to provide detailed advice and or instruction. Thus, there is an emerging role for health professionals to provide independent advice to those considering whether a mobility scooter is the appropriate and safe mobility solution.

This study is limited by the relatively small sample from just one geographic region of the country. Thus it is not representative of mobility scooter riders throughout New Zealand and should be considered as a descriptive survey as the results do not necessarily generalize to the wider user group.

The survey area was carefully chosen due to its mixed socio-demographic characteristics and pockets of retired community dwelling persons with a highly visible number of mobility scooter users. Thus it provides a sound description of this emerging group and some insight into their future needs.

The acquisition of a mobility scooter is a major decision in helping persons to maintain their independence. For many persons on a fixed income it is also a costly decision and one in which they may benefit from professional advice.

Healthcare professionals need to be informed of the benefits associated with the ownership and use of a mobility scooter by our aging population.

**Competing interests:** Nil.

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# Biases in describing residents in long-term residential aged care

Joanna B Broad, Toni Ashton, Thomas Lumley, Michal Boyd, Ngaire Kerse, Martin J Connolly

## Abstract

**Aim** In New Zealand, no reliable information describes use of long-term residential aged care. Instead, when estimating use, records of government subsidy payments are upscaled to adjust for private payers. This paper assesses consequential bias in reporting use of long-term care and considers the implications.

**Methods** Data from OPAL, a census-type survey of residents of aged-care facilities in Auckland in 2008, linked to routinely-collected hospitalisation, mortality and subsidy data from national databases. Demographic, functional and service use characteristics of unsubsidised residents were compared to subsidised.

**Results** Records of 5961 OPAL residents aged 65+ years were matched with subsidy data; 25% were unsubsidised. In low-level care (51% of all), unsubsidised residents had similar care needs to subsidised residents, but were 1.7 years older on average ($p<0.001$) with shorter length of stay. In high-level care (41% of all), unsubsidised residents had significantly lower care needs on six different measures and were less likely to die during the follow-up period. Upscaling yields undercounts at all care levels.

**Conclusions** National reports derived from current upscaling methods undercount residents. Stratification by region and age group would improve estimates. Age and care needs are misrepresented. Population policies that depend upon upscaled counts should, where possible, ascertain the biases introduced.

## Abbreviations:

| | |
|---|---|
| CCPS | Client Claims Processing System |
| DHB | District Health Board |
| GP | General Practitioner |
| interRAI LTCF | interRAI Long-Term Care Facilities Assessment System |
| MoH | Ministry of Health |
| NHI | National Health Index |
| NZ | New Zealand |
| NZACA | New Zealand Aged Care Association |
| OECD | Organisation for Economic Co-operation and Development |
| OPAL | Older People's Ability Level survey |
| RAC | residential aged care |
| SD | standard deviation |
| UN | United Nations |

Information used to describe use of residential aged care (RAC) in New Zealand (NZ) has been poor, there being no organisation or system that records all residents.[1] As a result, when estimates of demand are required—for improving care quality, workforce or service planning, financial budgeting or investment planning—estimates are based upon the only available data, namely payments for government-subsidised RAC.

Means-tested subsidies are available to NZ residents aged 65 years or over (65+) who are assessed as needing residential care, whether in rest-home care (lower level care), or in higher levels of care (specialised secure dementia care, hospital or psychogeriatrics care).[2] However those not subsidised—believed to be 33% to 38%—are not included.[3]

Upscaling is therefore used in official counts to adjust for private payers. NZ counts supplied for international comparisons, e.g. to the United Nations[4] (not upscaled) and the OECD[5] (upscaled) are also based on subsidy payments records.

Upscaling of data to account for people with absent, incomplete or missing information is a long-established and accepted method of counting whole populations.[6,7]

Unless explicitly manipulated, upscaling inherently assumes that the unknown 'people' are similar in all relevant respects to those for whom information is available. If residents who pay privately or are funded through other sources such as regional schemes for palliative care (and therefore are absent from the government payments systems) are dissimilar to those in the subsidy databases—by gender, age or care needs for example—demand estimates may mislead. In other populations those who pay privately differ from those whose care is subsidised, for example private payers in Korea need lower levels of care,[8] and in the USA are hospitalised less.[9,10]

Whether use of upscaled information from subsidised residents fairly describes total use in NZ is unknown. Assessing the accuracy of information about utilisation and demand is important to address, especially given that in NZ use of RAC in late-life appears higher than other countries.[11]

## Subsidy systems in New Zealand

Means-tested RAC subsidies for those aged 65+ years cover the full costs of care where assets are below a defined threshold.[12] Additionally, those in high-level care and who would otherwise pay privately (because their assets are higher than the threshold) are entitled to receive a "top-up" subsidy for costs that exceed an amount known as the "maximum contribution". This maximum contribution is central to upscaling. The level is set at the most recently agreed contract price in each local authority area for 24-hour rest-home care. It is the same for all residents regardless of the level of care they receive.[13]

The proportion of residents receiving a government subsidy varies by place and over time, partly through normal fluctuations and partly because, after 2006, the asset threshold increased by $10,000 annually (until 2012, after which the annual increase is set by the Consumer Price Index).[2,14] In July 2013 the asset threshold was $215,132. Subsidy recipients retain a small personal allowance, but otherwise their superannuation or other pension or main benefit contributes directly to the costs of care.[2]

## Upscaling to count RAC use

Because the cost of high-level care is always greater than the maximum contribution, all those in high-level care are assumed to receive a subsidy. Counts of the number of residents in this level of care are therefore not upscaled. But for counting those in rest-home care, counts of the "known", i.e. those receiving a subsidy, are upscaled. The extent of upscaling, the "upscaling factor", is determined by the proportion of all in continuing high-level care (continuing hospital care, specialist dementia care or psychogeriatrics care) who pay the maximum contribution privately and receive a "top-up" payment [MoH personal communication, April 2013].

The expressed assumption is that the proportion subsidised is the same across all levels of care.

Ministry of Health (MoH) estimates that in 2008 32% of residents in high-level care received a "top-up" subsidy[15] and would not have been subsidised if in lower-level care. The upscaling factor applied to counts of residents known to be in rest-home care was therefore:

1/(proportion on higher-level care subsidy)
=1/(1-0.32)
=1/0.68
=1.47

The impact of upscaling is therefore substantial, for it implies an increase of 47% over the residents known to receive subsidy payments. Based on that, for 2008, MoH official estimates were that 5.2% of the population aged 65+ years were in RAC at any one time, 15.4% of those aged 85 years or over.[3]

This paper examines whether unsubsidised residents differ systematically from private payers in demographic or functional characteristics, considers whether current upscaling methods lead to bias, and makes suggestions to improve national RAC estimates.

## Methods

In 2008, we conducted OPAL, a census-type survey of RAC facilities in the Auckland region.[16,17] Pre-coded forms were delivered to all certified facilities, with facility staff completing one form for each resident on the survey night (10 September 2008). Questions covered 36 demographic, functional and care items.

Residents were classified by bed type—predominantly rest-home care, dementia care, continuing hospital care or psychogeriatrics care. In all, 154 (89%) of all 172 eligible facilities participated. Of these, 149 also provided separate, numbered lists of National Health Index (NHI) numbers, the unique personal health identifiers enabling linkage to national service use datasets. Validity of NHI numbers was checked using a check-digit calculator and corrections made where possible. Survey methods are described in detail elsewhere.[16,17]

OPAL residents (n=6816) were categorised into one of three distinct care groups: rest-home (including short-stay such as respite care but excluding dementia care), dementia care, and hospital care (including psychogeriatrics care). We dropped people with no suitable matching NHI (n=525), those aged under 65 years (n=341) because subsidy criteria differ for younger residents, and those in other care groups (n=92). Some were dropped for more than one reason. Thus we retained for these analyses only those 5961 residents who were matched (by NHI, gender and age).

Subsidy data for residents were sourced from transactions data from the MoH Client Claims Processing System (CCPS). Each resident was classified as in receipt of a rest-home care subsidy, a dementia care

subsidy, a hospital care subsidy, or as having no record of a subsidy in the two-week subsidy payment period around the survey.

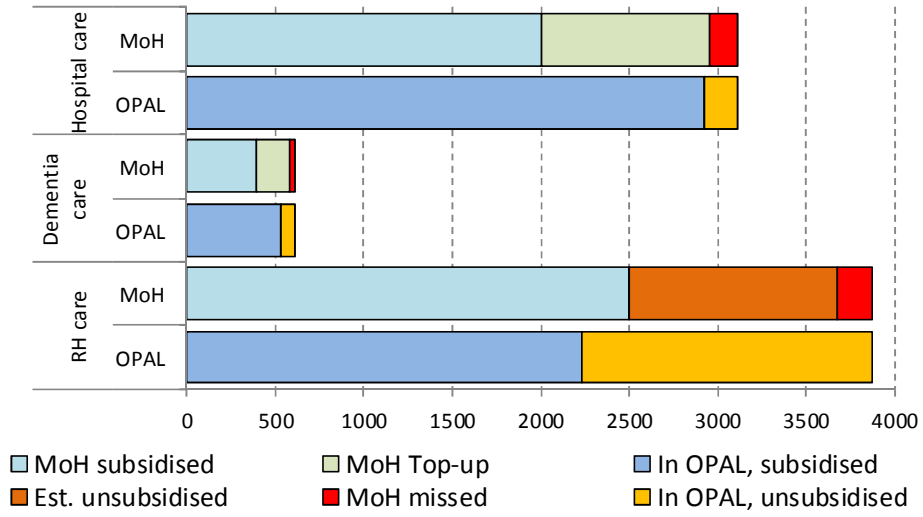
In the few instances where a resident received two or more subsidies, such as during a period of change, the higher-level subsidy was used. Electronic records of public hospitalisations, emergency department presentations and deaths during the 22-months following the survey were obtained from routinely collected MoH data.

Demographic, selected functional characteristics and service use (retrospectively and prospectively) of subsidised and non-subsidised residents were compared. Absolute differences with 95% confidence intervals were tabulated and tested using chi-square and t-tests. Upscaling factors for each of three age-groups in rest-home care were recalculated based on OPAL data using the formula shown above. Ethics approvals were obtained for the survey (NTX/08/49/EXP) and for matching to health and subsidy data (NTX/10/EXP/087).

## Results

**Receipt of subsidy—**Of the 5961 residents, about half (3059, 51%) were classified by the facility staff as in rest-home care, 445 (8%) were in specialised dementia care, and 2457 (41%) in hospital-level care (Figure 1). Linkage with subsidy payments data revealed that 30% received a rest-home subsidy, 6% a dementia care subsidy and 39% a hospital subsidy (Table 1).

**Figure 1. Comparison of Auckland OPAL counts with MoH upscaled counts**




Overall, no subsidy was paid for 25%: 43% of those in rest-home care, 13% in dementia care and 6% in hospital-level care. Of those in rest-home care, 55% received a rest-home subsidy and 2% a higher level subsidy. Of those in hospital-level care, 92% received a hospital-level care subsidy and 2% a lower level subsidy (Table 1).

**Upscaling factors—**To estimate the total number of rest-home residents (unsubsidised and subsidised) from subsidy records, the upscaling factor would be:

Number in rest-home care in OPAL/Number on rest-home subsidy(s)
=3059/(0.296*5961)
=3059/1764
=1.7345

Effectively, each 100 residents on a rest-home care subsidy in Auckland represented 173 residents. Use of a scaling factor of 1.47 would "miss" 466 Auckland residents (Figure 1).

The unsubsidised proportion rose with age group, so improved age-specific upscaling factors for rest-home care increased from 1.31 in those aged 65–74 years, to 1.69 in those aged 75-84 years and 1.84 in those aged 85+ years.

Unsubsidised residents were identified in higher care levels as well as rest-home level care. Upscaling factors specific to care level would be: 1.24 (=445/(0.06*5961)) for dementia care and 1.05 (=2457/(0.391*5961)) for high-level care.

**Table 1. Receipt of subsidies among residents aged 65 years and over**

| | Care type in OPAL: | | | |
|---|---|---|---|---|
| | Rest-home n=3059 51.3% | Dementia n=445 7.5% | Hospital n=2457 41.2% | All n=5961 100% |
| | % | % | % | % |
| Subsidy type: | | | | |
| Rest-home subsidy | **55.3** | 6.3 | 1.9 | 29.6 |
| Dementia care subsidy | 0.2 | **77.1** | 0.3 | 6.0 |
| Hospital subsidy | 2.0 | 3.8 | **91.7** | 39.1 |
| No subsidy, private paying | 42.5 | 12.8 | 6.1 | 25.3 |

**Resident characteristics—**On average, unsubsidised *rest-home* residents were 1.7 years older than subsidised residents at the time of survey ($p<0.001$), 3.1 years older when first admitted to the facility ($p<0.001$) and their stay-to-date in the facility 1.4 years shorter ($p<0.001$) (Table 2).

In most functional and care needs unsubsidised and subsidised residents were similar. However, the unsubsidised appear to be less bed- or chair-bound (2% vs. 4%, $p=0.05$), need less help to eat (2% vs. 4%, $p=0.04$), and more often visited an emergency department during the following 22 months (50% vs. 43%, $p<0.001$).

In *hospital-level care,* in many respects the unsubsidised and subsidised were similar (Table 3). However they were significantly more likely to be men, were as likely to be married or partnered, and were less dependent—in needing help to walk, being chair or bed-bound, needing attention at night, orientation to time and/or place, and urinary incontinence. More were seen urgently in the 2-weeks prior to OPAL (11.3% vs. 3.8% respectively, $p<0.001$) however fewer died within the 22-month follow-up period (39.3% vs. 54.5%, $p=0.003$).

Comparisons for those in *dementia care* showed the 13% unsubsidised were similar except they were less likely to require attention at night (63.2% vs. 78.9, $p=0.009$) and less often seen by a GP in the 2-weeks prior to OPAL (3.5% vs. 15.5%, $p=0.015$) (results not shown).

**Table 2. Characteristics of rest-home residents aged 65 years and over**

| | Unsubsidised n=1299 | Subsidised n=1760 | Difference (95%CIs) | p-value |
|---|---|---|---|---|
| Men (%) | 26.3 | 27.6 | -1.36 (-4.54, 1.81) | 0.40 |
| Married or partnered (%) | 14.6 | 16.0 | -1.42 (-3.99, 1.15) | 0.28 |
| Age group at survey (%): | | | | |
| 65-74 years | 6.3 | 12.8 | | |
| 75-84 years | 28.5 | 30.7 | | |
| 85+ years | 65.2 | 56.5 | | <0.001 |
| Age at survey, years (mean, SD) | 86.4 (6.9) | 84.7 (7.9) | 1.7 (0.1, 2.2) | <0.001 |
| Age at admission, years (mean, SD) | 84.5 (7.0) | 81.4 (8.5) | 3.1 (2.6, 3.7) | <0.001 |
| Length of stay, years (mean, SD) | 1.8 (2.1) | 3.3 (3.6) | -1.4 (-1.6, -1.2) | <0.001 |
| Admitted from acute hospital (%) | 31.4 | 30.9 | 0.56 (-2.76, 3.88) | 0.74 |
| Needs help to walk (%) | 4.8 | 4.7 | 0.11 (-1.41, 1.63) | 0.88 |
| Chair or bed-bound (%) | 2.4 | 3.6 | -1.25 (-2.46, -0.04) | 0.049 |
| Needs help to eat (%) | 2.2 | 3.5 | -1.29 (-2.47, -0.11) | 0.038 |
| Needs help to use toilet (%) | 20.3 | 19.1 | 1.23 (-1.62, 4.09) | 0.40 |
| Needs attention at night (%) | 36.6 | 36.1 | 0.43 (-3.02, 3.88) | 0.81 |
| Lost orientation to time (%) | 29.3 | 26.3 | 3.02 (-0.20, 6.24) | 0.064 |
| Lost orientation to place (%) | 12.0 | 11.3 | 0.70 (-1.60, 3.01) | 0.55 |
| Incontinent of urine (%) | 26.1 | 27.7 | -1.57 (-4.75, 1.60) | 0.33 |
| Persistently wanders (%) | 3.7 | 3.9 | -0.23 (-1.59, 1.14) | 0.75 |
| Behaviour disturbs (%) | 13.1 | 14.6 | -1.46 (-3.92, 1.01) | 0.25 |
| In two weeks prior to OPAL survey: | | | | |
| Seen acutely by GP (%) | 12.4 | 10.9 | 1.54 (-0.77, 3.85) | 0.19 |
| Seen urgently in hospital (%) | 3.8 | 3.4 | 0.36 (-0.98, 1.70) | 0.59 |
| In 22-months after OPAL survey: | | | | |
| Emergency department visit (%) | 50.4 | 42.6 | 7.73 (4.16, 11.30) | <0.001 |
| Any hospital stay (%) | 56.3 | 55.3 | 0.99 (-2.57, 4.55) | 0.78 |
| Death (%) | 32.3 | 33.1 | -0.74 (4.10, 2.63) | 0.67 |

**Table 3. Characteristics of hospital residents aged 65 years and over**

| | Unsubsidised n=150 | Subsidised n=2307 | Difference (95% CIs) | p-value |
|---|---|---|---|---|
| Men (%) | 38.0 | 30.4 | 7.61 (-0.38, 15.61) | 0.050 |
| Married or partnered (%) | 26.7 | 26.9 | -0.21 (-7.51, 7.10 | 0.96 |
| Age group at survey (%): | | | | |
| 65-74 years | 16.0 | 11.6 | | |
| 75-84 years | 28.0 | 33.4 | | |
| 85+ years | 56.0 | 55.0 | | 0.17 |
| Age at survey, years (mean, SD) | 84.1 (8.8) | 84.7 (7.7) | -0.6 (-2.0, 0.9) | 0.42 |
| Age at admission, years (mean, SD) | 81.7 (9.8) | 82.3 (8.0) | -0.5 (-1.8, 0.8) | 0.51 |
| Length of stay, years (mean, SD) | 2.3 (3.7) | 2.4 (2.6) | -0.1 (-0.5, 0.4) | 0.75 |
| Admitted from acute hospital (%) | 56.7 | 55.6 | 1.10 (-7.09, 9.28) | 0.79 |
| Needs help to walk (%) | 9.3 | 17.6 | -8.31 (-13.22, -3.40) | 0.009 |
| Chair or bed-bound (%) | 36.7 | 46.3 | -9.58 (-17.56, -1.61) | 0.022 |
| Needs help to eat (%) | 28.0 | 35.0 | -7.02 (-14.47, 0.42) | 0.080 |
| Needs help to use toilet (%) | 54.7 | 58.3 | -3.59 (-11.82, 4.63) | 0.39 |
| Needs attention at night (%) | 80.7 | 88.3 | -7.63 (-14.08, -1.18) | 0.006 |
| Lost orientation to time (%) | 42.7 | 58.3 | -15.68 (-23.84, -7.51) | 0.002 |
| Lost orientation to place (%) | 34.7 | 46.7 | -12.06 (-19.94, -4.18) | 0.004 |
| Incontinent of urine (%) | 46.0 | 60.6 | -14.55 (-22.78, -6.33) | 0.004 |
| Persistently wanders (%) | 6.7 | 5.9 | 0.77 (-3.33, 4.88) | 0.70 |
| Behaviour disturbs (%) | 19.3 | 22.0 | -2.69 (-9.33, 3.86) | 0.44 |
| In two weeks prior to OPAL survey: | | | | |
| Seen acutely by GP (%) | 20.9 | 16.6 | -4.11 (-2.55, 10.76) | 0.19 |
| Seen urgently in hospital (%) | 11.3 | 3.8 | 7.52 (2.39, 12.65) | <0.001 |
| In 22-months after OPAL survey: | | | | |
| Emergency department visit (%) | 55.3 | 49.8 | 5.57 (-2.64, 13.79) | 0.19 |
| Any hospital stay (%) | 56.7 | 50.8 | 5.91 (-2.28, 14.10) | 0.16 |
| Death (%) | 39.3 | 54.5 | -15.15 (-23.23, -7.08) | <0.001 |

## Discussion

Resident characteristics—Of all residents matched, 25% were unsubsidised: 43% in rest-home care, 6% in hospital-level care and 13% in dementia care. Differences between unsubsidised residents and others were observed in demographic and functional characteristics, and in service use.

In *rest-home* care, the 43% that were unsubsidised appear to be similarly dependent as those subsidised, although older and having shorter lengths of stay. Mortality of the two groups was also similar. Small differences between unsubsidised and subsidised residents in being bed- or chair-bound and in needing help to eat are not compelling given the number of statistical tests.

It is curious that the higher rate of urgent hospital presentation post-survey was not observed in the 2-weeks prior to the survey as reported by facility staff nor in actual admissions post-survey. For this care level, the current upscaling method does not bias estimates with respect to care needed, but bias does arise in terms of resident age (undercounting the very old) and length of stay (overstating duration of stay). Overall counts are marked underestimates.

A dissimilar pattern was seen in the 6% who were unsubsidised in *hospital-level care*; they had better function and longer survival than the subsidised. The reasons are unclear: they or their families may be more able to access services, facilities could accept their entry in part as a less resource-intensive income stream, or subsidised residents could enter later in their disability process than others. A longitudinal population-based study would describe care pathways and address these questions.

**Geographic variability—**With 43% of OPAL rest-home residents being unsubsidised, an upscaling factor for Auckland would be 1.73, rather than the 1.47 MoH uses for NZ overall. When the MoH national upscaling factor was used, 466 Auckland residents were missed (Figure 1). To cross-check these results, the CCPS data were checked for Auckland; 40% of residents in high-level care received top-up payments,[15] giving an upscaling factor of 1.67 for rest-home counts, very similar to OPAL's 1.73. Arguably upscaling factors should be region-specific, so higher in Auckland and correspondingly smaller in other regions, according to the CCPS proportions.

That a higher proportion of Auckland residents are assessed as eligible for care yet do not receive a subsidy indicates they are assessed as having greater financial assets than their counterparts elsewhere.

The average value of a home is higher in large urban regions including Auckland, where even a small flat or apartment would have a government valuation over the asset threshold of $215,132. For those where the family home is not exempt from consideration, it is likely the single most valuable asset when assessing subsidy eligibility. The proportion who need care but who are deemed ineligible for a subsidy will thus be influenced by regional differences in housing values.

Such geographic variations, together with variations in bed availability, the proportion ineligible (such as those without NZ citizenship or residency), dependency, and health service utilisation will differentially impact subsidy uptake even among those having equal incomes. In an apparent anomaly, weekly subsidy rates are permitted to differ

by region while asset thresholds are the same throughout the country. Review of the assets and income tests is suggested in order to avoid geographic inequities.

