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Likelihood of death amongst hospital inpatients in New Zealand: prevalent cohort study

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Title: Likelihood of death amongst hospital inpatients in New Zealand: prevalent cohort study

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Abstract

Objectives: 1) To establish the likelihood of dying within 12 months for a cohort of hospital inpatients in New Zealand on a fixed census date; 2) to identify associations between likelihood of death and key socio-demographic, diagnostic and service related factors; and 3) to compare results with, and extend findings of, a Scottish study undertaken for the same time period and census date.

Participants: 6,074 patients were resident in New Zealand hospitals on the census date (10 April 2013), 42% of whom were aged >65 years. 54.4% of patients were female. 69.1% of patients were NZ European; 15.3% were Maori; 7.6% were Pacific; 6.1% were Asian; and 1.9% were 'other'.

Setting: All NZ hospitals.

Results: 14.5% patients (n=878) had died within 12 months: 1.6% by 7 days; 4.5% by 30 days; 8.0% by 3 months; and 10.9% by 6 months. The strongest predictors of death within 12 months were: age >80 years (OR=5.52 [95% confidence interval 4.31, 7.07]); a history of cancer (OR=4.20 [3.53, 4.98]); being Māori; OR=1.62 [1.25, 2.10]); and being admitted to a medical specialty, compared to a surgical specialty (OR=3.16 [2.66, 3.76]).

Conclusion: Whilst hospitals are an important site of end of life care in New Zealand, their role is less significant than in Scotland, where 30% of an inpatient cohort recruited using similar methods and undertaken on the same Census date had died within 12

months. One reason for this finding may be the extended role of residential long-term care facilities in end of life care provision in New Zealand.

5 Key words: Hospitals, inpatients, palliative care, mortality, ethnicity.

Word count: 3,127

Strengths and limitations of this study

- First national picture of deaths amongst a cohort of inpatients present on one night in NZ hospitals and close replication of a Scottish study undertaken on the same census date providing novel insights into international trends in hospital use at end of life.
- Additional variables modelled for the first time– ethnicity, admission type and history of main hospital-based diagnoses.
- Only those variables collected by the NZ Ministry of Health included
- History of the various conditions, including cancer, based only upon diagnoses from hospitalisations occurring since 2004, so does not include conditions managed entirely within primary care, or hospitalisations prior to 2004.
- The problems of length-biased sampling mean that patients experiencing longer hospital stays are over-represented.

Background

New Zealand (NZ), in line with other resource rich countries, is facing an unprecedented demand for palliative care within the short to medium term. Largely as a result of rapid population ageing, deaths in NZ are estimated to increase by 48% by 2038.[1] Research conducted nationally has established that the acute hospital is a significant site of palliative care management with approximately one in five inpatients meeting Gold Standards Framework prognostic criteria for palliative care need,[2] of whom approximately two thirds will have died within 12 months.[3]

It is within this context that there has been increased interest nationally in hospital-based interventions to support improved palliative and end of life care management, including advance care planning and workforce capacity building.[4,5] Policy makers have also been looking internationally to identify innovations adopted in other countries facing similar challenges. However, international comparisons are limited by a lack of understanding of the comparability of patterns of service use at end of life. For example, previous estimates of the prevalence of palliative care needs amongst hospital inpatients range from 9% in Belgium,[6] to 17% in South Africa,[7] 20% in NZ,[8] 21%–36% in the UK,[9,10] and 35% in Australia.[11] Moreover, methods adopted in these studies differed, as did definitions of 'palliative care need' and no study took a whole country approach.

A 2010 study addressed some of these deficits by reporting that 29% of a cohort of Scottish hospital inpatients on a selected census date died within 12 months.[12] Factors associated with the likelihood of dying included being >85 years, living in an area of high deprivation, and being admitted under a medical specialty (rather than surgical). The study was replicated in both Scotland and NZ for the same 2013 census date. The 2013 Scottish study produced very similar results to the original Scottish study (30% dying within 12 months), supporting the robustness of the findings.[13] Replicating, and extending, the study within NZ was identified as helpful for national planning, supporting clinicians to respond appropriately to potential palliative care need, and in order to build a better understanding of comparative service use amongst people in the last year of life, internationally.