**Unsubsidised residents in high-level care—**The finding that use of subsidy data under-reports high-level care is a concern. It has been[16] and currently (MoH, personal communication) constitutes the area of fastest growth in the RAC sector.

Those in dementia or high-level care are not upscaled in national demand estimates as it is assumed that all receive top-up payments and therefore will appear in the payments systems. Contrary to expectations, in Auckland, 6% of people in hospital-level care and 13% in dementia care were unsubsidised. Even if in other regions this percentage is lower, national undercounting is likely.

The policy is that all new or intending residents are formally needs assessed, even if intending to pay privately. Otherwise, should private funds be exhausted the resident could require a government subsidy even if the care assessment did not justify RAC care.[18] Different reasons may explain non-receipt of subsidy in hospital-level care.

Official NZ citizenship or residency is a pre-requisite for subsidy receipt, and Auckland likely has disproportionately more people without citizenship or residency visas than elsewhere.[19] But in all regions, delays in assessment or in completing the application for subsidy may mean some period is not covered because of mandated time limits.

Various regional schemes exist that fund RAC care for palliative care, short-term rehabilitative or convalescent care, or long-term mental health care, rendering a subsidy application unnecessary. For all these reasons, the assumption that all in higher-level care will appear in the CCPS is invalid, will vary geographically and will lead to undercounts.

**National reporting—**Unless specifically addressed, upscaling to account for people with absent (or incomplete) information inevitably assumes that the unknown 'people' are similar to those for whom information is available.

The proportion that was unsubsidised in Auckland, even in MoH data, differed markedly from national figures, indicating that more accurate national estimates would likely be achieved if stratified by region. Further, in OPAL the proportion paying privately increased with age. Estimation stratified by age group would avoid undercounting at higher ages and over-counting at lower ages. This is important because the older age groups are growing the fastest.

In recent years MoH has vastly improved and standardised its methods of measuring present and future use of RAC.[1] In their reports provided to and published by the OECD for the financial years 2006/07 to 2011/12, the proportion of long-term care residents nationally who paid the whole cost of care themselves reportedly rose from 33% to 38%.[3] Those estimates use a new database that facilitates ongoing reporting, providing recent counts and projections by age group, by region, and for the nation.[15] However neither MoH nor OPAL data can be used to estimate residents missing from high-level care. Though it seems reasonable to use an upscaling factor derived from incomplete high-level care data to low-level counts, the method is not validated. A more accurate method of measurement is needed.

Accurate tracking of residents from RAC entry until discharge is currently possible only for those who are subsidised, and only from the date first subsidised. By 1 July 2015, all facilities will use the suite of health and support needs assessment tools known as interRAI, in particular, the interRAI LTCF (Long-Term Care Facilities Assessment System).[20-22]

Extensive international testing of these instruments has demonstrated success in reporting needs for care provision, funding and quality improvement.[23] It is hoped that roll-out of interRAI will enable prospective tracking of all people receiving long-term RAC, including hospital-level care, from prior to admission through to discharge from the facility.

**Strengths and limitations of this study—**The OPAL survey was population-based with very high participation. Assessments of dependency, function and care needs were recorded by the usual nurses and/or caregivers within facilities based on the bed-type currently occupied. It covered three large district health boards that together provide healthcare services to 26% of the older population in NZ.[24]

The study is limited in that it describes the situation five years ago, in a region that has long been regarded as over-endowed with RAC beds.[25 26] Nevertheless, the 25% who were un-subsidised in OPAL is considerably lower than the 37% and 42% in prior Auckland RAC surveys in 1988 and 1993.[27 28]

Although the response rate of 89% of certified facilities was high, it is possible that the survey does not represent all in RAC at the survey date. When analyses were weighted to adjust for non-response, to test the impact of non-participation, percentages changed only at the 2nd decimal place. In the interests of simplicity these were not reported.

For 525 (under 8%) of residents surveyed, data matching was not possible because no NHI was provided or because important identifiers (age, gender, location) in the MoH record were very different from the OPAL record. There is therefore a risk that matching led to bias. However, the unmatched proportion was small and care levels and other characteristics of those dropped correspond well those with linkage data – for example, 52% (vs. 51% with linkage data) were in rest-home care, 7% (vs. 8%) in dementia care and 41% (vs. 41%) in hospital-level care.

In comparison, in an industry survey of all NZ facilities, 57% were in rest-home care, 8% in dementia care and 33% in hospital care, but survey participation was much lower, at 43%, and may itself be biased.[29]

**Conclusions—**Policy and service provision should be informed by the knowledge that unsubsidised residents differ in demographic characteristics from subsidised residents in low-level care, by age and probably by region. Use of InterRAI may eventually render redundant the current method of estimation. Until then, in deriving NZ estimates of RAC demand, upscaling should take age and region into account to provide for regional variability and to reduce inaccuracies in international comparisons. Research is needed to describe care pathways near the end of life and to understand how those in hospital-level care are not receiving financial assistance for their care.

**Competing interests:** Nil.

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# Maternal and perinatal predictors of newborn iron status

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**Abstract**

**Aim** To describe iron status at birth in a population sample of children.

**Method** Cord blood samples were obtained at birth from 131 infants enrolled in the cohort study *Growing Up in New Zealand*. Cord blood serum ferritin (SF) and haemoglobin (Hb) concentrations were measured and associations of SF and Hb with maternal and birth characteristics were determined.

**Results** Demographics were comparable to the larger cohort, except for having a higher pre-pregnancy body mass index (26.9 vs. 25.4 kg/m$^2$, *P*=0.005), lower frequency of cigarette smoking during pregnancy (2% vs. 11%, *P*=0.0004), and smaller proportion with birth-weight <2500 g (0% vs. 5%, *P*=0.03).

Median (interquartile range) SF was 135 (88–180) mcg/L and mean (±SD) Hb was 160±17 g/L. Eight newborns (7%) had cord SF levels indicative of iron deficiency (SF <35 mcg/L), two newborns were anaemic (Hb <130 g/L) and none had iron deficiency anaemia.

Median SF was lower in newborns whose mothers consumed ≥3 servings of milk/day during the pregnancy (131 vs. 151 mcg/L, *P*=0.04). No other associations with SF or Hb were observed.

**Conclusion** Iron deficiency is present in 7% of newborns in New Zealand. Newborns whose mothers consumed more milk during pregnancy had a lower median SF concentration.

Iron deficiency (ID) is the most common micronutrient deficiency worldwide,[1] with pregnant women and children under 5 years old being most at risk.

It is estimated that 52% of pregnant women in non-industrialised countries and 23% in industrialised countries are anaemic.[2] In at least 50% of these women the anaemia is attributable to ID.[1,3] In New Zealand (NZ), no data is available for pregnant women, however the prevalence of ID among women over 15 years of age has increased from 3% in 1997 to 7% in the most recent survey (2008/09).[4]

Maternal iron status during pregnancy determines prenatal and postnatal health outcomes. Mid-pregnancy iron deficiency anaemia (IDA) is associated with an increased risk of maternal haemorrhage, sepsis, low birth weight, pre-term delivery and continuing IDA during and after lactation.[5,6]

Maternal ID can cause depletion of foetal iron stores.[7–9] A study of 3,269 pregnant women and their newborns identified a maternal serum ferritin (SF) threshold of 13.6 mcg/L, below which infants are at increased risk of ID.[10]

Perinatal ID can adversely affect the development and function of several organ systems.[11] The brain is particularly susceptible and iron is essential for many of the developmental processes (dendritogenesis, synaptogenensis, neurotransmission, energy metabolism and myelination) involved in the critical neurodevelopmental period from late gestation to 2 years of age.[11,12]

There is clear evidence that ID during infancy can have long-term adverse effects on cognitive, neurobehavioural and socioemotional development which persist following iron supplementation and resolution of ID.[13] Fewer studies have been conducted in newborns, and even less in healthy, term infants from uncomplicated pregnancies. However, perinatal ID does appear to have both immediate and long-term adverse effects on neurodevelopment.[14–16]

The prevalence of ID in NZ infants and toddlers (14%) is higher than in Australia, Europe and the United States (US) (7–9%).[17] Aside from one study reporting lower cord SF concentrations in Maori compared to non-Maori neonates,[18] the prevalence of ID and IDA in NZ newborns is unknown.

Our objectives were to describe the neonatal iron status of a sample of children from a national NZ birth cohort and determine whether maternal and infant demographics, pregnancy health and history, and dietary factors are associated with iron status at birth.

## Method

**Study design and study sample enrolment—**This study was completed within NZ's new child cohort study, *Growing Up in New Zealand* (*GUiNZ*).[19] *GUiNZ* enrolled 6,822 women during pregnancy, resulting in a cohort of 6,853 infants born during 2009 and 2010.[19] The *GUiNZ* cohort is demographically and ethnically diverse and aligns with the national birth cohort over the period of 2007–2010.[20]

Recruitment for this cord blood study involved contacting pregnant women already enrolled in *GUiNZ* and intending to deliver at Middlemore Hospital, the only maternity hospital in the study region where cord blood samples are routinely collected. Enrolled women consented to a larger than normal umbilical cord blood sample being collected, stored and used for the measurement of nutritional status biomarkers. Ethical approval was obtained from the Ministry of Health Northern Y Regional Ethics Committee.

**Collection of cord blood samples—**A dedicated cord blood collection kit was used. Delayed umbilical cord clamping is not routine practice at Middlemore hospital, therefore umbilical cord blood (20mL) was collected immediately following delivery into two plain tubes and two EDTA tubes.

**Data collection—**A face-to-face interview was completed with each woman at enrolment in the *GUiNZ* study. At this interview information describing maternal demographics, health and pregnancy history, smoking status, vitamin and mineral supplement use, and dietary patterns was collected.[19] Linkage was established with each woman's perinatal records using the National Health Index (NHI) number as the key linkage variable. The NHI number is a unique identifier assigned to each person in NZ for use within health and disability support services.

**Measurements—**The mother's self-prioritised ethnicity, educational qualifications, and neighbourhood-level deprivation were measured as described previously.[19]

Maternal diet during pregnancy was described using a semi-quantitative 44-item food frequency questionnaire (FFQ). Question formatting was consistent with that used in the dietary history questionnaire component of the 2008/2009 NZ Adult National Nutrition Survey.[21]

The antenatal FFQ allowed description of the frequency of consumption of the four core food groups (vegetables and fruits; breads and cereals; milk and milk products; lean meat, meat alternatives and eggs).[22,23] During pregnancy the NZ Ministry of Health recommends women consume, per day, at least

six servings of vegetables and fruit, at least six of breads and cereals, at least three of milk and milk products, and at least two of lean meat, meat alternatives and eggs.[24]

Women were asked whether they took iron supplements before or during the pregnancy. Infant gender, gestational age and birth-weight were recorded at delivery and obtained by perinatal data set linkage.

Immediately following cord blood collection, full blood count parameters (haemoglobin (Hb) concentration and mean cell volume) were measured using an automated Sysmex XE-5000 Analyser (Sysmex, Kobe, Japan). Other laboratory analyses were performed using Abbott Diagnostic Architect instruments (Abbott Park, Illinois, USA). Serum ferritin (SF) concentration was measured by Chemiluminescent Microparticle Immunoassay (CMIA technology). Serum iron and total iron binding capacity were measured calorimetrically based on the FerroZine method without deproteinisation.[25] C-reactive protein (CRP) was measured by immunoturbidimetry.

Due to the effect of the acute phase response on serum Hb and SF concentration, cord blood samples in which CRP was >5 mg/L were excluded from the analysis.[26] Cord blood samples with SF concentrations >370 mcg/L were also excluded as such values are considered indicative of inflammatory states or iron overload.[7] Anaemia was defined as cord serum Hb <130 g/L[10,27] and latent ID as cord SF <75 mcg/L.[28,29] Cord SF concentrations <75 mcg/L are associated with poorer neurobehavioral status in premature infants[30] and with poorer performance on mental and psychomotor tests at age 5 years in term infants.[29] Iron deficiency was defined as cord SF <35 mcg/L,[31] which correlates with a 70% loss of normal neonatal storage iron, the point at which brain iron concentration begins to decrease.[31]

**Statistical analysis—**Data was analysed using SAS version 9.3 (SAS Inc. Cary, NC, USA). The Chi-squared or Fisher's exact tests were used to compare categorical variables and *t*-tests to compare continuous variables. A *P*-value of <0.05 was considered significant in all analyses.

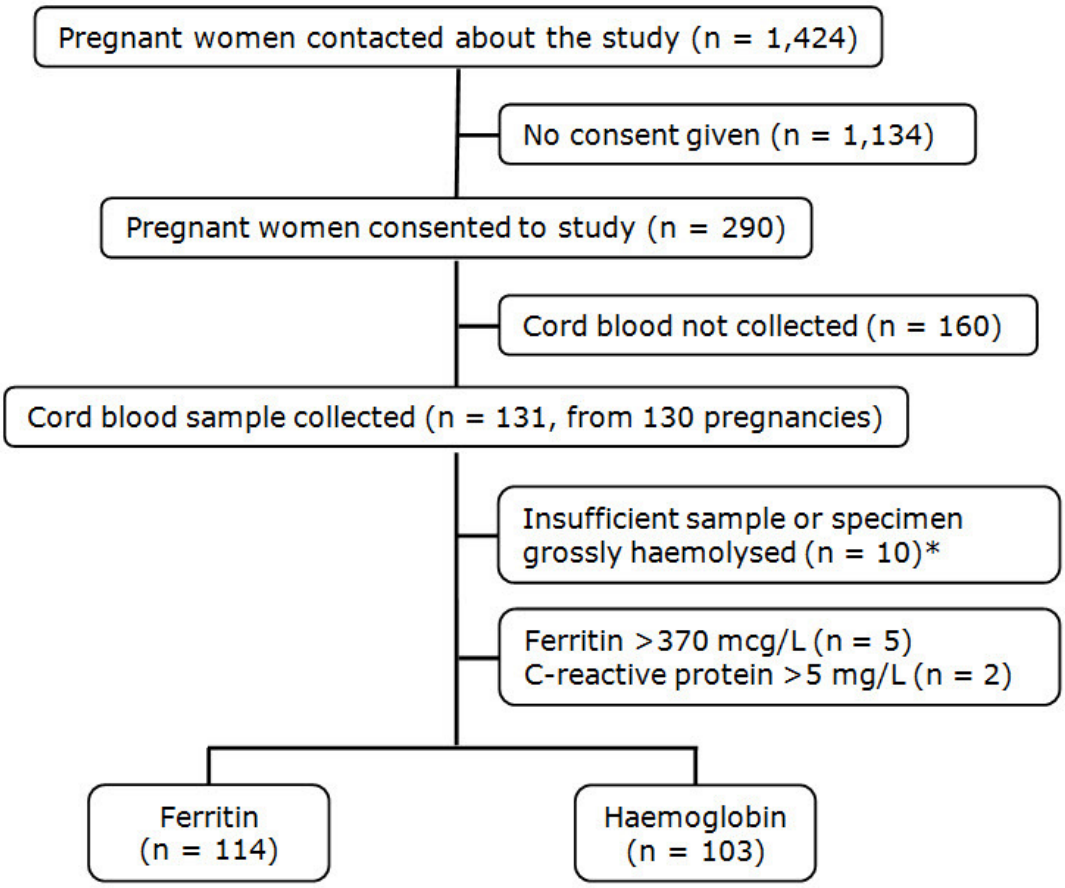
## Results

**Study population and sample—**The *GUiNZ* cohort consisted of 6,822 pregnant women at the time of enrolment.[19] A subsample of 1,424 women, with an estimated delivery date from July 2009 to March 2010 and who intended to deliver at Middlemore Hospital were invited to take part in a cord blood sub-study. Of these women, 290 (20%) gave consent for the collection and analysis of a larger than normal cord blood sample (Figure 1).

A cord blood sample was collected at delivery from the infants of 130 of these 290 women (131 children, including one set of twins).

Reasons for a sample not being collected included: the delivery occurring at a smaller birthing unit where cord blood samples were not collected; the delivery room staff not being aware that the mother was enrolled in *GUiNZ* and that she had consented to a larger cord blood sample being collected; the appropriate cord blood sample collection kit not being used; and delivery being via emergency caesarean section.

**Figure 1. Flow diagram describing participant enrolment**




*Haemoglobin concentration was measured on 8 of these but not included in analysis.

**Comparison of maternal and child characteristics of the cord blood group with the full *GUiNZ* cohort (Table 1)—**Maternal demographics, pregnancy history and health, diet and iron supplement use did not differ between women enrolled in this cord blood study and the remainder of the *GUiNZ* cohort.

In comparison with the *GUiNZ* cohort, a smaller proportion of women in this study smoked cigarettes during the pregnancy (2% vs. 11%, *P*=0.0004) and their mean pre-pregnancy body mass index (BMI) was greater (26.9 vs. 25.4 kg/m$^2$, *P*=0.005). None of the newborns in this cord blood study had a birth weight <2500 g (0% vs. 5%, *P*=0.03).

**Table 1. Comparison of maternal, pregnancy and newborn characteristics of those from whom a cord blood sample was obtained versus the remainder of the Growing Up in New Zealand cohort**

| Variable | Cord blood sample n (column %) or mean±SD | | *P*-value |
|---|---|---|---|
| | Obtained* n=130 | Not obtained n=6692 | |
| **Maternal demographics** | | | |
| Age in years | 30.5±5.9 | 30.0±6.0 | 0.43 |
| Self-prioritised ethnicity | | | |
| European | 71 (55) | 3537 (53) | |
| Maori | 14 (11) | 936 (14) | |
| Pacific | 19 (15) | 982 (15) | |
| Asian | 22 (17) | 981 (15) | |
| Other | 4 (3) | 237 (4) | 0.84 |
| Household deprivation† | | | |
| Least deprived (1 to 3) | 38 (29) | 1656 (25) | |
| Intermediately deprived (4 to 7) | 42 (32) | 2444 (37) | |
| Most deprived (8 to 10) | 50 (39) | 2590 (39) | 0.44 |
| Education | | | |
| No education / Secondary education | 37 (28) | 2081 (31) | |
| Tertiary education | 93 (72) | 4592 (69) | 0.51 |
| **Maternal health** | | | |
| Pre-pregnancy body mass index | 26.9±6.7 | 25.4±5.9 | 0.005 |
| Maternal rating of health | | | |
| Poor | 2 (2) | 150 (2) | |
| Fair | 13 (10) | 537 (8) | |
| Good | 49 (38) | 2272 (34) | |
| Very good | 37 (28) | 2366 (35) | |
| Excellent | 29 (22) | 1353 (20) | 0.49 |
| Self-reported health problems during pregnancy | | | |
| Anaemia | | | |
| Never | 119 (92) | 5813 (87) | |
| Before and/or during pregnancy | 11 (9) | 865 (13) | 0.13 |
| Diabetes | | | |
| Never | 123 (95) | 6437 (97) | |
| Before and/or during pregnancy | 6 (5) | 236 (4) | 0.50 |
| Heart disease or high blood pressure | | | |
| Never | 123 (95) | 6405 (96) | |
| Before and/or during pregnancy | 7 (5) | 274 (4) | 0.47 |
| **Use of iron supplements during pregnancy** | | | |
| In the 3 months before becoming pregnant | | | |
| Yes | 25 (19) | 1380 (23) | |
| No | 105 (81) | 4665 (77) | 0.33 |
| During the first 3 months of pregnancy | | | |
| Yes | 55 (42) | 2655 (44) | |
| No | 75 (58) | 3393 (56) | 0.72 |
| Since the first 3 months of pregnancy | | | |
| Yes | 76 (59) | 3888 (64) | |
| No | 54 (42) | 2157 (36) | 0.17 |
| **Cigarette smoking status** | | | |
| Smoked cigarettes before pregnancy | | | |
| Yes | 21 (16) | 1366 (21) | |
| No | 109 (84) | 5311 (80) | 0.23 |

| | | | |
|---|---|---|---|
| Smoked cigarettes during pregnancy | | | |
| Yes | 3 (2) | 661 (11) | |
| No | 127 (98) | 5387 (89) | 0.0004 |
| **Compliance with recommended number of servings of four main food groups‡** | | | |
| Vegetables and fruits | | | |
| Yes | 36 (28) | 1496 (25) | |
| No | 94 (72) | 4556 (75) | 0.44 |
| Breads and cereals | | | |
| Yes | 38 (29) | 1647 (27) | |
| No | 92 (71) | 4405 (73) | 0.61 |
| Milk and milk products | | | |
| Yes | 50 (39) | 2553 (42) | |
| No | 80 (62) | 3499 (58) | 0.40 |
| Lean meat, meat alternatives and eggs | | | |
| Yes | 23 (18) | 1383 (23) | |
| No | 107 (82) | 4667 (77) | 0.16 |
| **Pregnancy history** | | | |
| Parity | | | |
| First child | 57 (44) | 2795 (42) | |
| Subsequent child | 73 (56) | 3890 (58) | 0.64 |
| Pregnancy planning | | | |
| Planned | 83 (64) | 4008 (60) | |
| Unplanned | 47 (36) | 2653 (40) | 0.40 |
| Treatment to assist with becoming pregnant | | | |
| Yes | 13 (16) | 384 (10) | |
| No | 70 (84) | 3620 (90) | 0.06 |

| **Child characteristics** | | | |
|---|---|---|---|
| **Variable** | **Cord blood sample n (column %)** | | |
| | **Obtained n=128§** | **Not obtained n=6718** | ***P*-value** |
| Gender | | | |
| Boy | 57 (44) | 3469 (52) | |
| Girl | 71 (56) | 3249 (48) | 0.11 |
| Gestation | | | |
| Less than 37 weeks | 5 (4) | 431 (6) | |
| 37 weeks or greater | 123 (96) | 6277 (94) | 0.25 |
| Birth-weight | | | |
| <2500g | 0 (0) | 336 (5) | |
| 2500g–4000g | 108 (84) | 5288 (79) | |
| >4000g | 20 (16) | 1090 (16) | 0.03 |

*Includes one twin pregnancy with cord blood sample obtained from both twins.

†Area-level socioeconomic deprivation was measured using the NZ Index of Deprivation.[32]

‡At least six servings of vegetables and fruit, at least six of breads and cereals, at least three of milk and milk products, and at least two of lean meat, meat alternatives and eggs.[24]

§Three children who had cord blood samples collected did not have perinatal data.

**Iron indices measured in cord blood and the prevalence of newborn iron deficiency and anaemia (Table 2)—**Of the 131 samples, 10 (8%) were either grossly haemolysed or of insufficient volume and thus were excluded from the study (Figure 1). Seven samples had either CRP >5 mg/L (n=2) or SF >370 mcg/L (n=5) and were not included in the analysis. In those samples with normal CRP and SF <370 mcg/L,

the mean (±SD) serum Hb concentration (n=103) was 160 (±17) g/L and the median (inter-quartile range) SF concentration (n=114) was 135 (88–180) mcg/L.

Eight (7%) newborns had ID and another 15 (13%) had latent ID. Two newborns (2%), neither of whom had ID, were anaemic.

**Table 2. Measures of iron status in children enrolled in the cord blood study**

| **Variable** | |
|---|---|
| **Measures of inflammation** | **n (%)** |
| C-reactive protein in mg/L | |
| 0 to 5 | 119 (98) |
| 6 or higher* | 2 (2) |
| Ferritin in mcg/L | |
| 0 to 370 | 116 (96) |
| >370† | 5 (4) |
| **Measures of iron status** | **Mean±standard deviation (SD) or median (IQR‡)** |
| Haemoglobin in g/L (mean±SD) (n=103) | 160±17 |
| Mean cell volume in fL (mean±SD) (n=103) | 109±5 |
| Serum iron in µmol/L (mean±SD) (n=113) | 25.6±9.0 |
| Iron binding capacity in µmol/L (mean±SD) (n=103) | 40±8 |
| Iron saturation in % (mean±SD) (n=103) | 63±3 |
| Ferritin in mcg/L (median, IQR‡) (n=114) | 135 (88–180) |
| **Prevalence of anaemia**[10,27] (n=103) | **n (%)** |
| Anaemic§ (Haemoglobin <130 g/L) | 2 (2) |
| Non-anaemic (Haemoglobin ≥130 g/L) | 101 (98) |
| **Prevalence of iron deficiency**[7] (n=114) | **n (%)** |
| Iron deficiency (serum ferritin <35 mcg/L) | 8 (7) |
| Latent iron deficiency (serum ferritin=35–75 mcg/L) | 15 (13) |
| Iron-replete (serum ferritin=76–370 mcg/L) | 91 (80) |

*Values of 6 and 41 mg/L; †Values of 377, 425, 506, 553 and 606 mcg/L ; ǂ Interquartile range; § Values of 125 and 128 g/L.

Serum Hb and SF values for our sample were compared to other contemporary reports of cord blood iron status (Table 3). Mean Hb (160 g/L) was comparable to the weighted mean Hb (159 g/L) reported from a recent review of all published cord blood data[33] and to the mean Hb concentration observed in two smaller studies (156 g/L and 153 g/L).[34,35]

Median SF (135 mcg/L) was comparable to that reported from a review of published studies from 1974 to 2005 (SF=134 mcg/L),[7] but lower than that reported from a study of a rural middle class population living in South-East China enrolled from 2005 to 2007 (SF=164 mcg/L).[10]

**Table 3. Comparison of cord-blood serum haemoglobin and ferritin measures for full-term infants with SF ≤370 mcg/L and CRP ≤5mg/L from this and previous studies**

| **Cord serum haemoglobin concentration (g/L)** | | | | | | |
|---|---|---|---|---|---|---|
| **Study** | **n** | **Mean** | | | **2.5th – 97.5th Percentile** | |
| Present Study | 103 | 160 | | | 131–190 | |
| Lorenz et al. (2013)[33] | 1,538 | 159 | | | 133–184 | |
| **Study** | **n** | **Mean** | | | **Standard deviation** | |
| Present Study | 103 | 160 | | | 17 | |
| Paterakis et al. (1993)[34] | 35 | 156 | | | 12 | |
| Diagne et al. (1995)[35] | 159 | 153 | | | 13 | |
| **Cord serum ferritin concentration (mcg/L)** | | | | | | |
| **Study** | **n** | **Percentile** | | | | |
| | | **5th** | **25th** | **50th** | **75th** | **95th** |
| Present Study | 114 | 26 | 88 | 135 | 180 | 287 |
| Shao et al. (2012)[10] | 3,269 | 58 | 112 | 164 | 225 | 315 |
| Siddappa et al. (2007)[7] | 308 | 40 | 84 | 134 | 200 | 309 |

**Association of maternal, pregnancy and child characteristics with measures of iron status (Table 4)—**The median cord blood SF concentration was lower in newborns of mothers who consumed three or more servings of milk per day (131 vs. 151 mcg/L, *P*=0.04). Associations approaching significance were observed between maternal intake of two or more servings of meat, meat alternatives and eggs per day and lower cord SF (102 vs. 145 mcg/L, *P*=0.06) or Hb (154 vs. 161, *P*=0.09) concentration.

The ethnicity of the mother was weakly associated with cord serum Hb levels (*P*=0.05). Mean cord Hb concentrations were highest in infants of European mothers (164 g/L) and lowest in infants of Pacific mothers (150 g/L). No association was observed between cord SF or Hb concentration and any of the other maternal, pregnancy and child characteristics measured, including iron supplementation.

**Table 4. Cord blood serum ferritin and haemoglobin concentration by maternal demographics, health, pregnancy history, diet, and iron supplementation and by newborn characteristics**

| **Variable** | **Cord blood ferritin concentration (mcg/L)*** | | **Cord blood haemoglobin concentration (g/L)†** | |
|---|---|---|---|---|
| | **Median (25th, 75th centile) n=113‡** | ***P*-value** | **Mean [95% CI] n=102‡** | ***P*-value** |
| **Maternal demographics** | | | | |
| Age in years | | 0.99 | | 0.06 |
| <20 | 116 (114, 302) | | 137 [103–171] | |
| 20 – 24 | 151 (110, 171) | | 153 [145–161] | |
| 25 – 29 | 132 (93, 180) | | 158 [152–164] | |
| 30 – 34 | 136 (73, 202) | | 163 [156–170] | |
| 35 – 39 | 135 (95, 185) | | 165 [158–172] | |
| 40+ | 139 (81, 199) | | 157 [142–172] | |

| | | | | |
|---|---|---|---|---|
| Education | | **0.16** | | **0.34** |
| No or secondary education | 120 (81, 171) | | 157 [149–165] | |
| Tertiary education | 139 (94, 197) | | 161 [157–164] | |
| Self-prioritised ethnicity | | 0.16 | | 0.05 |
| European | 146 (92, 191) | | 164 [159–168] | |
| Maori | 135 (114, 242) | | 154 [145–163] | |
| Pacific | 102 (81, 134) | | 150 [142–158] | |
| Asian | 123 (47, 197) | | 160 [152–168] | |
| Other | 119 (81, 156) | | 161 [98–224] | |
| Household deprivation | | 0.85 | | 0.29 |
| Least deprived (1–3) | 140 (89, 214) | | 160 [155–166] | |
| Intermediately deprived (4–7) | 136 (99, 167) | | 163 [157–168] | |
| Most deprived (8–10) | 134 (66, 180) | | 157 [151–163] | |
| **Maternal health** | | | | |
| Pre-pregnancy body mass index | | 0.69 | | 0.87 |
| <30 kg/m$^2$ | 140 (94, 180) | | 161 [157–164] | |
| ≥30 kg/m$^2$ | 134 (70, 197) | | 161 [153–170] | |
| Maternal rating of health | | 0.48 | | 0.55 |
| Poor | 175 (134, 215) | | 161 [154–167] | |
| Fair | 146 (102, 197) | | 152 [141–163] | |
| Good | 135 (73, 171) | | 160 [155–166] | |
| Very good | 123 (81, 205) | | 162 [156–168] | |
| Excellent | 145 (116, 168) | | 159 [150–168] | |
| **Health problems during pregnancy** | | | | |
| Anaemia | | 0.10 | | 0.99 |
| Never | 134 (84, 180) | | 160 [156–163] | |
| Before and during pregnancy | 165 (93, 288) | | 160 [150–170] | |
| Diabetes | | 0.40 | | 0.12 |
| Never | 137 (89, 180) | | 160 [157–164] | |
| Before and during pregnancy | 129 (88, 205) | | 148 [132–165] | |
| Heart disease or high blood pressure | | 0.71 | | 0.73 |
| Never | 136 (88, 180) | | 160 [156–163] | |
| Before and during pregnancy | 134 (66, 199) | | 158 [143–172] | |
| **Use of iron supplements during pregnancy** | | | | |
| In the 3 months before becoming pregnant | | 0.22 | | 0.52 |
| Yes | 149 (115, 213) | | 158 [151–164] | |
| No | 134 (82, 178) | | 160 [156–164] | |
| During the first 3 months of pregnancy | | 0.51 | | 0.50 |
| Yes | 143 (95, 189) | | 158 [153–164] | |
| No | 134 (82, 180) | | 161 [156–165] | |
| Since the first 3 months of pregnancy | | 0.91 | | 0.23 |
| Yes | 136 (93, 197) | | 158 [154–162] | |
| No | 134 (82, 180) | | 162 [157–168] | |
| **Smoking status** | | | | |
| Smoking before pregnancy | | 0.65 | | 0.97 |
| Yes | 129 (88, 176) | | 160 [149–171] | |
| No | 136 (88, 181) | | 160 [156–163] | |
| Smoking during pregnancy | | 0.55 | | 0.32 |
| Yes | 202 (99, 214) | | 169 [126–213] | |
| No | 135 (84, 180) | | 159 [156–163] | |
| **Number of daily servings from 4 main food groups** | | | | |
| Vegetables and fruits ≥6 per day | | 0.21 | | 0.54 |
| Yes | 124 (84, 175) | | 162 [154–169] | |
| No | 139 (91, 189) | | 159 [155–163] | |
| Breads and cereals ≥6 per day | | 0.16 | | 0.23 |
| Yes | 123 (81, 171) | | 156 [150–163] | |
| No | 142 (91, 194) | | 161 [157–165] | |

| | | | | |
|---|---|---|---|---|
| Milk & milk products ≥3 per day | | 0.04 | | 0.49 |
| Yes | 131 (82, 175) | | 161 [156–165] | |
| No | 151 (88, 199) | | 158 [153–164] | |
| Lean meat, meat alternatives and eggs ≥2 per day | | 0.06 | | 0.09 |
| Yes | 102 (71, 138) | | 154 [146–161] | |
| No | 145 (93, 189) | | 161 [157–165] | |
| **Pregnancy** | | | | |
| Parity | | 0.64 | | 0.42 |
| First child | 137 (98, 180) | | 158 [153–163] | |
| Subsequent child | 134 (82, 181) | | 161 [156–165] | |
| Pregnancy planning | | 0.90 | | 0.35 |
| Planned | 136 (93, 180) | | 161 [156–165] | |
| Unplanned | 134 (81, 214) | | 158 [153–162] | |
| Treatment to assist with becoming pregnant | | 0.74 | | 0.71 |
| Yes | 132 (70, 246) | | 159 [149–169] | |
| No | 136 (96, 171) | | 161 [156–166] | |
| **Child characteristics** | | | | |
| Gender | | 0.71 | | 0.22 |
| Boy | 127 (70, 171) | | 162 [156–168] | |
| Girl | 137 (100, 191) | | 158 [154–162] | |
| Gestation | | 1.00 | | 0.72 |
| Less than 37 weeks | 121 (38, 176) | | 157 [140–174] | |
| 37 weeks or greater | 135 (90, 181) | | 160 [156–163] | |
| Birth-weight in grams | | 0.31 | | 0.94 |
| <2500 | NA | | NA | |
| 2500 to 4000 | 137 (93, 181) | | 160 [156–164] | |
| >4000 | 111 (73, 146) | | 160 [154–166] | |

* Excluded are those with insufficient sample or specimen grossly haemolysed (n=10), with C-reactive protein >5 mg/L (n=2), and ferritin >370 mcg/L (n=5).

† Excluded are those with insufficient sample or specimen grossly haemolysed (n=10), with C-reactive protein >5 mg/L (n=2), ferritin >370 mcg/L (n=5) and where haemoglobin was not measured (n=11).

ǂ One mother had a twin pregnancy with ferritin and haemoglobin concentration of first twin reported.

CI=confidence interval.

NA=Not applicable .

## Discussion

The newborns in this study were a subsample broadly generalizable to the national NZ birth cohort. Iron deficiency, as defined by cord SF concentration, was present in 7% of the newborns and 2% were anaemic. No newborns had both low cord SF and anaemia.

Newborns of mothers who consumed three or more servings of milk per day during pregnancy had a significantly lower median cord SF concentration (131 mcg/L). Cord Hb concentrations varied with ethnicity, being highest in newborns of European mothers and lowest in those of Pacific mothers.

Associations approaching statistical significance were observed between more frequent maternal intake of lean meat, meat alternatives and eggs and lower cord SF and Hb concentration.

The maternal and infant characteristics of the cord blood study group aligned with the full *GUiNZ* cohort. The only exceptions were that, compared to the *GUiNZ* cohort,

maternal cord blood study participants had a higher BMI, a smaller proportion smoked cigarettes while pregnant and none of their infants were of low birth-weight.

Higher maternal BMI and not smoking are both associated with higher SF concentration.[36,37] Better maternal iron status during pregnancy is associated with a reduced risk of low birth weight.[38] Hence the influence of the biases in our sample will be to underestimate the true prevalence of ID.

The number of participants from whom a cord blood was obtained was smaller than anticipated. This reflects the very early stage of this cohort study at which we sought to gain consent for collection of a biological sample. In comparison, with the child cohort now aged 4 years, we have a 94% response rate to our request to collect skin swabs and a 91% for collection and storage of a saliva sample.

Cord blood samples were only collected from half of those who consented. This was mostly due to the breakdown of delivery room processes or the delivery occurring by emergency caesarean section. Our ability to investigate the relationship between maternal characteristics and iron status at birth was thus limited by the reduced statistical power.

It would have been desirable to have collected maternal blood samples for iron studies from the women who consented to cord blood sampling and also a blood sample for measurement of iron status from their child during the first 2 years of life. However enrolment of the pregnant women did not occur until the third trimester, and with enrolment occurring over a wide geographical area with a large number of antenatal care providers, it was not possible to collect additional antenatal blood samples from the enrolled women.

Given the small number who gave consent for the collection of a cord blood sample we were concerned that seeking consent for additional blood sampling during early childhood would potentially lead to attrition of participants from the study. With most attrition from longitudinal studies occurring in the years immediately following enrolment we specifically sought to limit the inclusion of more invasive data collection methods during this phase.

Various biomarkers including SF, serum iron, serum Hb, iron saturation, mean cell volume, iron binding capacity, zinc protoporphyrin/haem ratio and serum transferrin receptor concentration are used to describe iron status. However, many of these measures are not specific for ID and do not have an established reference range for neonates.[6,33] Serum ferritin concentration is well established as an indicator of ID in older children and adults.[7] More recent work shows that cord SF concentration is an appropriate indicator of ID in neonates.[10,33]

The median cord SF (135 mcg/L) and mean cord serum Hb (160 g/L) concentrations observed in our study correlate with published contemporary data on cord blood iron status.[7] Shao and colleagues recently reported a higher median cord SF concentration of 164 mcg/L in a study of 3,269 infants from a relatively homogenous population, being predominantly rural, middle-class and ethnic Han in origin.[10] In contrast, our study sample was both socioeconomically and ethnically diverse. Both of these factors are determinants of iron status in women of child bearing age and infants in NZ.[4,17]

Maternal and pregnancy factors previously identified that predispose to ID at birth include maternal ID, anaemia, diabetes, cigarette smoking, and intrauterine growth restriction.[7] Of particular relevance to our study findings is that the prevalence of several of these factors is increasing in NZ. Since 1996/97 the proportion of adults who are obese has increased from 19% to 28% and a further 35% are overweight.[4] Among adults, diabetes prevalence has increased from 3.8% in 1996/97 to 5.5% in 2011/12.[4] In contrast there are more positive trends with respect to smoking, with 17% of adults smoking daily in 2011/12, compared to 25% in 1996/7.[4]

Greater milk consumption during pregnancy was associated with a lower median cord SF concentration in this study. Previous studies, including one conducted in early pregnancy,[39] have shown an association between increased dairy intake and reduced SF.[40,41] It has been suggested that iron supplementation may be necessary during pregnancy to prevent anaemia in women with high milk intakes.[39] An alternative would be to increase the nutrient content of milk consumed by pregnant women.[42]

The suggestion of an association between more frequent consumption of meat, meat alternatives and eggs and decreased cord SF and Hb concentrations appears counterintuitive. Such an association is potentially explained by confounding due to ethnicity. Among the full *GUiNZ* cohort the frequency of consumption of meat, meat alternative and eggs was greater in Pacific women, the ethnic group in this cord blood subsample with the lowest cord Hb concentration.[23]

There is a cumulative adverse effect on newborn iron status when multiple maternal risk factors are present. Large-for-gestational-age infants of mothers with comorbid obesity and diabetes are at particularly high risk.[43] Therefore, high-risk neonates can be identified during pregnancy and appropriate interventions should be taken to avoid the long-term effects of ID. A recent systematic review and meta-analysis confirms that daily prenatal iron supplementation improves birth weight, with the relationship between iron supplementation and birth weight showing a linear dose-response.[38]

This study provides a preliminary indication of the prevalence of ID in NZ newborns. The longitudinal nature of the *GUiNZ* study will allow us to follow the cognitive, neurobehavioural and socioemotional development of all the participants (including those of this subsample) over time.

Since it is possible to measure biomarkers of iron status on dried blood spots, the potential exists to investigate the relationship between iron status at birth and subsequent cognitive development by utilising stored dried blood spots collected by newborn screening programmes.[44]

As maternal iron status during pregnancy determines iron status at birth, and ID at birth is already a predictor of impaired neurodevelopment and cognitive function, pregnancy is the optimal time to intervene in order to prevent neonatal ID.[10] While medicinal iron is one potential strategy, the identification of ID increases the likelihood of other nutritional deficiencies being present.

Given the increasing prevalence globally of chronic diseases during pregnancy, and hence of nutritional compromise in newborns, evidence-based strategies to improve nutritional status during pregnancy are needed for higher income as well as middle and lower income countries.

**Competing interests:** Nil.

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# Influence of gender and other factors on medical student specialty interest

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**Abstract**

**Aim** Medical schools must select and educate to meet anticipated health needs. Factors influencing career choice include those of the student and their background as well as subsequent experience. Women have comprised over 50% of medical classes for over 20 years.

This study describes gender patterns of current specialty interest among medical students at the University of Auckland, and models the predictive effect of gender compared to other career influencing factors.

**Method** The study analysed career intention survey data from 711 graduating medical students (response rate, 79%) from 2006 to 2011.

**Results** Interest level was highest for medicine, followed by subspecialty surgery, general practice and paediatrics. There were differences by gender for most specialties, but not for general practice. Women were more likely than men to be interested in Obstetrics and Gynaecology, Paediatrics, Geriatrics, Public Health or General Medicine, and less interested in Surgery, Anaesthesia, Emergency Medicine or post graduate study. Each specialty had a different pattern of influencing factors with the most important factor being the experience on a clinical attachment.

**Conclusion** Factors in career choice are complex and vary by gender and specialty. General practice levels of interest are too low for workforce needs. Predictive models need to be validated in longer term studies but may help guide selection and curriculum design.

Selection into medical school in New Zealand, (NZ) starts a journey of at least 12 years to becoming a vocationally-trained medical specialist. Choosing a career is a complex and iterative process determined by both an individual's background and experiences.[1]

As a group, medical students must have the propensity to fill all the specialties in the health system, so future health needs are met. Some of the current challenges in workforce planning relate to insufficient interest in careers in general practice and psychiatry.[2] External factors reported to contribute are perceived status,[3] nature of work or income relative to other specialties.[4,5]

For over 20 years, women have made up over 50% of medical students.[6] Concerns continue to be expressed about the impact of feminisation of the medical workforce on productivity,[7] status of the profession[8] or on women themselves while they remain concentrated in certain areas of work, such as general practice, or at lower levels of the profession.[9]

In New Zealand in 2012, women made up 41.3% of the workforce but only 30% of specialists, with only 9% of doctors working in surgical specialties being female.[10] This variation in specialty by gender is often attributed to a women's desire for flexibility, given that the majority of female doctors are primary care-givers.[11] Yet, this may not be the complete story.

In a study of NZ internal medicine specialists, flexibility was more important to women than men, interest in the career was the most important factor for both genders.[12]

Gendered experiences as a medical student may influence specialty interest. Female medical students have reported difficulty imagining themselves in a specialty where they experienced isolation, or lacked role models or practical experience from participation.[13]

Furthermore, mentoring relationships are strongly influenced by gender[14] with female doctors less satisfied with professional mentoring, due to a difference in preferred mentoring styles between men and women, and a lack of senior female mentors.[15]

This study aimed to describe gender patterns of current specialty interest among final year medical students at the University of Auckland, and to clarify the predictive effect of gender compared to other influencing factors on specialty choice.

Given the importance of primary care in the New Zealand health care system and the tendency for female doctors to eventually work in general practice we focused on factors that predict an interest in that specialty.

## Methods

Subjects were medical students enrolled in the University of Auckland Faculty of Medical and Health Sciences Health Professional Students and Graduates Tracking Project (FMHS Tracking Project) that has been described previously.[16] Ethical approval was granted by The University of Auckland Human Participants Ethics Committee.

This study used data from participants from 2006-2011 who completed a questionnaire at the end of their final year of medical school. In this they rated their level of interest in 18 different specialties as 'no interest', 'some interest' or 'strong interest'. 'No interest' and 'some interest' were combined for the purposes of analysis. Students also rated the importance of a range of influencing factors on their career choice and reported upon their family and financial status (see Table 1).

The results were analysed using SPSS (IBM, New York). Odds ratios were used to compare probability of strong interest in a specialty by gender while controlling for the other variables in Table 1.

Models of influencing factors for each specialty were created using logistic regression (maximum likelihood, forward stepwise model). $R^2$ refers to the percentage of variance in the outcome explained by the independent variables in the model. An $R^2 > 0.25$ was taken to be meaningful.