Aims

- To identify the proportion of a cohort of NZ public hospital inpatients dying within 12 months of a given census date.
- To identify associations between likelihood of death and key socio-demographic, diagnostic and service related factors.
- To compare results with, and extend findings of, a Scottish study undertaken for the same time period and census date.

Materials and methods

The NZ Ministry of Health provided data for all publicly-funded hospitalisations (hospitalisations in public acute hospital and publicly-funded surgeries in private hospital) in NZ over the period 20 January 2004 to 10 April 2013 for people in hospital overnight on the census date of 10 April 2013. Data included: demographic information (age, gender, deprivation of area of residence, prioritised self-identified ethnicity); hospitalisation (admission date and type, discharge date and type, length of stay, specialty and diagnosis); and mortality information. Self-reported ethnicity was prioritised, whereby those identifying with more than one ethnic group are classified firstly to Māori, then to Pacific or Asian ethnicity.[14]

For each hospitalisation the patient's primary diagnosis was classified using ICD 10 chapter. To identify prior history of five selected diagnostic groups (cancer, circulatory diseases, respiratory diseases, injury/poisoning/other consequences of external causes, and digestive diseases), all diagnoses coded for all prior hospital admissions over the period 20 January 2004 to 10 April 2013 (including the index stay) of each patient in the index cohort were reviewed and coded with a binary indicator (1=yes, 0=no). The measure of deprivation used was the NZ Index of Deprivation 2006,[15] an area-based deprivation score grouping the NZ population into ten deciles based on place of

residence, with decile 1 representing the 10% least deprived areas in NZ and decile 10 the most deprived, collapsed into quintiles.

Three multiple logistic regressions (described below) were used for modelling to investigate associations between potential predictor variables and mortality at 12 months. Both the AIC (measure of relative quality of statistical models) and c-index (the area under receiver-operating curve) were used to test goodness-of-fit.

In ***Model 1,*** the response variable was whether the patient died within 12 months. There were four predictor variables in the model: gender (female as referent), age group (0–<15, 15–<60, 60–64, 65–69, 70–74, 75–79, 80–84 and 85+; 15–<60 was used as referent), deprivation quintile (Q1 is the most deprived and Q5 is the least deprived, Q5 was used as referent) and specialty (medicine, surgery or procedure, surgery was used as referent). Of the 6,074 patients recorded as resident in NZ hospitals on the census date 6,029 patients were included for modelling; patients for whom deprivation status was not available were excluded (n=45).

Model 2 was developed from Model 1 by adding three predictor variables: admission type (acute, arranged or wait-listed, acute was used as referent, patients always inherited

the original admission type); prioritised ethnicity (European, Māori, Pacific, Asian, and other, European was used as referent); and history of cancer.

Model 3 was further developed from Model 2 by adding four other diagnostic history groupings: circulatory diseases, respiratory diseases, injury/poisoning/other consequences of external causes, and digestive diseases.

MS Excel 2010 and SAS 9.4 were used for all analyses. Ethics approval was obtained from the University of Auckland Human Participants Ethics Committee (ref: 02/11/2015).

Results

In total, 6,074 publicly-funded patients stayed overnight in NZ hospitals on the census date, 46% of whom were men and 54% women. 42% of patients were aged >60 years, of whom 17% were aged >80 years (Table 1). Sixty eight per cent were acute admissions, 18% arranged admissions, and 14% wait-listed admissions. Based on NZ death registration records, 878 (14.5%) patients died during the 12-months following the census date: 1.6% by 7 days, 10.9% by 6 months, and 14.5% by 12 months. One hundred and thirty patients (2.1%) died during the index stay and this accounted for 14.8% of all deaths within the 12-month follow-up period.