**Table 1. Variables included from the Exit questionnaire**

| |
|---|
| **Influencing factors on specialty interest** |
| (rated as positive, no influence or negative) |
| Experiences during clinical attachments |
| Experiences of lectures and other formal teaching |
| Area of need in health care |
| Family members and/or friends who work in the field |
| The extent of student debt |
| Income |
| Medical role models |
| Flexibility |
| **Family status** |
| Single |
| Married/living with partner |
| Dependent Children |
| **Kind of community where intending to work in the long term?** |
| City |
| Rural/Regional |
| Undecided |

## Results

There were responses from 738 students for an overall response rate of 82%. Gender was not known for 27 students (anonymised responses), leaving a total of 711 eligible students across six years (79%). Women made up 57% of the sample, with a slightly higher proportion of women than men responding (81% vs 77%).

The greatest level of strong interest was seen for internal medical specialties (subspecialty medicine and general medicine) followed by subspecialty surgery, general practice, and paediatrics (see Figure 1.).

The proportions exceed 100% as, on average, students at exit indicated a strong interest in 3.27 specialty careers.

There were 220 students with a strong interest in general practice. They had on average 2.8 other strong interests with only 20 students reporting a strong interest in general practice alone.

For women, subspecialty medicine held the highest level of interest whereas for men, this was subspecialty surgery (see Figure 2).

Women were significantly more likely than men to have a strong interest in obstetrics and gynaecology, geriatrics, public health, neonatology, general paediatrics and general medicine (Table 2). Women were less likely than men to be interested in subspecialty surgery, anaesthetics, academic research, general surgery, post graduate study and emergency medicine.

There was no significant gender difference in interest in medical sciences, subspecialty medicine, general practice, pathology, psychiatry and radiology.

**Figure 1. Number of graduating medical students with a strong interest in each specialty area**

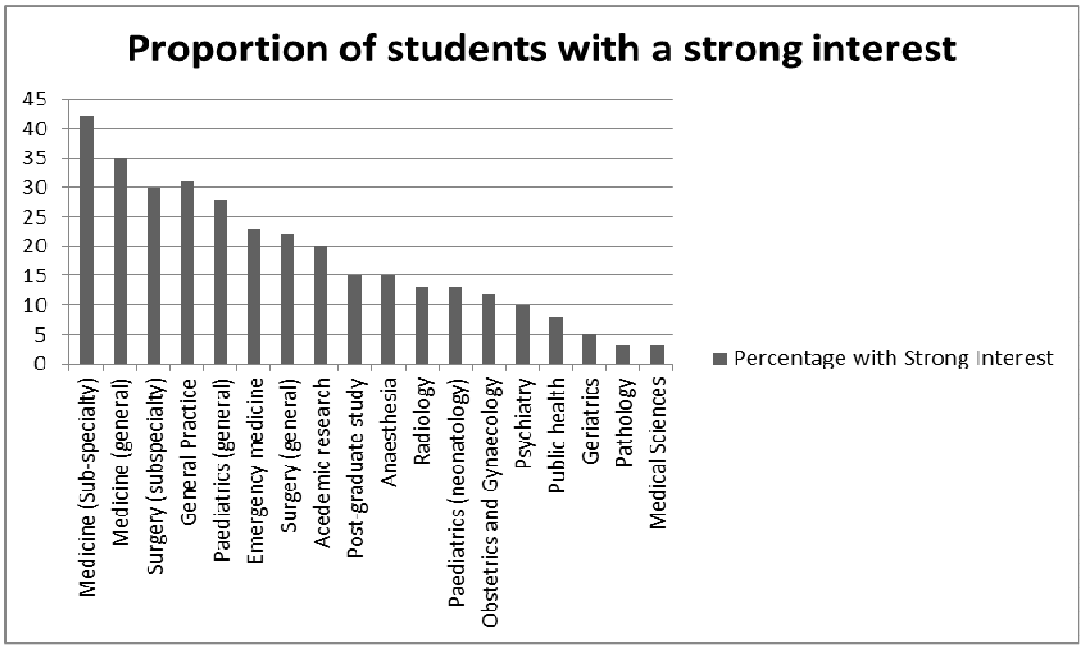


**Figure 2. Proportions of graduating medical students with a strong interest in each specialty, *by gender***

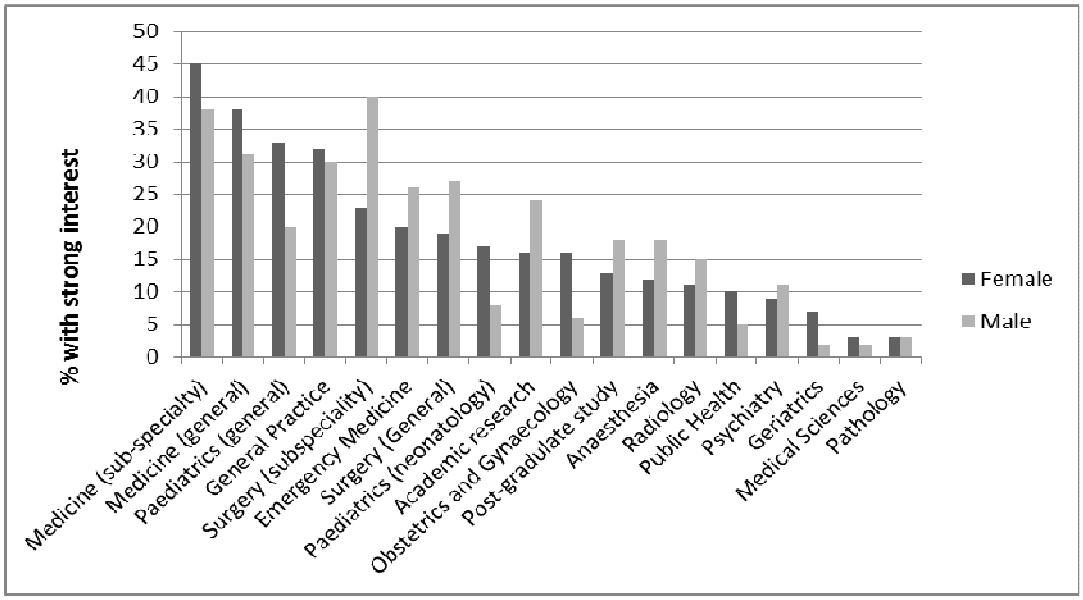

**Table 2. Likelihood of interest compared between women and men**

| Specialty | Odds Ratio (95% CI) |
|---|---|
| **Women are more likely than men to have a strong interest** | |
| Obstetrics and Gynaecology | 3.4 (1.9–5.9) |
| Geriatrics | 3.0 (1.3–7.0) |
| Public Health | 2.3 (1.2–4.3) |
| Paediatrics (neonates) | 2.3 (1.4–3.7) |
| Paediatrics (general) | 2.0 (1.4–2.8) |
| Medicine (general) | 1.4 (1.0–1.9) |
| **No significant difference in interest** | |
| Medical sciences | 1.5 (0.6–3.8) |
| Medicine (subspeciality) | 1.3 (1.0–1.8) |
| General Practice | 1.1 (0.8–1.5) |
| Pathology | 1.1 (0.4–2.5) |
| Psychiatry | 0.8 (0.5–1.3) |
| Radiology | 0.7 (0.5–1.1) |
| **Men are more likely than women to have a strong interest** | |
| Emergency Medicine | 0.7 (0.5–0.9) |
| Postgraduate study | 0.7 (0.4–0.9) |
| Surgery (General) | 0.6 (0.4–0.9) |
| Academic research | 0.6 (0.4–0.9) |
| Anaesthesia | 0.6 (0.4–0.9) |
| Surgery (subspeciality) | 0.5 (0.3–0.6) |

Table 3 shows the models (with an $R^2 > 0.25$) that predicted a strong interest in a specialty. This builds on Table 2 by showing the relative impact of gender and other variables.

The best fitting model was that for subspecialty surgery ($R^2 = 0.48$). In addition to the positive effect of a clinical attachment (OR = 2.930), intending to work in the city (0.438) and having a family member or friend work in the area (0.579) were positive predictors of a strong interest. Being female (-0.724), supported by student allowance (-0.433) and valuing flexibility (-1.207) were negative predictors.

The only other model with an $R^2 >0.4$ was general practice. A positive clinical attachment was associated with an OR of 2.358; the other positive contributors were flexibility (1.384), intending to work in a rural area (1.298), dependent children (0.719), money (0.498) and family status (0.349). Intending to work in the city and positive effect of medical role models were negative predictors (-1.034 and -1.467 respectively).

The model for general practice had the most variables (eight), and that for obstetrics and gynaecology the least (two, $R^2 = 0.327$). Other than a positive experience on a clinical attachment (2.740) the only other predictor of strong interest was being female (1.177).

In this analysis, female gender was a positive predictor of interest in obstetrics and gynaecology (1.177), geriatrics (0.866), neonatology (0.567), paediatrics (0.466), subspecialty medicine (0.164) and general medicine (0.132). It was a negative predictor in subspecialty surgery (-0.724), general surgery (-0.493) and anaesthetics (-0.490).

No model significantly predicted a strong interest in radiology, public health, post-graduate study, medical sciences, emergency medicine or academic research. With the exception of emergency medicine, numbers in these specialties were small. The strongest predictor for every specialty was a positive experience on a clinical attachment.

**Table 3. Models of interest by specialty, starting with the best model**

| Specialty | Odds Ratio |
|---|---|
| **Subspecialty surgery ($R^2$ = 0.48)** | |
| Positive clinical attachment | 2.9 |
| Family/Friend work in area | 0.6 |
| Intend to work in the city | 0.4 |
| Support by student allowance | -0.4 |
| *Female* | *-0.7* |
| Flexibility | -1.2 |
| **General Practice ($R^2$ = 0.447)** | |
| Positive clinical attachment | 2.4 |
| Flexibility | 1.4 |
| Intend to work in a rural area | 1.3 |
| Dependent children | 0.7 |
| Income | 0.5 |
| Family status | 0.4 |
| Intend to work in the city | -1.0 |
| Medical role models | -1.5 |
| **Psychiatry ($R^2$ = 0.381)** | |
| Positive clinical attachment | 3.6 |
| Area of need | 0.7 |
| Family/friend work in area | -1.2 |
| **General surgery ($R^2$ = 0.365)** | |
| Positive clinical attachment | 2.6 |
| Income | 0.6 |
| *Female* | *-0.5* |
| Flexibility | -1.5 |
| **Paediatrics ($R^2$ = 0 363)** | |
| Positive clinical attachment | 3.0 |
| *Female* | *0.5* |
| Level of debt | -0.7 |
| Dependent children | -1.5 |
| **Geriatrics ($R^2$ = 0.356)** | |
| Positive clinical attachment | 3.4 |
| Family/Friend work in area | 1.4 |
| *Female* | *0.9* |
| **Subspecialty Medicine ($R^2$ = 0.335)** | |
| Positive clinical attachment | 2.2 |
| Intend to work in the city | 0.4 |
| *Female* | *0.2* |
| Support by scholarship | -0.3 |
| Support by student loan | -0.5 |
| Support by partner income | -1.2 |
| **Obstetrics and Gynaecology ($R^2$ = 0.327)** | |
| Positive clinical attachment | 2.7 |
| *Female* | *1.2* |
| **Neonatology ($R^2$ = 0.326)** | |
| Positive clinical attachment | 2.8 |

| Specialty | Odds Ratio |
|---|---|
| *Female* | *0.6* |
| Support by savings | 0.4 |
| **Anaesthetics ($R^2$ = 0.315)** | |
| Positive clinical attachment | 2.9 |
| Support by part-time employment | 0.3 |
| *Female* | *-4.9* |
| **General Medicine ($R^2$ = 0.295)** | |
| Positive clinical attachment | 2.3 |
| Family/Friend work in area | 1.0 |
| *Female* | *0.1* |
| Support by scholarship | -0.4 |
| Support by student loan | -0.6 |
| Dependent children | -1.4 |

## Discussion

Our study of over 700 contemporary NZ medical students confirms the persistence of historical preferences for some specialties including by gender.

We found women were more likely to be interested in obstetrics and gynaecology, paediatrics, geriatrics, public health and general medicine.

Men were more likely to be interested in surgical specialties, anaesthetics, academic research and post-graduate study. We were particularly interested in levels of student interest in general practice, as it is largest NZ workforce, containing a disproportionately high number of women, yet is the most threatened, especially in rural areas.

While it is estimated that 50% of the medical workforce of the future will be needed in primary care to cope with the increased health care requirements of an aging[17] population we found only 30% of students with a strong interest in general practice, and no gender difference. Furthermore, only 3% of students had a strong interest in general practice alone, which is more predictive of a subsequent GP career.[18]

On the other hand, students had a strong interest in at least three careers, suggesting there is still some 'plasticity' in choice, with a gradual narrowing down to what doctors finally decide to become. Recent Medical Council of New Zealand workforce surveys support the notion of a later switch from other specialties towards general practice, particularly for women.

Of all female doctors in training only 13% are training in internal medicine while 36.4% are training in general practice. Women made up 59% of those training in general practice in 2012.[10] Our data confirmed the finding of others of a positive relationship between intention to work in a rural area, and interest in general practice.[19]

Factors that influence the decision to choose one specialty over another may be considered broadly as student or curriculum factors. Through the use of predictive models, our study was able to shed light on some of these career influences. Even though the survey questions were broad, we were able to produce moderately good predictive models for 11 of the 18 specialties.

A major new finding is that that the important factors in career choice are not the same for each specialty. While some student factors featured commonly such as gender, location of future practice, and student loans, career flexibility was a positive predictive factor in only two specialties; general practice and psychiatry, in which women and men were equally likely to have a strong interest.

Women were more likely to be interested in paediatrics or obstetrics and gynaecology; careers with demanding training programmes and unpredictable work schedules. In contrast, women were far less likely than men to be interested in anaesthesia, which has a relatively short training programme and a more predictable work pattern. Explanations for these findings are that at exit from medical school students have yet to experience the demands of working as a junior doctor, or the full impact of caregiving requirements on training and work.

In support of this is that our findings suggest men may favour flexibility as much as women at this stage of their careers. For the few students with children, this was a positive predictor of interest in general practice, and negative for general medicine or paediatrics.

Another finding was how strongly clinical attachments influenced career choice, compared with student factors, including gender. Role models by themselves did not seem to account for this effect, so we presume it is the nature of the work itself, including factors such as intellectual stimulation and variety.[20]

Our findings support the need for medical students and junior doctors to be engaged in a range of meaningful clinical experiences not only for their learning but to help in career planning. We were, however, concerned to find a negative impact of role models upon interest in general practice. It is not clear whether the role models were in general practice or among other specialists.

A study of medical schools in the United States found the level of interest in primary care correlated with the attitudes from specialists outside of primary care.[21] A recent study of medical students in Christchurch found that hospital specialists did not greatly influence medical students attitudes to primary care unless they were a mentor.[22]

The difference in these findings may be explained by more personal experience of general practice before entering medical school in NZ compared to the United states. The Christchurch study concurs with our findings that experience during a clinical attachment strongly influences future career choice. Future research may determine the key features in a positive clinical attachment, in a career sense, as well as how negative role models affect choices.

Our findings suggest an interaction among gender and other factors in career choice. This may vary by setting and even by culture. For example, in a UK study, female students were less likely to choose surgery as they had not sufficiently seen, heard, done, or imagined this during surgical placements.[13]

In Taiwan, female and male medical students perceived that genders were treated differently.[23] Both reported the same career influencing factors yet ended up with different specialty interests. In contrast, amongst Swedish medical students, the only specialty with a significant difference in interest between women and men was

obstetrics and gynaecology. There was no significant difference between genders in influencing factors such as interest, degree of patient contact, technical skills or combining work and family.[24]

The strengths of the study are its size, response rate, and internal consistency. The main weakness is that this survey was taken during the final year at medical school with analysis based on specialty intention, not actual practice. Longer term tracking is planned to validate these predictions.

Moreover, recent versions of the survey ask students to nominate their first choice of career, which will better guide workforce planning, as it is a better predictor. Demographic variables such as age or ethnicity were not included in the exit survey nor were background history such as growing up in the city or a rural area or having a prior degree. These might be areas for future study.

## Conclusions

Our study reveals something of the complex interplay among curriculum and student factors in career determination. There is a need to be aware of both when looking at selection and curriculum policies during medical school and beyond. Those in a position to offer career advice, training or jobs to NZ's future specialists need to understand the steps and factors in career decision making, and how these may differ by specialty and gender. Gender differences are more than a desire for flexibility.

Experience on a clinical attachment is the most important influencing factor at this stage in a doctor's career. All clinical teachers and the health education system more broadly must be mindful of how formative clinical attachments are in the student's minds, and be cognisant of their own critical roles in developing the NZ medical workforce as a whole, not just in their own specialty.

Having a greater availability of general practice placements during the early postgraduate years may help confirm this as the first career choice, not one kept in reserve for after other specialties are tried.

**Competing interests:** Nil.

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THE NEW ZEALAND MEDICAL JOURNAL
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# Electrophysiology assessment and radiofrequency ablation of arrhythmias in adult patients with congenital heart defects: the Christchurch experience

Kim Frankish, Matthew Daly, Judy Greenslade, Sharron Denekamp, Anna Chapman, John Lainchbury, Iain Melton, Darren Hooks, Ian Crozier

**Abstract**

**Introduction** Adults with congenital heart disease (CHD) frequently have cardiac arrhythmias, many of which are best treated with radiofrequency ablation (RFA). We present our experience in this group.

**Methods** Retrospective chart based review of diagnosis, arrhythmia type, results of cardiac electrophysiological assessment, and procedural and long-term clinical success of radiofrequency ablation.

**Results** Forty-five patients were identified with CHD and arrhythmias undergoing RFA; including surgically repaired atrial septal defects (21), Ebstein's anomaly (12), repaired transposition of the great arteries (3), repaired Tetralogy of Fallot (4), repaired ventricular septal defect (3), repaired coarctation (1) and unrepaired anomalous pulmonary venous anatomy (1).

Arrhythmias were atrial flutter (24), atrial fibrillation (1), atrial tachycardia (3), atrioventricular nodal re-entrant tachycardia (5), and atrioventricular re-entrant tachycardia (12).

Procedural success was ultimately obtained in 36 patients, with 6 having unsuccessful ablation and 3 an undetermined result.

Twelve patients required a repeat procedure. One patient required a third procedure and had insertion of permanent pacemaker and atrioventricular nodal ablation.

With follow-up (range 2–264 months) 31 patients (69%) remained in sinus rhythm, 9 have developed atrial fibrillation, 3 are in atrial flutter or atrial tachycardia, 1 patient reports ongoing palpitations with no documented arrhythmia and 1 patient has died.

Procedural complications were major venous access bleeding (2), transient heart block during slow pathway ablation with late complete heart block (1).

**Conclusions** The majority of arrhythmias in adult patients with congenital heart defects can be successfully treated with radiofrequency ablation at a relatively low risk.

Historically, many patients with congenital heart defects (CHD) died in childhood owing to the condition's haemodynamic effect. In the last 50 years, however, the number of patients with CHD surviving to adulthood has increased dramatically due to the development of effective cardiac surgical correction.[1] These patients have a high incidence of cardiac arrhythmias[2] due to their congenital defect or as a

consequence of their cardiac surgery which predisposes to scar mediated re-entrant cardiac arrhythmias.

The management of these arrhythmias is a major issue especially as they may cause haemodynamic embarrassment due to residual cardiac compromise and medical management may be ineffective or poorly tolerated. The majority of these arrhythmias are suitable for cardiac electrophysiological assessment (EPS) and radiofrequency ablation (RFA).[3] These patients provide special challenges during EPS and RFA due to abnormal anatomy; surgical baffles and scarring; and compromised vascular access. However, with advancement in the understanding of the mechanisms of these arrhythmias, and sophisticated mapping system technology it is becoming easier to map and correct these arrhythmias.

We report on the Christchurch experience with electrophysiology study and radiofrequency ablation for the diagnosis and treatment of adults with congenital heart defects, both with and without previous corrective cardiac surgery.

## Methods

The study population consisted of all adults with a prior diagnosis of a congenital cardiac defect that underwent EPS and RFA at Christchurch hospital from 1992 to 2013. Patients were identified from our database, and all data was collected retrospectively using patient medical records and procedure reports. Details of arrhythmia diagnosis, congenital heart defect, previous surgery, electrophysiological diagnosis, and the procedural outcome of ablation when performed were collected.

Informed consent was obtained for each procedure. Patients were studied under conscious intravenous sedation with local anaesthetic at the site of vascular access.

Multiple diagnostic and ablating cardiac electrophysiological catheters were placed using fluoroscopy, and 3D mapping systems were incorporated for more complex cases from November 2001. Some patients underwent cardiac computerised tomography scanning before the procedure to provide venous and atrial anatomic details.

Tachycardias and pathways were mapped with conventional mapping techniques, entrainment mapping and, when available, 3D activation maps. Following the diagnostic assessment, radiofrequency ablation was performed targeting the pathways and critical components of re-entrant circuits.

Procedural success was determined by abolition of pathway conduction, block of critical isthmuses and non-inducibility of tachycardia. Clinical success was determined from the clinical follow-up reports.

## Results

We identified 45 patients with CHD and arrhythmias undergoing EPS and RFA in our institution. The study population consisted of 46.5% males with ages ranging between 17–76 years.

The patients had the following underlying CHD: atrial septal defects with previous surgical repair (21); Ebstein's anomaly (12); repaired transposition of the great arteries (3); repaired tetralogy of Fallot (4); repaired ventricular septal defect (3); repaired coarctation (1) and unrepaired anomalous pulmonary venous anatomy (1). Clinical arrhythmias diagnosed prior to EPS included atrial flutter (24); atrial fibrillation (1); atrial tachycardia (3); atrioventricular nodal re-entrant tachycardia (5); and atrioventricular re-entrant tachycardia (12).

Of the 45 patients in the study group, procedural success was ultimately obtained in 36 patients; 6 had an unsuccessful ablation and 3 had an undetermined result. One patient underwent diagnostic EPS initially and was found to have multiple atrial

tachycardias. This patient subsequently received a permanent pacemaker and atrioventricular nodal ablation rather than undergoing an attempted ablation of the atrial tachycardias.

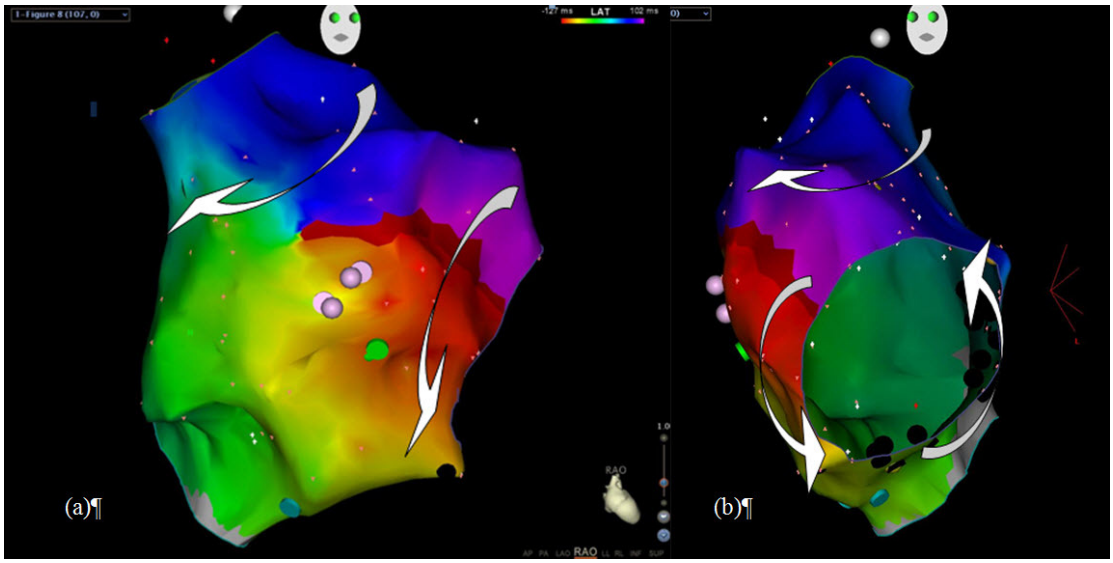
In our group, 12 patients required a repeat study. Of the 12 patients that re-presented with arrhythmias following an initial RFA attempt, 6 were found to have a different arrhythmia and 6 had the original arrhythmia. Of the six with the original arrhythmia 4 had previous acute success and 2 had previous failed ablations. One patient required a third procedure, and had an insertion of a permanent pacemaker and subsequent AV nodal ablation. The outcomes from the 13 repeat procedures in 12 patients were 9 successful, 1 partially successful, 2 undetermined, and 1 unsuccessful.

Overall, of the 45 patients, 37 (82%) had their arrhythmias successfully treated.

**Atrial septal defect patients—**In the 21 patients with atrial septal defects, all had previous surgical repair. Fifteen had atrial flutter, of which 3 had typical tricuspid annular flutter only and 11 had incisional atrial flutter, including 4 with figure of 8 circuits.

The majority of atypical and figure of 8 flutters were around the atriotomy scar on the lateral wall of the right atrium, with the figure of 8 circuits having the second limb through the tricuspid isthmus (Figure 1). For tricuspid annular-dependent circuits a line of ablation from the tricuspid annulus to the inferior vena cava was performed and block across the line was checked with differential pacing. Ablation for atypical circuits involved lines from scar tissue anchored to inferior vena cava, superior vena cava or tricuspid annulus.

**Figure 1. CARTO3 maps of right atrium showing activation of figure of 8 atrial flutter**

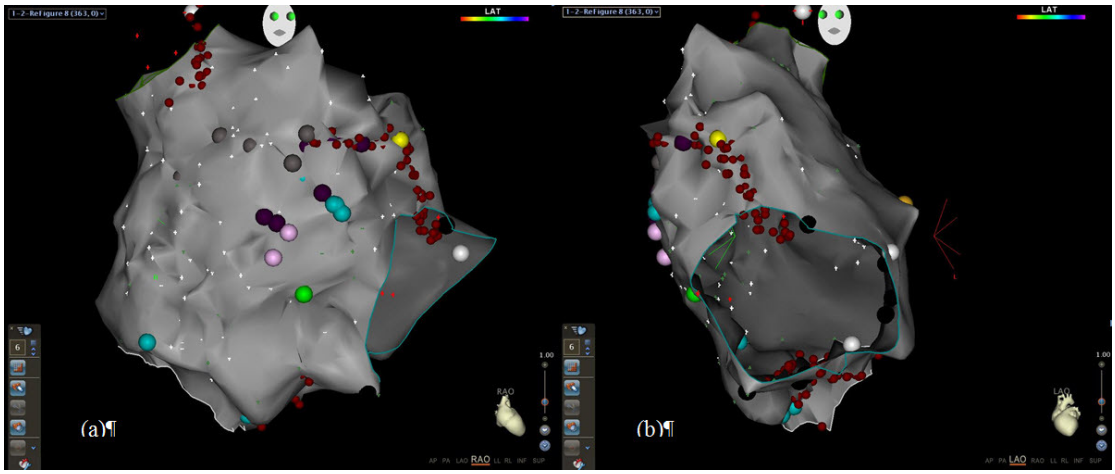



**Note:** Red shows early signals through to purple being latest signals. The red bar depicts where early signals meet late signals, indicating a reentrant circuit. Arrows show direction of wave fronts: around tricuspid annulus and around the superior vena cava. The wave fronts meet anteriorly and split into the two circuits at the point of the atriotomy scar (pink dots). Green dots show area of entrainment, black

dots show annular points and blue dots show points of double potentials. **(a)** Right anterior oblique projection **(b)** Left anterior oblique projection.

For patients with figure of 8 tachycardias, 2 or more line sets were required for success (Figure 2). Block across these lines was checked with differential pacing. Of the 15 patients with atrial septal defects and atrial flutter, procedural success was achieved in 11 patients, though 4 patients required a repeat procedure to achieve success. One patient with two previous ablation attempts was unable to be ablated and subsequently underwent AV nodal ablation and insertion of a permanent pacemaker.

**Figure 2. CARTO3 maps of right atrium showing lines of ablation (red dots) performed to terminate the figure of 8 atrial flutter**




**Note:** Lines were performed from tricuspid annulus to inferior vena cava, superior vena cava to lateral scar and lateral scar to tricuspid annulus. Grey dots depict the area of lateral atriotomy scar, purple and pink dots depicts interesting and fractionated signals, blue dots show double potentials and green dots show areas of entrainment. The yellow dot shows the point at which flutter terminated to sinus rhythm.

Two patients had multiple focal atrial tachycardias. One received AV nodal ablation and a pacemaker; the other had an undetermined result from their ablation procedure.

Three patients had atrioventricular nodal re-entrant tachycardia treated with slow atrioventricular nodal pathway ablation, two had procedural and clinical success and 1 had an unsuccessful procedure.

The sole patient with permanent atrial fibrillation underwent an atrial fibrillation ablation with total pulmonary vein isolation and ablation to fractionated left atrial signals, roof line between right and left superior pulmonary veins, a mitral isthmus line and a tricuspid isthmus line.

With long-term follow-up (range 2–180 months) 11 patients remain in sinus rhythm, 2 patients have recurrent atrial flutter, 1 patient is deceased, 6 patients have developed atrial fibrillation and the patient with atrial fibrillation remains in chronic atrial fibrillation.

**Ebstein's anomaly patients—**Twelve patients had Ebstein's anomaly, of which two patients had previous surgery for Wolff Parkinson White syndrome. Clinical arrhythmias were atrioventricular tachycardia associated with ventricular pre-excitation (Wolff Parkinson White syndrome) in 11 patients; one of these patients also had typical atrial flutter; and one patient with multiple incisional atrial flutters from previous cardiac surgery.

In the 11 patients with pre-excitation, all pathways were right-sided and 4 patients had multiple pathways. Ten patients had procedural and clinical success, although 2 required a repeat procedure for recurrence of the same pathway. One patient had a failed procedure and has not represented for a repeat study.

The patient with typical atrial flutter underwent successful cavotricuspid isthmus ablation in addition to successful pathway ablation.

One patient, with previous successful pathway ablation, returned with atypical atrial flutter. This was found to be an incisional flutter around the atriotomy scar and was successfully ablated.

The patient with multiple incisional atrial flutters underwent two separate ablations of multiple circuits. Whilst they had inducible arrhythmia at the end of the procedure, they have had overall clinical success.

With long-term follow-up (range 2–264 months), no patient who underwent pathway ablation has had pathway recurrence. Of the two patients receiving ablations for atypical flutter, one remains in sinus rhythm, the other has ongoing multiple atrial tachycardias.

**Tetralogy of Fallot patients—**Four patients had surgically-repaired tetralogy of Fallot. Two patients had atrial flutter; one typical, one incisional figure of 8; both had procedural success. One patient had a right atrial focal tachycardia with procedural success. However, they subsequently developed atrial flutter and were found to have both typical tricuspid flutter and incisional flutter. At repeat EPS and RFA the typical flutter was successfully ablated, with block achieved for the tricuspid line, but block across the lateral line was not achieved. One patient had atrioventricular re-entrant tachycardia with ventricular pre-excitation and procedural success.

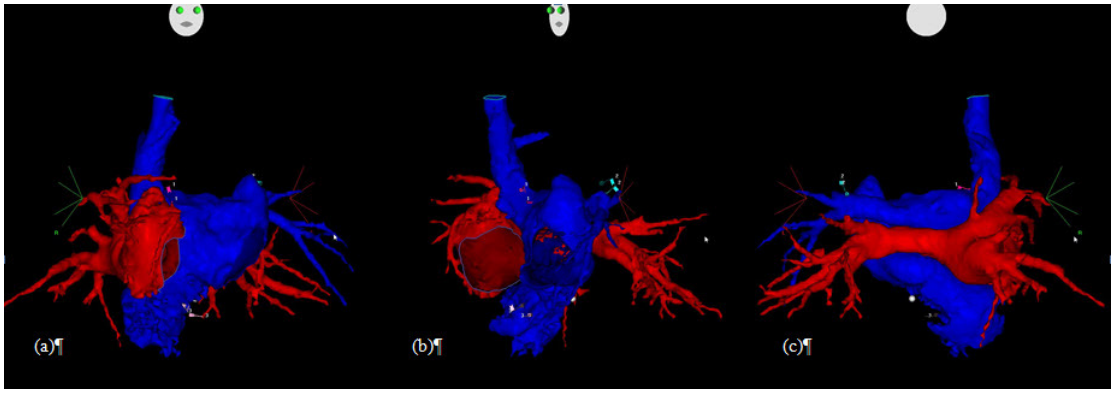
With long-term follow-up (range 23–97 months) two patients remain in sinus rhythm, one patient has recurrent atrial flutter and atrial fibrillation and one patient has ongoing palpitations without documented arrhythmia.

**Transposition of the great arteries patients—**Three patients had Mustard atrial baffle repairs of transposition of the great arteries (Figure 3) and atrial flutter. One patient had cavotricuspid isthmus flutter; one had micro re-entrant flutter in the systemic atria; and one had multiple atrial flutter circuits, including cavotricuspid isthmus flutter and upper and lower-loop circuits in the systemic venous atria. In patients with cavotricuspid isthmus-dependent flutter, isthmus block was achieved by ablation from the inferior vena cava to baffle, then completing the isthmus line via a retro-aortic approach to the tricuspid end of the isthmus.

Procedural and clinical success was obtained in all, though 1 patient required a second procedure for success.

With long-term follow-up (range 10–38 months) all patients currently remain in sinus rhythm.

**Figure 3. Computerised tomographic images of atria in a patient with Mustards repair of transposition of the great arteries**




**Note:** Red shows the pulmonary venous atrium, which feeds into the right ventricle and pumps oxygenated blood to the body. Blue shows the systemic venous atrium. The inferior vena cava and superior vena cava have been redirected to feed into the left ventricle and pump deoxygenated blood to the lungs. (a) Right anterior oblique projections (b) Left anterior oblique projection (c) Posterior-anterior projection.

**Other patients—**These patients included ventricular septal defect (2); ventricular septal defect with coarctation (1); surgically repaired coarctation with bicuspid aortic valve (1); and unrepaired anomalous venous anatomy (1). The arrhythmias were atrioventricular nodal re-entrant tachycardia (2) with procedural and clinical success in both, though one patient required a repeat procedure. Three patients had atrial flutter; one typical, one both typical and atriotomy dependent flutter. The patient with anomalous venous anatomy had atypical cavotricuspid isthmus dependent flutter. All 3 patients had procedural and clinical success.

With long-term follow-up (range 13–180 months), 4 patients remain in sinus rhythm and one patient has developed atrial fibrillation.

**Procedural duration—**The procedure duration was 191±92 minutes (mean±standard deviation), (range 30–450 minutes). The screening time was 45±28 minutes (range 5-117 minutes). The radiation dose was 36±39 Gy.cm$^2$ (range 2-161 Gy.cm$^2$).

**Procedural complications—**Of the 45 patients undergoing a total of 58 procedures, three procedural complications occurred. Two patients had major venous access bleeding, with one requiring a blood transfusion. One patient had transient AV block during slow pathway ablation for AVNRT and subsequently re-presented with complete heart block and required a permanent pacemaker.

## Discussion

Patients with congenital heart disease are now surviving into adulthood due to effective cardiac surgical correction.[1] These patients are at increased risk of cardiac

arrhythmia due both to a higher incidence of pathway mediated arrhythmias, and also due to the occurrence of arrhythmias that are a consequence of the cardiac surgery.[2]

Arrhythmia management can be especially challenging in this group of patients. The arrhythmias may be poorly tolerated, due to the associated residual cardiac defects but also the nature of the arrhythmias. In particular, atriotomy dependent atypical atrial flutters are difficult to manage with drug therapy, can become incessant and may be highly symptomatic.

These arrhythmias are suitable for treatment with curative intent by RFA[3]; however most of these procedures are performed in large centres, with large volumes of adults with congenital heart disease.

We present the experience of our small general arrhythmia service with a low volume of cases with congenital heart disease. In our series of adults with congenital heart disease and arrhythmias the majority of these patients treated with radiofrequency ablation had both procedural and long-term clinical success, with a low risk of complications. Procedure durations were often long, but the procedures were well tolerated.

There are a number of special considerations that need to be taken into account when performing ablations in adults with congenital heart disease.

In patients who have had an atriotomy for surgical correction of their congenital defect, incisional atrial flutter was the commonest mechanism of supraventricular tachycardia.

Incisional atrial flutter was the commonest arrhythmia in our series, occurring most commonly in patients that had undergone closure of an atrial septal defect, but also in patients with atrial baffle repairs for transposition of the great arteries, and surgical correction of accessory pathways in Ebstein's anomaly. These atrial flutters are difficult to manage with medical therapy, are often incessant, and can usually be cured by ablation,[3] making this the treatment of choice for most patients.

The atrial flutter circuit is determined by the previous surgery, and in the majority of cases, is dependent on areas of scaring and slow conduction on the anterior wall of the right atrium, in the area of the surgical atriotomy.[4–6] However, as reported in other series, in none of our patients were the atrial flutters confined to the area of septal repair.[6]

Many patients also had simultaneous tricuspid annular atrial flutter resulting in a "dual loop figure", also known as a figure of 8 circuit.[7,8] (Figure 1). Patients with figure of 8 flutters required both a cavotricuspid isthmus ablation line and a second line between the atriotomy scar and adjacent anatomical boundary (Figure 2). Furthermore, as these patients often have extensive right atrial scarring and multiple potential circuits, non-clinical tachycardias may be inducible following successful ablation of the clinical arrhythmia, but do not predict clinical failure as we saw in our patients.

Patients with atrial baffle repairs for transposition of the great arteries provide special challenges. The atrial anatomy is greatly distorted by the surgical repair, making access to the pulmonary venous atrium difficult (Figure 3). We observed both incisional and cavotricuspid dependent atrial flutter in our patients. Cavotricuspid

dependent atrial flutter is the most commonly observed arrhythmia in these patients and requires ablation in both the systemic venous atria from the inferior vena cava to the baffle, with the completion of the line from the baffle to the tricuspid valve in the pulmonary venous atria.[9] We chose to perform this via a retro-aortic approach, though others have described accessing the pulmonary venous atria via a baffle puncture.[10]

Ebstein's anomaly is associated with the Wolff Parkinson White syndrome and pathway mediated atrioventricular tachycardia in 6 to 36% of cases.[11] These pathways are almost exclusively right sided[12] and approximately half the patients will have multiple pathways[12,13] as seen in our series.

These pathways can be challenging to ablate, with lower procedural success rates and higher recurrence rates than seen with other pathways[11,14] due to the distortion of the tricuspid annulus, difficulty in achieving catheter stability and the frequent occurrence of multiple pathways. We found that a number of patients with Ebstein's anomaly required a second ablation attempt to achieve long-term clinical success.

Adults with congenital heart disease and arrhythmias require different approaches to other patients undergoing ablation. Preparation prior to the case will facilitate the procedure and outcomes. In particular, detailed knowledge of the patients' anatomy and the details of the surgical procedure greatly facilitate a successful outcome.

Knowledge of the surgical incisions and atrial anatomy will guide the likely site of any incisional arrhythmia. In selected cases, prior CT scanning helps define the anatomy (Figure 3), whilst 3D mapping can facilitate defining atypical flutter circuits (Figure 1). We used CT scanning to define atrial anatomy in the 3 patients with prior transposition of the great arteries repair, and 3D mapping in all the recent cases of atrial flutter.

In conclusion, we report our results with the cardiac electrophysiological assessment and ablation of arrhythmias of adults with congenital heart disease. With appropriate preparation, and knowledge of the patients' anatomy and surgical details the majority of these patients can undergo successful treatment of their arrhythmias.

**Limitations—**This report is retrospective and is therefore subject to the inherent biases in data recording and retrieval that arise from investigations of this nature. We report on a small number of patients in a single centre and our findings may not be able to be generalised to the wider population.

## Conclusions

We report our results for ablation of arrhythmias in adults with congenital heart disease. The majority of these arrhythmias can be successfully treated at a relatively low risk.

**Competing interests:** Nil.

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# Prognostic value and long-term variation of high sensitivity troponin T in clinically stable haemodialysis patients

S Honegger Bloch, David Semple, Karishma Sidhu, Ralph Stewart, Helen Pilmore

**Abstract**

**Aim** To provide data on the long-term prognostic relevance and variation of high sensitivity troponin T (hsTnT) in haemodialysis patients.

**Methods** In 238 stable, asymptomatic haemodialysis patients from a single-centre hsTnT was measured at baseline, 18 and 22 months and outcomes assessed for 24 months.

**Results** Baseline hsTnT was a significant predictor of all cause (+10ng/l, HR 1.017, 95%CI 1.011–1.023, p<0.0001) and cardiovascular death (HR 1.02, 95%CI 1.013-1.0026, p<0.0001). HsTnT>140ng/L was a strong predictor of cardiovascular mortality (HR 8.51, 95%CI 1.907–38.032; p<0.0001). HsTnT increased by >50% in less than one-third of patients, and doubled in only 10% of patients, during 18 and 22 months follow up.

**Conclusion** In clinically stable hemodialysis patients, higher hsTnT was associated with both total and CV mortality. In most patients variation in levels of hsTnT between 18 and 22 months was <50%, and on average the increase in hsTnT was small.

In most patients with end stage kidney disease (ESKD) plasma levels of troponin T are elevated about the normal range, but few studies have analysed the newly introduced fifth generation highly sensitive troponin assays in these patients. When evaluated in general populations these assays have superior sensitivity for detection and diagnosis of myocardial infarction due to high assay precision at the 99th percentile for the normal population.[1-3]

Depending on patient demographics, median hsTnT concentrations between 49 and 69 ng/l have been documented in haemodialysis patients.[4-6] For highly sensitive troponin I (hsTnI) assays a greater proportion of dialysis patients have levels within the normal range for the general population.[5,7]

Elevated cardiac troponin (cTn) concentrations in haemodialysis patients may reflect reduced clearance due to declining residual renal function,[5,8] chronic myocardial strain attributed to hypertension, chronic fluid overload, shunt flow, increased pulse pressure, anaemia and cardiomyocyte remodelling.[5,9,10] Recurrent myocardial damage from dialysis related myocardial stunning is also possible.[11,12]

Given the chronicity, as well as the presumed progression of cardiac structural damage with long-term haemodialysis,[11] as well as continuously declining residual renal function, one would expect that serum cTn concentrations may increase with time on dialysis. However, studies using older generation cTn assays have reported no significant change for up to 15 months.[13,14]

It is not known whether the new 5th generation assays, with a 10 fold increase in sensitivity, provide more discriminative information regarding variation in troponin over time.

The aim of this study was to determine how hsTnT levels varied over a 22 month interval, and to evaluate the prognostic value of hsTnT for all cause and cardiovascular mortality during 2 years follow up.

## Materials and Methods

The study was approved by the Northern×Ethics Committee, Auckland, New Zealand.

**Patients and clinical data—**The study cohort has previously been described.[6] The mean age was 63 years and the mean duration of dialysis 38.5 months. A third of patients had known ischaemic heart disease (defined as previous myocardial infarction, angina/angina equivalent with confirmed coronary disease on angiogram or positive stress imaging study or coronary revascularisation), with the majority (67%) of these having had prior myocardial infarction. Of the 160 (66.6%) patients with an echocardiogram 27% had an ejection fraction of<50%.

Diabetes mellitus was present in 64% of the patients and in 95% of these, diabetes was the cause of end stage renal failure. The majority of patients were Māori (15%) or Pacific Islanders (48.5%) in keeping with the demographic of our dialysis population.

The majority of the study cohort received haemodiafiltration using high flux membranes. Of 239 prevalent patients from our in-centre hospital unit and 3 satellite units, 238 underwent baseline hsTnT testing prior to dialysis on a midweek dialysis in April 2011. At 18 and 22 months repeat hsTnT testing was performed, immediately before dialysis after a 2-day inter-dialytic period. Patients were followed for 24-months until April 2013.

Data relating to mortality were collected by systematic review of all patients' electronic records. Cardiovascular (CV) death was defined as cardiac arrest, fatal myocardial infarction or stroke, heart failure, death resulting from peripheral vascular disease or from a complication of a cardiovascular procedure.