On the census date, the two most deprived population quintiles (Q1 and Q2) contributed 50% of hospitalisations, whereas the two least deprived quintiles (Q4 and Q5) contributed only 29% of hospitalisations. At 12 months from the census date, the two most deprived quintiles contributed 51% of deaths and the two least deprived quintiles contributed 27% of deaths. A much greater proportion of those with a history of cancer had died within 12 months at 33%, when compared with 9% without a history of cancer. 10% of those with a history of cancer had died within 30 days of their admission (Table 2). Patients with one of the five chosen diagnostic groups (cancer, circulatory diseases, respiratory diseases, injury/poisoning/other consequences of external causes, and digestive diseases) as primary diagnosis in the index hospital stay contributed to 69% of all deaths (602 of 878 deaths within 12 months of census date, Figure 1).

Model 1 showed mortality rose steeply with age, for example, patients over 85 were far more likely to die (OR=5.52 [95% confidence interval 4.31, 7.07]), compared to patients between 15 and 59 years (Table 3). Patients in the most deprived quintile were more likely to die (OR=1.54 [1.17, 2.02]) compared to patients in the least deprived quintile. Patients admitted to a medical specialty were also more likely to die (OR=3.16 [2.66, 3.76]) compared to patients admitted to a surgical specialty. Those admitted for a procedure were less likely to die (OR=0.26 [0.12, 0.57]), than those admitted to a

surgical specialty. The high c-index (0.79) indicates that almost 80% of the variability was explained by the model.

Model 2 showed Māori were more likely to die (OR=1.62 [1.25, 2.10]), than Europeans, as were patients with a history of cancer (OR=4.20 [3.53, 4.98]) compared to those without. Waitlisted patients were less likely to die (OR=0.34 [0.24, 0.48]) compared to those who came in acutely (Table 3). Including the additional variables improved the c-index considerably, to 0.84.

The addition of previous hospital diagnoses in ***Model 3*** showed patients with a history of circulatory diseases were more likely to die (OR=1.34 [1.09, 1.64]), compared to patients without a history of circulatory diseases (Table 3). Those with a history of respiratory diseases were more likely to die (OR=1.82 [1.53, 2.16]), versus those without. Those with a history of digestive diseases were more likely to die (OR=1.51 [1.26, 1.80]), vs. those without. After adjusting for these additional diagnostic groups, history of cancer remained highly significant (OR=3.92 [3.29, 4.67]). The c-index of 0.85 indicates that the model was only slightly improved by including four additional diagnostic history variables.

Discussion

This study identified that 14.5% of patients resident in NZ hospitals on one day had died within 12 months. This proportion is much lower than that reported by a study of Scottish inpatients conducted using the same method and census date, where 30% had died within 12 months.[16] Similarly, whilst in Scotland 8% of patients died during the index admission (representing 32% of all deaths in this cohort within the 12 month period), the figures for NZ were much lower at 2%, accounting for 15% of all deaths in the cohort over 12 months.

Reasons for the much lower mortality in NZ compared to Scotland are not easily determined, but several interpretations warrant consideration. One important difference to note is the younger age of the NZ inpatient hospital population compared to the Scottish inpatient hospital population – 73% of the Scottish inpatients were ≥60 years, and 32% were ≥80 years,[17] while just 42% of the NZ inpatients were aged ≥60 years, of whom 17% were aged ≥80 years (see Table 1). The younger age in NZ's cohort means fewer deaths would be expected, and reflects the fact that the Scottish and NZ acute hospital populations are different.

There is also evidence that hospitals represent a much more significant place for end of life care and death in Scotland than in NZ. In Scotland 59% of deaths occur in hospital,

18% in residential long-term care and 23% in other settings, which includes home.[18] In NZ, a much lower percentage die in hospital at 34%, and a much higher proportion die in residential long-term care at 31% and in other settings including home, which account for 35% of all deaths. The argument that, in NZ, high-level residential long-term care facilities may act as 'de facto' hospices is also supported by a recent study by Connolly et al.[19]

Whilst our findings confirm that the proportion of a prevalence sample of hospital inpatients dying within 12 months in NZ is lower than in Scotland, the fact that 14.5% do so is not insignificant. Indeed, when considered alongside our previous NZ research showing that in a cross-sectional inpatient cohort, one in five meets criteria for palliative care needs, this study helps build a picture of the acute hospital as a major site of end of life care delivery.