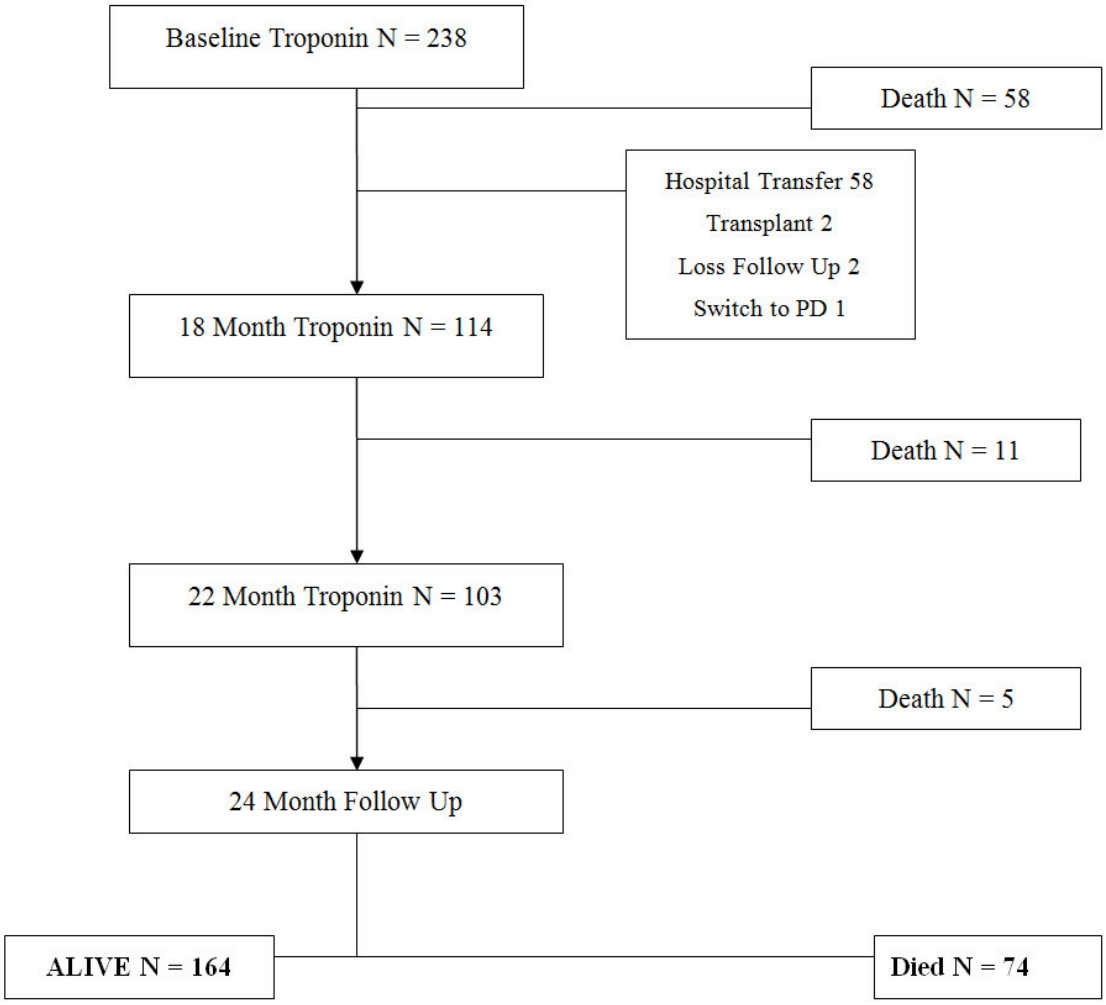
Data collected included age, gender, ethnicity, body mass index, cause of end stage renal disease, time on dialysis and the presence of ischaemic heart disease, previous coronary revascularisation, presence of diabetes, presence of atrial fibrillation and smoking status. The most recent echocardiographic findings (left ventricular ejection fraction and presence of left ventricular hypertrophy) were included if the echocardiograph was performed within 2 years of the baseline troponin levels.

Patients who transferred to other dialysis centres in New Zealand during the follow up period did not undergo repeat hsTnT tests (Figure 1). However, data on mortality and cardiovascular events to 24 months was available for all patients.

**Blood collection and hsTnT assay—**HsTnT tests at each time point were performed concurrently over a 1-week period across the 4 dialysis units involved in this study. Samples were taken away from the long weekend break, before a midweek dialysis session. HsTnT levels were reviewed on the same day and in the event of a significant increase patients were assessed clinically and with an ECG within 24 hours and further investigations performed if indicated.

All hsTnT tests were performed using an automated high-sensitivity troponin T Roche assay on a Roche Modular E170 analyser (limit of detection 5 ng/L, 99th percentile at 13.5 ng/L, coefficient of variation of less than 10% at 13 ng/L).

**Figure 1. Flowchart**




**Statistical analysis—**Categorical data are reported as frequencies and percentages and continuous data as medians with inter-quartile range (IQR). Differences in hsTnT levels between baseline and 18 months and baseline and 22 months were tested by the Wilcoxon signed-rank test. Percentage change in hsTnT from baseline to 18 months and from baseline to 22 months was plotted against baseline hsTnT values to depict the variability in hsTnT over the follow-up period.

Baseline hsTnT was categorised into groups according to different cutoffs of 14, 28, 70, 140 ng/L, corresponding to clinically relevant and easily applicable multiples of the upper limit of normal (1×ULN, 2×ULN, 5×ULN, 10×ULN respectively). Kaplan-Meier curves were generated and the differences between survival curves were compared using the log-rank test.

Univariate Cox proportional hazards regression was used to assess if baseline hsTnT and baseline characteristics were independent predictors of survival. Stepwise Cox proportional hazards regression was performed to determine if baseline hsTnT was still a predictor for mortality after adjusting for baseline characteristics.

Statistical analyses were performed using the statistical package SAS version 9.3 (SAS Institute, Cary, NC).

All p-values resulted from two-sided tests and a p-value of $<0.05$ was considered statistically significant.

## Results

Baseline characteristics and population demographics have been previously reported and are included in Table 1.[6] The median age was 63 years. The population had an equal gender distribution with a high incidence of Pacific Islanders (49%) and a high proportion (64%) of patients with diabetes mellitus representing our usual dialysis population.

**Table 1. Baseline variables as independent predictors of all cause and cardiovascular death: univariate analysis**

| Risk factor | | All-cause mortality | | | CVS mortality | | |
|---|---|---|---|---|---|---|---|
| | N (%) | Hazard ratio | 95%CI | P-value | Hazard ratio | 95%CI | P-value |
| Baseline hsTnT (continuous) 10 ng/L increase | 238 | 1.017 | 1.011–1.023 | <0.0001 | 1.02 | 1.013–1.026 | <0.0001 |
| Troponin 0–28 ng/L | 38 (16%) | 1 | | | 1 | | |
| Troponin 29–70 vs 0–28 ng/L | 91 (38%) | 2.688 | 0.932–7.748 | 0.0672 | 3.066 | 0.692–13.585 | 0.1403 |
| Troponin 71–140 vs 0–28 ng/L | 73 (31%) | 4.126 | 1.447–11.767 | 0.008 | 3.159 | 0.683–14.622 | 0.1412 |
| Troponin>140 vs 0–28 ng/L | 36 (15%) | 6.682 | 2.26–19.761 | 0.0006 | 11.551 | 2.639–50.555 | 0.0012 |
| Age <65 years | 137 (58%) | 1 | | | 1 | | |
| Age ≥65 years | 101 (42%) | 3.322 | 2.049–5.384 | <0.0001 | 2.796 | 1.476–5.296 | 0.0016 |
| European | 65 (27%) | 1 | | | 1 | | |
| Māori | 35 (15%) | 0.636 | 0.317–1.279 | 0.2043 | 1.123 | 0.418–3.015 | 0.8184 |
| Other | 22 (9%) | 0.457 | 0.176–1.184 | 0.1068 | 0.953 | 0.293–3.094 | 0.936 |
| Pacific | 116 (49%) | 0.53 | 0.316–0.887 | 0.0156 | 0.895 | 0.405–1.979 | 0.7847 |
| Male | 123 (52%) | 1 | | | 1 | | |
| Female | 115 (48%) | 1.429 | 0.903–2.260 | 0.1272 | 1.515 | 0.804–2.852 | 0.1987 |
| Non smoker | 166 (73%) | 1 | | | 1 | | |
| Previous smoker | 36 (16%) | 0.985 | 0.529–1.833 | 0.9609 | 1.064 | 0.468–2.415 | 0.883 |
| Current smoker | 24 (11%) | 0.316 | 0.099–1.007 | 0.0515 | NA | NA | 0.9861 |
| BMI <35 kg/m$^2$ | 188 (79%) | 1 | | | 1 | | |
| BMI ≥35 kg/m$^2$ | 50 (21%) | 0.733 | 0.403–1.334 | 0.3089 | 1.119 | 0.545–2.296 | 0.7596 |
| Atrial fibrillation | 27 (11%) | 1.48 | 0.780–2.808 | 0.2306 | 1.257 | 0.492–3.215 | 0.6327 |
| Ischaemic heart disease | 77 (32%) | 2.244 | 1.421–3.543 | 0.0005 | 2.292 | 1.221–4.302 | 0.0098 |
| Revascularisation | 17 (7%) | 0.711 | 0.260–1.947 | 0.5067 | 0.352 | 0.048–2.563 | 0.3024 |
| Heart failure | 25 (10%) | 1.381 | 0.709–2.690 | 0.3422 | 1.144 | 0.407–3.219 | 0.7989 |
| Diabetes mellitus | 152 (64%) | 1.135 | 0.701–1.837 | 0.6075 | 1.601 | 0.78–3.284 | 0.1996 |
| Ejection fraction >50% | 112 (70%) | 1 | | | 1 | | |
| Ejection fraction ≤50% | 47 (30%) | 1.707 | 1.011–2.881 | 0.0452 | 1.384 | 0.659–2.907 | 0.3912 |
| Albumin (continuous) 1 g/L increase | 238 | 0.889 | 0.847–.932 | <0.0001 | 0.882 | 0.827–0.94 | 0.0001 |
| Albumin ≥38 g/L | 196 (82%) | 1 | | | 1 | | |
| Albumin <38 g/L | 42 (18%) | 3.264 | 2.003–5.321 | <0.0001 | 3.283 | 1.662–6.487 | 0.0006 |
| Calcium <2.5 mmol/L | 190 (80%) | 1 | | | 1 | | |
| Calcium ≥2.5 mmol/L | 48 (20%) | 1.145 | 0.658–1.992 | 0.6311 | 1.389 | 0.677–2.85 | 0.3703 |
| Phosphate <2.0 mmol/L | 168 (71%) | 1 | | | 1 | | |
| Phosphate ≥2.0 mmol/L | 70 (29%) | 1.044 | 0.634–1.719 | 0.865 | 1.348 | 0.701–2.593 | 0.3715 |
| Parathyroid hormone <66 pmol/L | 185 (80%) | 1 | | | 1 | | |
| Parathyroid hormone ≥66 pmol/L | 47 (20%) | 1.423 | 0.835–2.426 | 0.1947 | 1.927 | 0.972–3.82 | 0.0603 |
| Haemoglobin ≥100 g/L | 49 (21%) | 1 | | | 1 | | |
| Haemoglobin ≥100 g/L | 189 (79%) | 0.753 | 0.443–1.280 | 0.2946 | 0.778 | 0.369–1.638 | 0.5084 |
| CRP (continuous) 1 mg/dL increase | 238 | 1.011 | 0.999–1.024 | 0.0685 | 1.019 | 1.004–1.034 | 0.0111 |
| CRP ≤10 mg/dL | 167 (70%) | 1 | | | 1 | | |
| CRP ≥10 mg/dL | 71 (30%) | 1.957 | 1.223–3.106 | 0.0044 | 3.148 | 1.676–5.91 | 0.0004 |

**Table 2. Categorical baseline variables as predictors of all-cause and cardiovascular mortality: multivariate analysis**

| Risk factor | All-cause mortality | | | CVS mortality | | |
|---|---|---|---|---|---|---|
| | Hazard ratio | 95%CI | P-value | Hazard ratio | 95%CI | P-value |
| Troponin 0–28 ng/L | 1 | | | 1 | | |
| Troponin 29–70 vs 0–28 ng/L | 1.53 | 0.519–4.506 | 0.4407 | 2.25 | 0.489–10.344 | 0.2975 |
| Troponin 71–140 vs 0–28 ng/L | 2.156 | 0.733–6.339 | 0.1627 | 1.988 | 0.412–9.606 | 0.3924 |
| Troponin>140 vs 0–28 ng/l | 3.923 | 1.292–11.918 | 0.0159 | 8.517 | 1.907–38.032 | 0.005 |
| Age <65 years | 1 | | | 1 | | |
| Age ≥65 years | 2.559 | 1.541–4.251 | 0.0003 | 2.303 | 1.177–4.507 | 0.0149 |
| Albumin ≥38 g/L | 1 | | | 1 | | |
| Albumin <38 g/L | 2.905 | 1.754–4.81 | <0.0001 | 2.191 | 1.058–4.537 | 0.0348 |
| CRP ≤10 mg/dL | 1 | | | 1 | | |
| CRP ≥10 mg/dL | 1.947 | 0.834–4.436 | 0.1248 | 2.208 | 1.123–4.345 | 0.0217 |
| Ischaemic heart disease | 1.857 | 1.153–2.99 | 0.0109 | 1.778 | 0.785–4.03 | 0.1679 |

**Troponin testing—**Of the 238 patients evaluated at baseline, 114 and 103 patients respectively had hsTnT measured at 18 and 22 months (Figure 1). One patient at the 18-month test was found to have an hsTnT >10,000 ng/L. He was admitted to hospital on the same day with a NSTEMI, declined a coronary angiogram and died subsequently from a cardiac arrest.

Another patient at 18 months was an inpatient with a NSTEMI while one patient at 22 months was an inpatient due to recent valvular heart surgery. These three patients were excluded from the variability analysis for the given times.

**Troponin variability—**The median hsTnT level for all 238 patients at baseline was 63 ng/L (IQR 37–108). At 18 months median hsTnT was 68.5 ng/L (IQR 40–100) in the remaining 114 patients and at 22 months 66 ng/L (IQR 39–102) in 103 patients.

Pre-haemodialysis hsTnT values were above the 99th percentile for the normal population (>13.5 ng/L) in 232 of 238 (97%) at initial testing, in 111 of 114 (97%) at 18 months and in 102 of 103 (99%) at 22 months.

The median change in hsTnT from baseline to 18 months was 5.5 ng/L (IQR -4–22); 31% (35/114) of patients had an increase in the 18-month hsTnT level of greater than 50% while 3% (3/114) underwent a reduction in hsTnT of greater than 50% (Figure 2A).

Sixty-seven percent of patients maintained an hsTnT level that was within 50% of the baseline level. Similar findings were found when comparing baseline hsTnT levels and levels at 22 months (Figure 2B).

**Figure 2A. Bland-Altman plot comparing baseline with 18-month troponin**

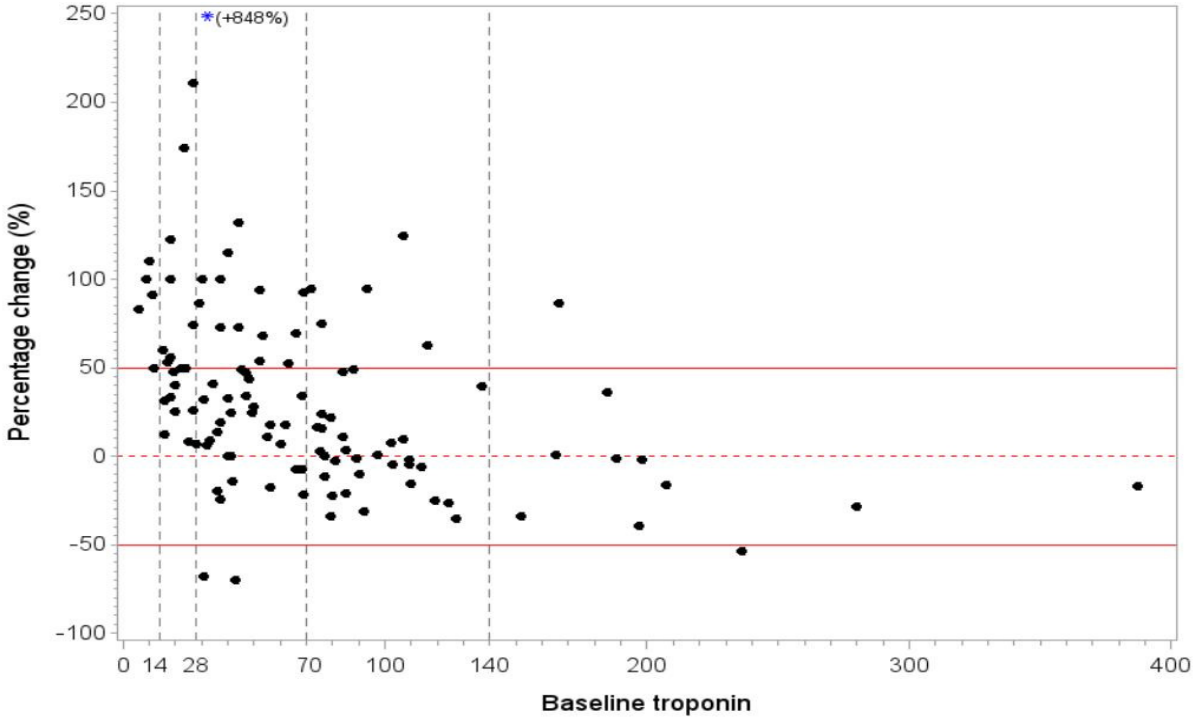
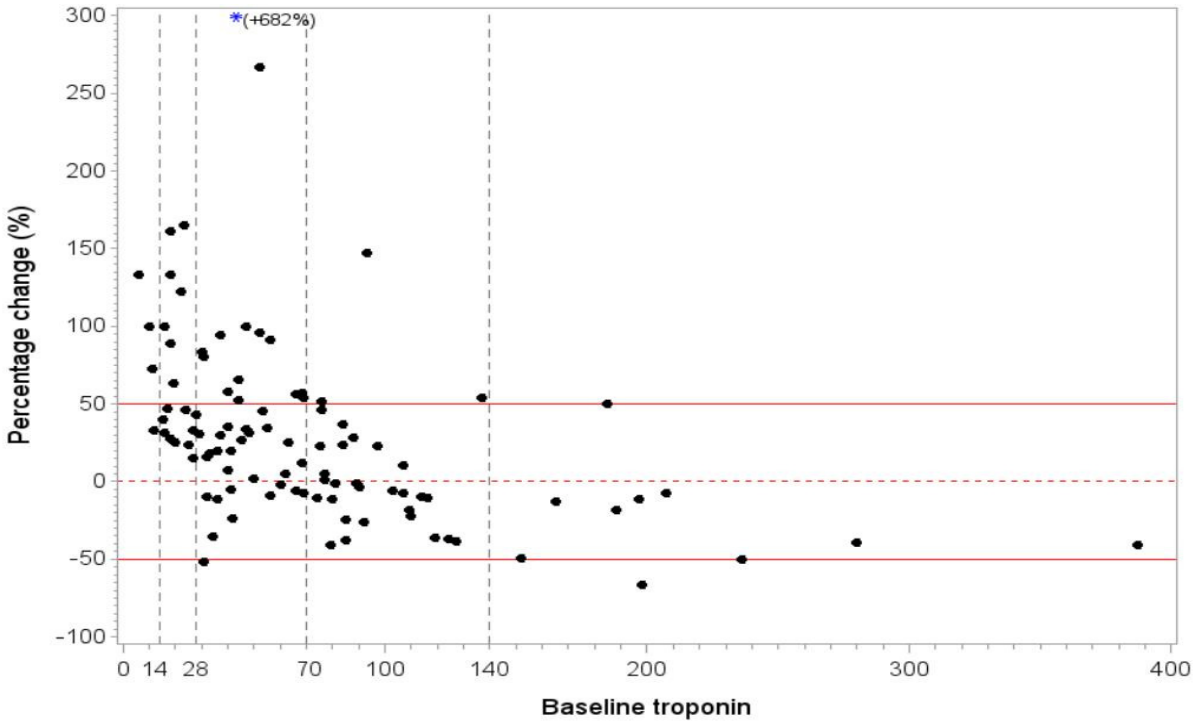



**Figure 2B. Bland-Altman plot comparing baseline with 22-month troponin**



**Troponin and mortality—**During 24 months follow-up 74 patients (31%) died, corresponding to an annual mortality of 15.5%. 39 deaths were from cardiovascular causes including 22 sudden deaths in the community.

Other causes of cardiovascular death were witnessed in hospital cardiac arrest (N=10), myocardial infarction (N=4), ischaemic gut (N=2) and heart failure (N=1). 17 deaths (23%) were due to patient withdrawal. Median baseline hsTnT was lower in survivors (55 ng/L (IQR 32–89)) compared to patients who died of all causes (84 ng/L (IQR 51-130), p<0.0001) and CV causes (83 ng/L (IQR 48–234), p=0.0005).

Higher baseline hsTnT levels were associated with an increase in both all-cause and CV mortality (Table 1). Other predictors of all cause death on univariate analysis were age, ischaemic heart disease, reduced ejection fraction, hypoalbuminaemia and elevated CRP. Predictors of CV mortality were age, ischaemic heart disease, hypoalbuminaemia and elevated CRP.

To determine a clinically relevant hsTnT level that may predict death, incremental increases in hsTnT above the upper limit of normal of the hsTnT assay were analysed. Cut off levels of 2, 5 and 10 times the upper limit of normal (corresponding to 28 ng/L, 70 ng/L and 140 ng/L) were associated with all cause and cardiovascular death (Figure 3A,B). HsTnT >140 ng/L (>10 times the upper limit of normal) was associated with the highest risk of cardiovascular death (HR 11.55, 95%CI 2.64–50.56, p=0.0012).

Baseline hsTnT values were also analysed in quartiles (Fig 3C,D). Those in the highest hsTnT quartile (108–3760 ng/l) were at significantly increased risk of all cause (HR 5.24, 95%CI 2.29–11.96, p<0.0001) and cardiovascular death (HR 5.77, 95%CI 1.93–17.26, p=0.0017) at 2 years compared to the lowest quartile.

**Figure 3A. All-cause survival according to troponin values:<28 (less than 2 times ULN), 29–70 (2–5 times ULN), 71–140 (5–10 times ULN), >140 (>10 times ULN)**

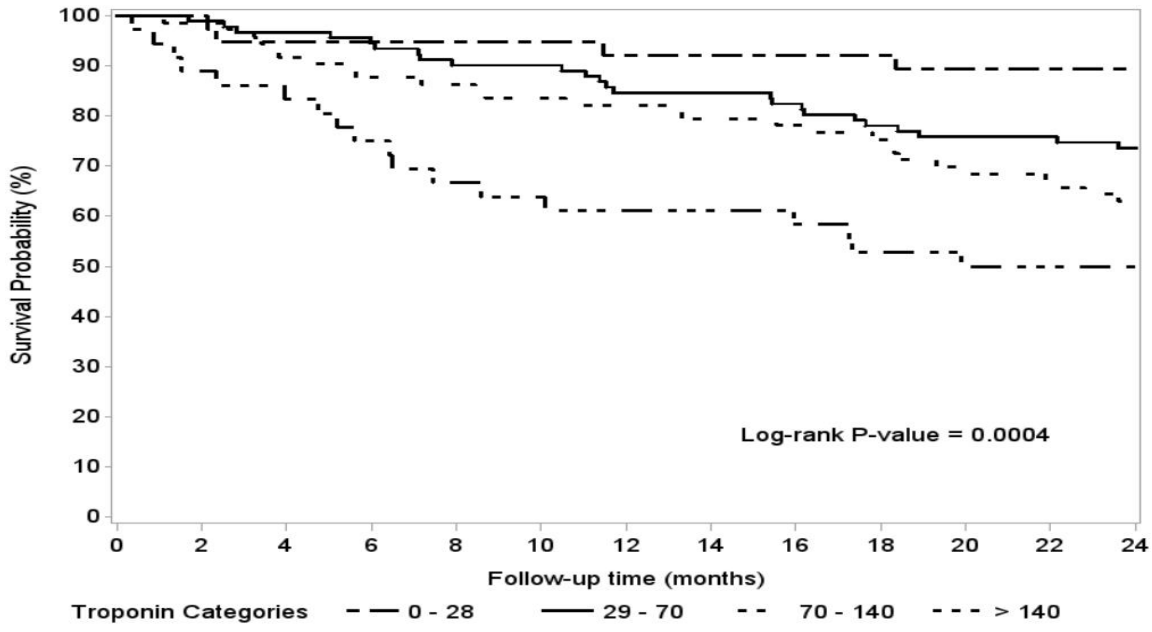


**Figure 3B. Cardiovascular survival according to troponin values:<28 (less than 2 times ULN), 29–70 (2–5 times ULN), 71–140 (5–10 times ULN), >140 (>10 times ULN)**

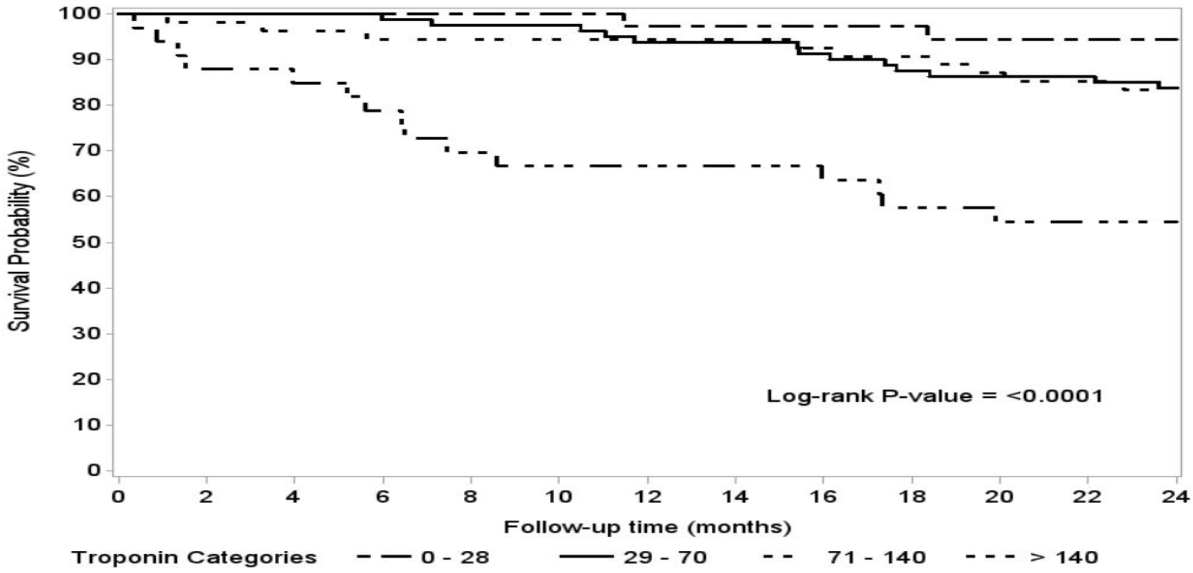



**Figure 3C. All-cause survival according to troponin quartiles**

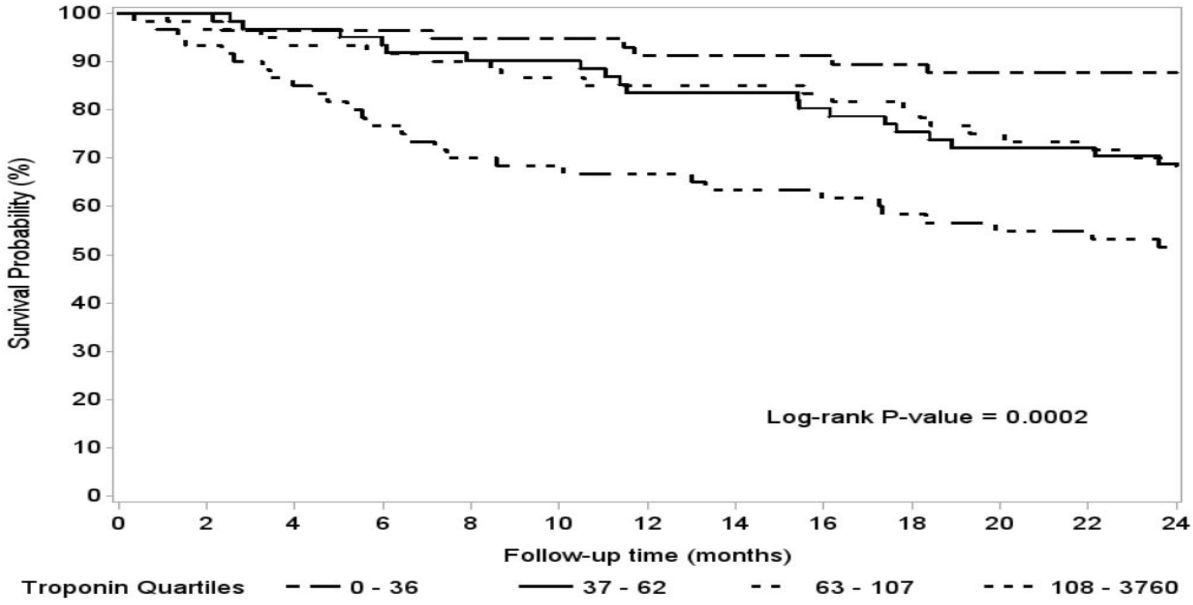
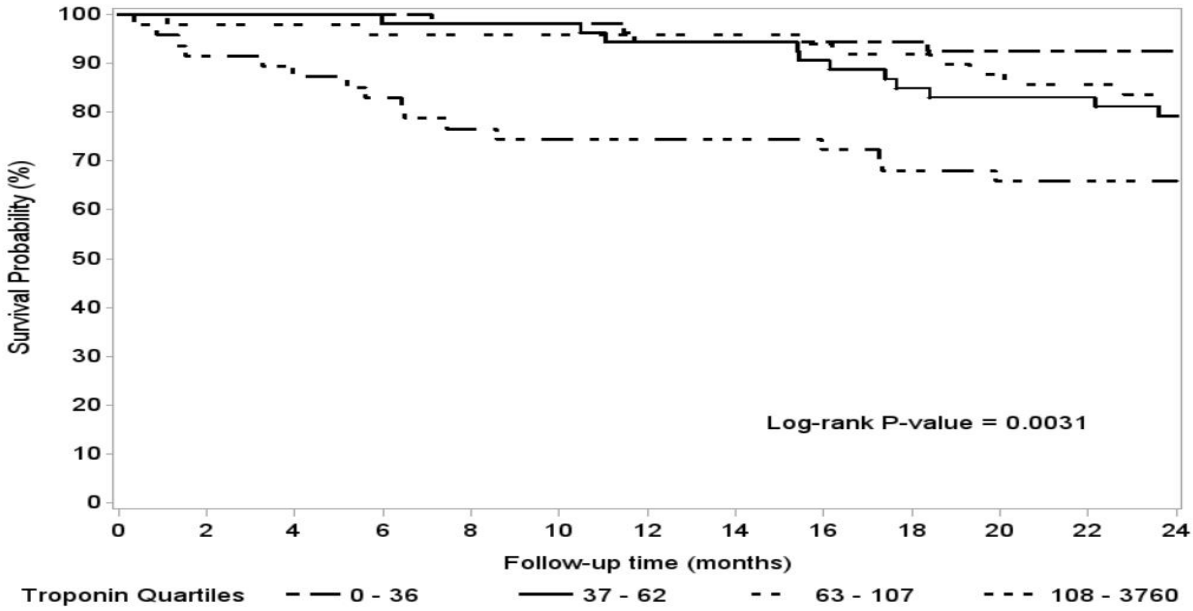


**Figure 3D. Cardiovascular survival according to troponin quartiles**




After adjustment in the multivariate analysis, hsTnT as a continuous variable remained a significant predictor of both all cause and cardiovascular mortality while hsTnT>140 ng/L was the strongest categorical predictor (Table 2).

Age, ischaemic heart disease and hypoalbuminaemia were also significant predictors of all-cause mortality while age, hypoalbuminaemia and elevated CRP were significant predictors for cardiovascular mortality in the multivariate analysis.

## Discussion

To our knowledge this longitudinal study is the longest follow up analysis evaluating the variability of hsTnT levels and one of the largest evaluating their predictive value for long-term mortality in patients with end stage kidney disease.

Other recent studies have also reported that prevalent asymptomatic haemodialysis patients almost universally have elevated TnT levels.[4,6,15] Pianta et al demonstrated that hsTnT were stable between 2 dialysis sessions over a 2-week period in 103 haemodialysis patients.[4] Similarly our group reported that the mean hsTnT did not change significantly over 1 month with a mean of 76.1 ng/l versus 76.0 and a variability of <54% in 95% of the 75 patients.[6]

In another small study the median change in troponin over 6 months was 44% using a pre-commercial assay.[15] However, to the best of our knowledge no previous studies have evaluated variation of hsTnT levels over longer periods.

Our data demonstrate that median baseline hsTnT values remain elevated but relatively stable over a nearly 2 year follow up period in clinically stable haemodialysis patients. At 18 and 22 months hsTnT, had increased >50% in about one-third of patients and more than doubled in just over 10% of patients.

These results are consistent with longitudinal studies which used older generation troponin assays.[7,13] The modest increase in median hsTnT and relatively large individual variation limit the value of serial measures of TnT to assess change in prognosis over 18 to 22 months. However, a large increase in TnT may indicate clinically significant change in cardiac disease. Also knowledge of TnT measured during usual care may be useful when a patient subsequently presents with a suspected acute coronary syndrome.

While several studies have investigated the prognostic value of serum troponins,[16–19] few have evaluated hsTnT assays.[5,6,20] In our study, patients who died during 24 months follow up had significantly higher baseline hsTnT levels than surviving patients.

To our knowledge, this is the first study to demonstrate that this was true for both all cause and cardiovascular mortality.

To define a clinically useful and easy level at which hsTnT was a strong predictor of mortality we examined the association of death and hsTnT levels at 2, 5 and 10 fold the upper limit of the normal range.

Levels 2, 5 and 10 times the upper limit of normal were associated with all cause and cardiovascular death, and levels of hsTnT>140 ng/L (>10 times the upper limit of normal) were the strongest of all independent predictors of cardiovascular death (HR 8.5).

Elevated hsTnT above 108 ng/L, the upper quartile for the study population were associated with a 5-fold increased risk of all cause and almost 6-fold increased risk of cardiovascular mortality at 2 years when compared to the lowest quartile, whereas hsTnT levels in the second and third quartiles were associated with a smaller increased risk of all-cause mortality, and the association with cardiovascular death was not statistically significant.

Artunc et al did not find a significant independent association between hsTnT and all cause death but reported a 5 fold increased risk of death with hsTnT concentrations >38 ng/L during nearly 2 years follow-up of 239 patients.[5] Our data are also consistent with McGill who found hsTnT was the only and most powerful predictor of all-cause mortality after 48 months.[20]

All patients with an hsTnT of<24.15 ng/L survived to 48 months while 54 of 114 (47.4%) with values above this level died. In our study all patients with a baseline hsTnT of <23 ng/L (24 of 239 or 10%) survived for 2 years, suggesting that low hsTnT predicts low mortality. However 90% of hemodialysis patients have an hsTnT ≥23 ng/L and overall mortality at 2 years was 34% (which corresponds to the overall mortality rate in our haemodialysis population). We conclude a higher cut-off is needed to identify patients at higher mortality risk.

We suggest 28 and 140 ng/L, which correspond to 2 and 10 times the 99$^{th}$ percentile as clinically applicable cut-off levels. hsTnT <28 ng/L identifies haemodialysis patients with a low overall mortality risk, while levels >140 ng/L were a strong predictor of cardiac death.

A cut-off of 10 times the upper limit for normal therefore seems a practical and useful risk stratification tool to identify haemodialysis patients needing further cardiac investigations and to inform therapeutic decisions.

The strengths of our study are the large sample size and long follow up compared to previous studies, and the unbiased, single centre haemodialysis cohort. There are however several limitations. There was no measurement of hsTnT between initial troponin and 18 months testing because we did not have funding for testing during this time.

There was a relatively large drop out of patients from the variability analysis due to transfer to other centres. Additionally no measurements of residual renal function were performed, which could have revealed a correlation to hsTnT over time.

Finally a significant number of deaths were due to withdrawal from dialysis. This proportion was similar to those reported previously in Australia and New Zealand.[21] Troponins from this cohort were not separately analysed but patients in this group were included in the all-cause mortality where the hsTnT levels were higher than the group who remained alive at the end of the study. It is likely that this group had high comorbidity as it is well known that many patients who withdraw from dialysis do so due to, at least in part, the burden of coexistent disease.

In conclusion, hsTnT levels remain elevated in chronic haemodialysis patients over 18 – 22 months, and vary by <50% in most patients. Consideration of baseline hsTnT testing in patients on hemodialysis has been recommended by the Kidney Disease Outcomes Quality Initiative (K/DOQI).[22] However the cost effectiveness of repeat testing needs to be addressed with further studies. A 2-fold increase in hsTnT above the upper limit of normal identifies patients with reduced overall survival, while a 10-fold increase in baseline hsTnT was the strongest, independent predictor of cardiac death.

Further studies are needed to reliably evaluate the prognostic importance of longer term changes in hsTnT, and to determine whether a baseline reference measurement improves the ability to diagnose acute myocardial infarction in patients with ESKD on haemodialysis.

**Competing interests:** Nil.

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# Metastatic renal cell carcinoma—an unexpected finding after laparoscopic cholecystectomy

Greg Turner, Richard Flint

**Abstract**

Tumours metastasising to the gallbladder from other sites are rare; we aim to present a case of this unusual site of metastasis and give an overview of the current literature surrounding it. A case of renal cell carcinoma (RCC) with gallbladder metastasis is presented, along with a brief summary of the literature.

A 55-year-old female presented with symptoms due to a large right RCC. Staging investigations were negative for metastasis and she underwent curative resection. She presented 8 years later with cholecystitis, and histological examination of the gallbladder specimen identified metastatic renal cell carcinoma which was not identified on preoperative imaging.

RCC metastases to the gallbladder are unusual, but probably more common than recognised. They're frequently not identified preoperatively, and prognosis is similar to isolated metastases to other organs.

Tumours metastasising to the gallbladder from other sites are rare, and frequently not identified during preoperative imaging. We present an unusual case of renal cell carcinoma (RCC), discovered years later during an unrelated laparoscopic cholecystectomy.

## Case report

A 55-year-old female with a history of bariatric surgery presented in 2005 with a 6-week history of intermittent macroscopic haematuria and right-side abdominal pain.

A computed tomography (CT) scan revealed an isolated right RCC measuring 11.1×10.9×9.8 cm. She underwent an elective open radical right nephrectomy from which she recovered with no incident. The histopathology of the specimen confirmed a completely excised RCC of clear cell type with invasion of the distal renal vein but no lymph node involvement. She did not receive any adjuvant therapy and was subsequently discharged back to the care of her general practitioner

She re-presented in September 2013 with acute epigastric pain. An ultrasound scan (USS) demonstrated cholelithiasis, gallbladder wall thickening, and pericholecystic fluid consistent with acute cholecysititis. No polyp was described at this time. Her biliary tree was dilated and subsequent magnetic resonance cholangiopancreatography (MRCP) confirmed choledocholithiasis. She had successful duct clearance during endoscopic retrograde cholangiopancreatography (ERCP) and went forward for acute laparoscopic cholecystectomy, at which the gallbladder appeared inflamed, but otherwise unremarkable.

Upon opening the gallbladder an irregular 2.7×1.8×1.4 cm polyp was noted.

 

The histopathology of the gallbladder specimen revealed underlying changes of chronic cholecystitis. Surprisingly the incidental nodule was identified as metastatic RCC of the same type as in 2005.

CT staging was immediately performed which demonstrated multiple small pulmonary metastases measuring up to 6 mm but no further abdominal metastases. She was commenced on sunitinib (a tyrosine kinase inhibitor) with good response. Restaging CT 5 months after diagnosis showed involution of pulmonary nodules, the largest being 2 mm.

## Discussion

Here we report an unusual finding of a RCC metastasis found incidentally in a gallbladder specimen several years after a complete resection. Tumours metastasizing to the gallbladder are extremely rare and appear to arise from a variety of primary sites that include not only the kidney but also breast, gastrointestinal tract and cutaneous melanoma[1].

There are less than 50 cases of RCC with metastasis to the gallbladder described in the international literature yet the true incidence may be surmised from large autopsy series that have found RCC metastases in the gallbladders of 0.6% of cases[2]. Although gallbladder metastases are uncommon it is not surprising that RCC can act in this strange way.

As many as 40% of patients diagnosed with RCC will have regional or distant metastases at time of presentation[3] and nearly half will develop metachronous metastases after excision of the primary lesion.[4–6]

Although the most common sites of metastasis are lung, bone, liver and brain[7] most clinicians treating RCC can describe extraordinary sites of new-found disease As far as the authors are aware, however, this is the first case of RCC metastasising to the gallbladder published in New Zealand.

A recent review by Chung et al[8] analysed 33 patients diagnosed with histologically proven RCC metastasis of the gallbladder. As in this current case these are most commonly of the clear cell type (at least 85%) and usually present as metachronous lesions (67% of patients). The median time between nephrectomy and diagnosis of the metachronous gallbladder metastasis was 4.0 years (range 0.2–27 years) and in 39% of patients the gallbladder was the only site of metastasis.

A surprising finding in this review was that 45% of gallbladder metastases were not identified by preoperative imaging despite a median size of 3.0cm (range 1.1–7.5cm). The prognosis appeared similar to resection of isolated RCC metastases from other organs with overall survival of 68% and recurrence free-survival of 54% at a median time of 1.5 year post-cholecystectomy.[9]

In summary, metastatic RCC tumours of the gallbladder are rare, and frequently not identified on preoperative imaging. The prognosis is not certain but appears to depend on the primary tumour type and extent of disseminated disease rather than the finding of RCC in the gallbladder.

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THE NEW ZEALAND MEDICAL JOURNAL
Journal of the New Zealand Medical Association

# Reply to Wang et al response to 'Evaluation of New Zealand's bicycle helmet law' article

Wang et al responded[1] to my article[2] by detailing a number of points that merit additional consideration to provide for a better understanding of the outcome from the New Zealand helmet law.

They state: *Since the NZ MHL went into effect on 1 January 1994, this study sheds no light on the cycling environment in a 6-year window around the MHL.*

The articles provided cyclist and pedestrian fatality data for each of the 6 years as this was readily available and indicates an improving road safety situation, with a reduction for pedestrians 238 to 138 (1991–93 compared to 1994–96), down by 21%.

Census information[3] shows travel to work details from 1991 to 1996 having a reduction from 5.39% to 4.04%, a relative reduction of 25%.

Census details of cycling to work levels:

1976 – 3.4%
1981 – 5.46%
1986 – 5.59%
1991 – 5.39%

(helmet law 1994)

1996 – 4.04% (75% of 5.39)
2001 – 3.12% (58% of 5.39)
2006 – 2.52% (47% of 5.39)
2013[4] – 2.2% (41% of 5.39)

Wang el al state: *In fact, there was a 67% decline in serious traumatic brain injury (TBI) comparing data for the years nearest the helmet law (1988–1991 vs. 1996–1999).*

New Zealand road fatalities were reduced by 28% during the period. In 1995 NZ adopted the campaign strategy used by Transport Accident Commission (TAC) in Victoria, Australia. The key priorities were anti drink-driving and deterring driving at excessive speed that helped to reduce road deaths by 49%, from 777 in 1989 to 396 in 1992.

The TAC data from Victoria[5] for head injury claimants by bicyclists involved in motor vehicle accidents, detailed that most were age less than 18 years of age, pre cycle helmet law, for the period 1987–1989, see Table 1.

**Table 1. Transport Accident Commission data from Victoria, Australia, for the period 1987–1989**

| Age (years) | Head (Hd) | Concussion (Con) | Hd + Con | Total claims | Percent Hd+Con |
|---|---|---|---|---|---|
| 0–11 | 56 | 27 | 83 | 514 | 16.15 |
| 12–17 | 82 | 45 | 127 | 1162 | 10.93 |
| 18+ | 40 | 22 | 62 | 812 | 7.64 |
| **Total** | **178** | **94** | **272** | **2488** | **10.93** |

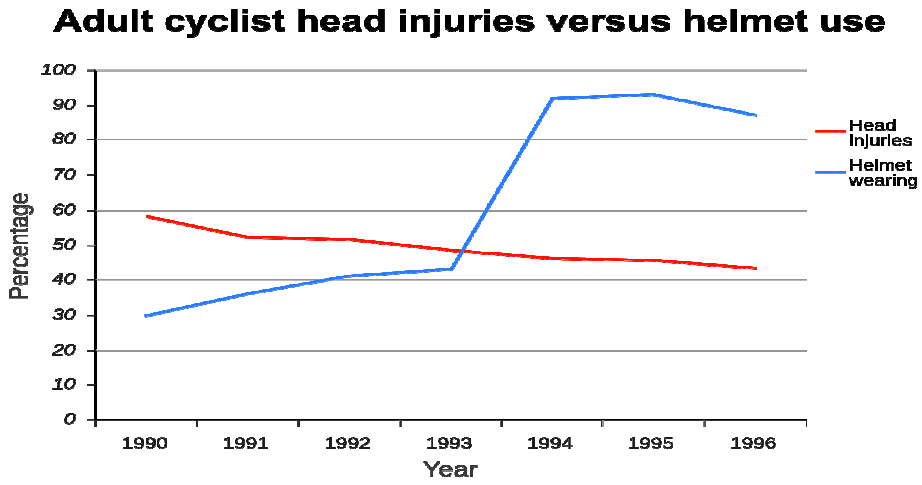
The younger age groups had higher rates of head injury. For New Zealand, survey information suggests the largest reductions in cycling were for the age group 5–17 years,[6] reducing from 80 minutes per week in 1989/90 to 46 minutes in 97/98. Tin Tin et al report: *The rate of traumatic brain injuries fell from 1988–91 to 1996–99; however, injuries to other body parts increased steadily.*[7]

A 2001 study by Robinson re-evaluated NZ data,[8] finding that the reduction in head injuries per limb injuries, for crashes not involving motor vehicles injuries, was part of a larger downward time trend and bore no direct correlation to the dramatic increase in helmet-wearing following the introduction of the helmet law.

Robinson concluded: *Because the large increases in wearing with helmet laws have not resulted in any obvious change over and above existing trends, helmet laws and major helmet promotion campaigns are likely to prove less beneficial and less cost effective than proven road-safety measures.*

See Figure 1 below from
http://en.wikipedia.org/wiki/Bicycle_helmets_in_New_Zealand

**Figure 1**




Wang et al give the impression in their Figure 1 of a major benefit by selecting the injury rates and percent helmeted. They provided two graphs, one serious injuries and the other serious TBI, both per 100,000 hours travelled. The first shows a reduction

from about 25 to 21 for the claimed serious injuries, down by about 17%. The second for serious TBI shows a reduction from about 3.4 to 1.2 and they claim a 67% reduction. Viewing side by side gives the impression of a major reduction in serious TBI compared with other general serious injuries, 67% v 17%.

In the 2012 article, Table 4 details serious injuries per 100,000 hours travelled for the same periods, reducing from 10.27 to 4.86, down by 53%. Also Table 4 details overall injuries per 100,000 hours travelled, reducing from 25.61 to 21.38 and then increasing to 30.74. It seems that Wang et al have used the incorrect data. Using serious TBI v serious injury data would have shown roughly a 67% v 53% reduction. Care is required in considering data on TBI in that the criteria for admissions can change due to several factors.[9]

Wang et al make a number of other points they consider I should have addressed but unfortunately the length of the article was limited to 3000 words and this restricted its content. The main findings—*failed in aspects of promoting cycling, safety, health, accident compensation, environmental issues and civil liberties. It is estimated to cost about 53 lives per year in premature deaths and result in thousands of fines plus legal aspects of discrimination in accident compensation cases*—are certainly valid in general terms, despite it having some shortcomings. More accurate calculations can be made.

Recently the UK Cyclists' Touring Club (CTC) stated[10]: *However CTC is not only concerned about the harmful effects of mandatory helmet use. By creating exaggerated perceptions of the risks of cycling, even voluntary helmet promotion campaigns have been found to deter some people from cycling. Given that the* ***health benefits*** *of cycling* ***outweigh the risks*** *by around 20:1* ***(one recent study put it at 77:1)****, it can be shown that* ***only a very small reduction in cycle use is needed*** *for helmet promotion (let alone helmet laws) to shorten more lives than helmets themselves could possibly save, regardless of how effective helmets might be.*

Recent data[11] released since the paper's publication show NZ bicycle travel to school 5–17year age group is down from 14.2 million journeys in 1989/90 to 3.3 million in 2009–13. New Zealand's population increased 31.2% from 1990 to 2013. The incidents of ischaemic heart disease, stroke and diabetes that cycling may help to prevent are approximately 600+ per 100,000 population.[12]

The argument put by Wang et al of a reduction in TBI are largely explained by the combined effects of decreased cycling levels and improved road safety post law. The increase in the accident rate and all body injuries per cyclist plus the negative long-term health consequences of discouraging cycling have to be seriously considered.

**Colin F Clarke**

(Colin F Clarke studied mechanical engineering at Huddersfield Polytechnic. He qualified in 1970 as a British Cycling Federation coach. He has been a cyclist for more than 40 years and has worked as a road safety instructor teaching children how to ride bicycles safely. He has cycled in more than 20 countries, including approximately 8000 kilometres in NZ.)

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THE NEW ZEALAND MEDICAL JOURNAL
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# The New Zealand Medical Journal to be published monthly

*Excerpt from an Editorial published in the NZMJ 1914 March;13(49):37–38.*

OUR readers will please take notice that, by direction of the Branch Council, this journal will in future be published every month. This alteration has been prompted by many reasons, the chief of which is a desire, in view of coming events, to maintain efficient organisation of the Association.

The greater frequency of publication will now permit of correspondence, and comments on scientific or medico-legal matter appearing in our pages, and interest will thus, it is hoped, be kept alive and vigorous. Reports of meetings of the various divisions will always be welcome.

The change will mean additional expense and additional labour, but will, we believe, become fully justified. There should be sufficient material, and if members of the Association will each take a share in promoting the progress of their own journal, success is assured.

There is now a call for a general advance all along the line, and if we are forced to fall back, the shame of failure will not fall alone upon the Editor, but upon the members of the Association, whose duty and privilege it is to give to this publication their whole-hearted and generous support.

In the next issue we intend to publish an article concerning a method of anaesthesia which may revolutionise surgery, and make the surgery of the chest as great a triumph as abdominal surgery.

 

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## Effect of high-dose simvastatin on brain atrophy and disability in secondary progressive multiple sclerosis

Immunomodulatory strategies derived from relapsing-remitting multiple sclerosis have not proven effective when extended into secondary progressive multiple sclerosis. Simvastatin has immunomodulatory and neuroprotective properties that could make it an appealing candidate drug for patients with secondary progressive multiple sclerosis.

This hypothesis is tested in this double-blind controlled trial carried out in three neuroscience centres in the UK. 140 appropriate patients were randomly assigned to receive either 80mg of simvastatin or placebo for 24 months. The primary outcome was the annualised rate of whole-brain atrophy measured from serial volumetric MRI.

The atrophy rate was significantly lower in the simvastatin cohort. Apparently the simvastatin was safe and well tolerated. The researchers recommend a larger phase-3 trial. An editorial commentary commends the trial and agrees that further study is warranted.

Lancet 2014;383:2213–2221.

## *Helicobacter pylori* eradication therapy to prevent gastric cancer in healthy asymptomatic infected individuals

*H. pylori* infection is known to be associated with the incidence of gastric ulcer and neoplasm. This meta-analysis looks at the question—does searching for *H. pylori* and treating with eradication therapy among healthy asymptomatic infected individuals reduce the subsequent incidence of gastric cancer?

The researchers found 6 eligible randomised trials were suitable for analysis. 51 (1.6%) gastric cancers occurred among 3294 individuals who received eradication therapy compared with 76 (2.4%) in 3203 control subjects (relative risk 0.66).

It is noted that all but one study were conducted in East Asia, so it is not possible to assess the effect of searching for and eradicating *H. pylori* in Western populations.

BMJ 2014;348:g3174.

## Testosterone deficiency and quality of life in testicular cancer survivors

Testicular cancer is usually treated successfully by orchidectomy which may be followed by chemotherapy and/or radiotherapy. As such patients are predominantly young men they may be expected to live normal lifespans. The possibility that such survivors may suffer from testosterone deficiency and a decrease in quality of life (QoL) is examined in this prospective study of Australasian patients.

There were 54 evaluable patients. They were regularly tested after the conclusion of treatment for serum levels of testosterone, FSH and LH. They also completed QoL and mood questionnaires. The researchers report that they found biochemical hypogonadism in 18 patients (33%) and low–normal testosterone in 13 patients (24%). They found no association between testosterone levels and QoL. They recommend hypogonadal patients should be considered for testosterone replacement to prevent long-term morbidity.

Internal Medicine Journal 2014;44:813–817.

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# Professional Misconduct (Med11/197P)

## Dr S

On 19 March 2012 the Health Practitioners Disciplinary Tribunal (the Tribunal) considered a charge laid by a Professional Conduct Committee against Dr S, a medical practitioner.

The charge alleged Dr S was guilty of professional misconduct in that he inappropriately and with reckless disregard for patient safety prescribed opioids and benzodiazepines to five patients.

Dr S admitted the charge of professional misconduct. The Tribunal found there was:

- a pattern of inappropriate and excessive prescribing of addictive drugs
- an insufficient maintenance of professional boundaries

The Tribunal found Dr S's conduct constituted negligence, malpractice and the bringing of discredit to the profession and therefore the charge of professional misconduct was established.

The Tribunal found that this was a case where it was appropriate for a rehabilitative approach to be taken. Dr S was censured and ordered to pay $24,000 costs. The following conditions were placed on his practice:

- Dr S continue to engage with his psychologist for a period of 18 months; consultations are to be at least monthly and at Dr S' cost.
- Dr S continue in his mentoring relationship with a medical practitioner for a period of 12 months. If any cost issues arise they are to be met by Dr S.
- His mentor is to confirm to the Medical Council each six months that the previous two conditions have been complied with.
- Dr S complete his Professional Plan as it relates to upskilling his computer and IT skills, so as to enhance his ability to access in-consultation clinical information; and he is to complete the BPAC and BMJ self-directed learning modules. Both of these requirements are to be met to the satisfaction of his mentor, the intent of the condition being that Dr S continue to discuss these issues with his mentor while he is undertaking those courses.
- Dr S shall discuss his quarterly prescribing reports with his mentor during the period of mentoring described above.

The full decision relating to the case can be found on the Tribunal web site at www.hpdt.org.nz
Reference No: Med11/197P

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# Professional Misconduct (Med12/215P)

**Dr M**

**Charge**

On 4 October 2012 the Health Practitioners Disciplinary Tribunal (the Tribunal) considered a charge laid by a Professional Conduct Committee against Dr M, a medical practitioner.

The charge alleged Dr M was guilty of professional misconduct in that:

- she entered into an inappropriate personal and/or sexual relationship with a former patient (Mr X) who Dr M knew was vulnerable; and/or
- once a complaint had been laid she requested Mr X delete text messages from his phone and encouraged him to mislead the Medical Council and the Professional Conduct Committee (PCC) about their relationship.

At the time of the events Dr M was 39-40 years old and Mr X was 19-20 years old. Dr M was his doctor from August 2009 until April 2010 when Dr M transferred his care to another doctor in the practice and began a friendship with Mr X. Mr X was a highly vulnerable young man.

**Finding**

The Tribunal found that there was a sexual relationship between Dr M and Mr X and considered that it was more likely than not that Dr M ended the doctor/patient relationship for the sole purpose of initiating a sexual relationship. The Tribunal found the first particular established and warranted discipline.

The Tribunal was satisfied Dr M did urge Mr X to delete their texts. The Tribunal was of the opinion it was because she was very concerned about the ongoing investigation and wanted to make sure that any texts between them had been deleted. The Tribunal was less certain that Dr M encouraged him to mislead the Medical Council. However, the Tribunal considered it most likely that Dr M did encourage Mr X to minimise the relationship to the PCC. The Tribunal considered there was not sufficient evidence to find this particular established as the particular required the Tribunal to find Dr M encouraged Mr X to mislead **both** the Medical Council and the PCC.

## Penalty

On 11 February 2013 the Tribunal issued the penalty decision and ordered that Dr M:

- be censured;
- be suspended for 18 months;
- undertake an assessment by the Medical Council's sexual misconduct assessment team and comply with their requirements prior to the resumption of practice; and
- pay 30% of the costs.

The full decision relating to the case can be found on the Tribunal web site at www.hpdt.org.nz
Reference No: Med12/215P

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# Professional Misconduct (Med12/224P)

**Dr N**

## Charge

On 11 March 2013 and 29 April 2013 the Health Practitioners Disciplinary Tribunal (the Tribunal) considered a charge laid by a Professional Conduct Committee against Dr N, a medical practitioner.

The charge alleged Dr N was guilty of professional misconduct in that she acted inappropriately and/or contrary to the best interests of her patients with regard to the prescribing and/or dispensing of misoprostol. It was asserted this was contrary to the provisions of the Contraception Sterilisation and Abortion Act 1977 (the CSA Act) and otherwise inappropriate in respect of three patients. It was also alleged there were failures to document the prescribing and/or dispensing of misoprostol in respect of those three patients, and in respect of a fourth patient.

## Finding

The hearing proceeded on the basis of an Agreed Summary of facts and Dr N accepted that she was guilty of professional misconduct.

The Tribunal found that misoprostol was prescribed or dispensed to three patients (patients A, B and C) in a manner contrary to the legal pregnancy termination procedures specified in the CSA Act. There was no attempt to refer the patient in each instance for counselling and to another certifying consultant; the misoprostol was not given on licensed premises; and proper records were not kept.

The Tribunal found there was a complete failure to provide the patients with an opportunity to consider expected risks, side effects, benefits and costs of the options. Dr N acted unilaterally and in a manner which could not be said to be in the patient's best interests.

The Tribunal found that before prescribing and dispensing misoprostol to Patient A, Dr N failed to undertake appropriate clinical assessments and failed to ensure Patient A had adequate support.

The Tribunal found in relation to patient B, Dr N instructed a nurse by telephone to dispense misoprostol without Dr N seeing the patient and undertaking the appropriate clinical assessments.

The charge also alleged in relation to patient A and B that Dr N should have excluded the risk of the pregnancy being ectopic. The Tribunal found, that while in fact Dr N failed to exclude the risk of either of the pregnancies being ectopic; it would not have been feasible to do so. Consequently, the Tribunal considered it was not appropriate to include this allegation as an aspect of the disciplinary charge.

The Tribunal was satisfied that there was a pattern of failures to document the prescribing of misoprostol in relation to four patients.

The Tribunal found the charge of professional misconduct well established.

## Penalty

Dr N was censured and suspended for a period of six months.

On resumption of practice, Dr N was ordered to practise under the following conditions for a period of three years:

- that she attends regular peer group meetings and disclose the fact of the charge to her peer review group;
- that she attends appropriate courses stipulated by the Medical Council to focus on clinical note taking, prescribing practices and informed consent;
- that she disclose the fact of the charge in her disciplinary history to all current and future employers; and
- that she have mentoring from a mentor approved by the Medical Council at her expense.

The Tribunal recommended to the Medical Council that it recommends to the Minister of Health that Dr N be prohibited from prescribing or supplying misoprostol for the maximum period of three years (from the resumption of practice), and consideration be given to an appropriate Gazette Notice being published to this effect.

The Tribunal ordered Dr N pay $38,310.00 costs.

The Tribunal denied Dr N's application for permanent name suppression.

## Appeal

Dr N appealed against the Tribunal decision not to grant her permanent name suppression.

On 16 December 2014 the High Court allowed the appeal and granted Dr N name suppression. The Court found it necessary to grant Dr N name suppression in order to fairly protect the other name suppression orders that were in place.

The full decision relating to the case can be found on the Tribunal web site at www.hpdt.org.nz
Reference No: Med12/224P

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# Professional Misconduct (Med12/225D)

**Dr N**

## Charge

The Director of Proceedings charged that Dr N (the Doctor) was guilty of professional misconduct.

The charge alleged that the Doctor:

1. administered the unapproved medicine Novielle Gel Plus to the patient as dermal filler without first obtaining her informed consent in that he failed to advise her:
   a. that it was an unapproved medicine; and/or
   b. there was a risk of a granuloma forming.
2. administered the unapproved medicine Novielle Gel Plus to the patient as dermal filler without first taking adequate steps to ensure it would be safe and efficacious when used as a dermal filler. In addition, he administered it to the patient when she was not known or identifiable to him at the time that was done which was a breach of the Medicines Act.
3. failed to refer the patient for specialist care in a timely manner when symptoms of inflammation or infection arose and prescribed further medication and provided further treatment without adequate clinical justification.
4. failed to adequately document the care that he gave to the patient.

## Findings

The Doctor admitted the charge and the Tribunal found that the charge was made out in all respects. The Tribunal found that the Doctor's conduct in relation to each of the four particulars both separately and cumulatively amounted to professional misconduct.

## Background

The hearing proceeded on the basis of an Agreed Summary of Facts.

Novielle Gel Plus is an injectectable polymer which is approved for use in the USA for use in vocal cord augmentation. It was also marketed in the USA as a dermal filler. However, at no time was it approved for use as a dermal filler in the USA.

At the time of the events which are the subject of the charge Novielle Gel Plus was an "unapproved medicine" in New Zealand. This meant that the product could only be supplied and administered in accordance with the Medicines Act 1981, which requires

that unapproved medicines may only be administered to a patient who was known or identifiable to the prescriber.

While visiting with family in New Zealand the patient consulted with the Doctor, on 24 July 2009, about the hollows on her face beneath her cheeks. The Doctor recommended the patient undergo a malor / cheek lift. The Doctor told the patient it would involve him injecting dermal filler into the hollows. He explained that the product was safe and he had used it for the last 5 years without complication.

The Doctor explained the common side effects such as bruising, slight swelling and tenderness. The Doctor did not advise the patient that a significant risk associated with the administration of dermal filler is the formation of granuloma. At no time did the Doctor tell the patient that the product he was intending to use was an unapproved medicine in New Zealand. He told the patient that he was intending to use a product that he had used since 2005, when in fact the product he would be actually using that day was a different brand to that which he had used in the preceding years.

At the time the Doctor was supplied the Novielle Gel Plus the patient was not a patient known or identifiable to him under the requirements pertaining to unapproved medicines by the Medicines Act 1981.

After a couple of weeks the patient developed swelling and inflammation in her cheeks and she received treatment from her GP on the recommendation of the Doctor. In the following months, the patient continued to develop swelling and inflammation in her cheeks and a number of granuloma formed on her face.

The patient decided to return to New Zealand to see the Doctor. By this time a large granuloma had developed which was drained by her daughter's GP prior to seeing the Doctor. The Doctor saw the patient on 25 October 2009 and without any clinical justification injected KenacortA into each granuloma, provided laser therapy and prescribed further medications. Two weeks later the Doctor reviewed the patient and followed the same course of action as he had on 25 October 2009. The Doctor arranged for follow up treatment to be provided by her GP. The Doctor accepted his advice was without clinical justification and that he should have referred her to a plastic surgeon.

The patient returned to Australia and the ongoing difficulties continued. In March 2010 the patient consulted a plastic surgeon. Her most recent surgery was in November 2012, having undergone nine other surgical procedures in an attempt to remove the granuloma from her cheeks.

Other than his notes taken at the initial consultation, the Doctor failed to make any record of the care that he provided to the patient.

**Penalty**

The Tribunal ordered that the Doctor be:

- censured;
- subject to three conditions of practice for 2 years;
- fined $8,000; and

- pay costs of $9,400.

The Tribunal directed that a copy of its decision and a summary be published on the Tribunal's website and the New Zealand Medical Journal.

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# Professional Misconduct (Med12/230P)

**Dr N**

On 20-21 May 2013 the Health Practitioners Disciplinary Tribunal (the Tribunal) considered a charge laid by a Professional Conduct Committee against Dr N (the Doctor), a medical practitioner. The charge alleged the Doctor had an inappropriate and/or sexual relationship with a former patient and that subsequently, when contacted by a registrar, she failed to advise him that the patient's assertions of a relationship with her were not delusional.

The hearing proceeded on the basis of an Agreed Summary of facts and the Doctor accepted that she was guilty of professional misconduct. The Tribunal found all the particulars of the charge were established and the Doctor was guilty of professional misconduct.

The Tribunal suspended the Doctor for a period of four months. The following conditions were placed on her practice:

- Prior to the resumption of practice, at her own cost, the Doctor was ordered to obtain psychological and/or psychiatric reports to the satisfaction of the Medical Council.
- If the Doctor chooses to work in a [suppressed] field, she must first be accepted on the registrars training programme for that field. This condition is to apply for three years from the resumption of practice or until she completes her training.
- For a period of three years from the date upon which the Doctor may resume practice as a health practitioner, she is to provide to any person or organisation which employs her as a health practitioner with a copy of the decision.
- For a period of three years upon resuming practice as a medical practitioner, the Doctor is to have a mentor such as a clinical psychologist, for the purposes of engaging with her over managing stress and the challenges of clinical work. The mentor shall be a person approved by the Medical Council. Any costs are to be met by the Doctor and the mentor is to be provided with a copy of the decision.
- For a period of three years upon resuming practice as a medical practitioner, the Doctor is to participate in a peer group. She is to disclose to members of the peer group that she has been the subject of professional discipline which involved breaching professional boundaries. She is to confirm to the Medical Council of New Zealand that she has done this.

The Tribunal censured Dr N and ordered her to pay costs of $34,800.00.

The full decision relating to the case can be found on the Tribunal web site at www.hpdt.org.nz
Reference No: Med12/230P

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# Professional Misconduct (Med13/243D)

**Dr Manilall Maharajh**

## Charge

On 12-16 August 2013, the Health Practitioners Disciplinary Tribunal (the Tribunal) considered a charge laid by the Director of Proceedings against Dr Manilall Maharajh (The Doctor), medical practitioner formerly of Tauranga, now of Australia. The Doctor was the patient's psychiatrist.

The charge alleged The Doctor was guilty of professional misconduct in that he:

- entered into an inappropriate and/or sexual relationship with a vulnerable patient;
- prescribed Fluoxetine to the patient without adequate clinical justification;
- discharged the patient by telephone on 18 August 2008,which was an inadequate discharge given the patient's personality characteristics and vulnerabilities;
- continued the sexual relationship after the clinical relationship ended;
- interfered with the legal process by attempting to improperly influence and procure the withdrawal of complaints to the Health and Disability Commissioner.

## Finding

The Tribunal considered that there was adequate clinical justification to prescribe Fluoxetine but it found all the other elements of the charge established.

The Tribunal was satisfied that there had been multiple and severe breaches of standards over a long period of time which were very significant. The Tribunal considered the manner in which The Doctor took advantage of a young, vulnerable and sexually inexperienced woman for his own sexual gratification was complete abrogation of his professional responsibilities as a psychiatrist and of the trust inherent in the professional relationship

The charge of professional misconduct was made out.

## Penalty

The Tribunal ordered that The Doctor's registration be cancelled.

He was censured and ordered to pay costs of $73,000.00.

The full decision relating to the case can be found on the Tribunal web site at www.hpdt.org.nz
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