The consistency of predictors of the likelihood of dying within 12 months between NZ and Scotland when the same variables are modelled is interesting, although not unexpected. Indeed, the finding that age is the strongest predictor of death within 12 months reflects the situation in many resource rich countries where dying in advanced age is now the norm.[20] Similarly, the association between living in an area of high deprivation and mortality rates is well known and holds true for both NZ and Scotland[21,

[22, 23] although it is important to note that deprivation of place of residence became non-significant in the NZ models once diagnostic history and ethnicity were adjusted for.

The NZ study also extended the findings of the Scottish study by modelling additional variables. This identified that inpatients with a history of cancer were more likely to die than those without a history of cancer, as were those whose admission was acute and Māori inpatients. Again, whilst these findings are important, they are also expected given known associations between cancer and mortality rates, the nature of acute admissions, and the higher rate of chronic conditions, including cancer, among Māori compared to non-Māori.[24,25]

Strengths and limitations

This study provides a national picture of deaths amongst a cohort of inpatients present on one night in NZ hospitals. It closely replicates a Scottish study undertaken on the same census date (although unlike the Scottish study it did not exclude obstetric patients). It extends that study by modelling additional variables – ethnicity, admission type and history of main hospital-based diagnoses. However, certain limitations must be acknowledged. History of the various conditions, including cancer, is based only upon diagnoses from hospitalisations occurring since 2004, so does not include conditions managed entirely within primary care, or hospitalisations prior to 2004. The problems

of length-biased sampling mean that patients experiencing longer hospital stays are over-represented in both studies. Finally, it was possible to include only those variables collected by the Ministry of Health in our modelling.

Conclusion

This study compared the likelihood of death of a cohort of NZ hospital inpatients with a cohort of Scottish hospital inpatients from the same census date over a 12-month period. From the NZ cohort, 14.5% had died within a 12 month period – half that of the Scottish cohort (30%). Whilst the reasons underpinning this finding warrant further research, overall the study points to interesting variations in health service usage between countries and confirms the utility of conducting international comparative studies, of which there are few within palliative care.

A. Contributorship statement: MG made a substantial contribution to study design and interpretation, drafted the majority of the paper and revised following co-author feedback, and acts as guarantor for the paper; JB made a substantial contribution to study design and interpretation, led the analysis, had input into the paper, and approved the final version; XZ contributed to study design, undertook the analysis, and reviewed and approved the final paper; LJ contributed to study design and interpretation, provided input into the paper, and approved the final version; DC made a substantial contribution to study design (he designed the original Scottish study) and interpretation, provided input into the paper, and approved the final version.

B. Competing interests: none declared.

C. Funding: there was no dedicated funding for this study.

D. Data sharing statement: Access to the data analysed for the purposes of this study is via the New Zealand Ministry of Health.

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Table 1. Demographics, hospitalisations and mortality of cohort

	In hospital on 10 April 2013* N = 6074		Died within 7 days N = 98		Died within 30 days N = 276		Died within 3 months N = 488		Died within 6 months N = 665		Died within 9 months N = 768		Died within 12 months N = 878	
	n	col %	n	row %	n	row %	n	row %	n	row %	n	row %	n	row %
All	6074	100.0	98	1.6	276	4.5	488	8.0	665	10.9	768	12.6	878	14.5
Gender														
Women	3302	54.4	48	1.5	141	4.3	249	7.5	331	10.0	381	11.5	432	13.1
Men	2772	45.6	50	1.8	135	4.9	239	8.6	334	12.0	387	14.0	446	16.1
Age at discharge														
0-14	949	15.6	3	0.3	5	0.5	9	0.9	13	1.4	14	1.5	17	1.8
15-59	2269	37.4	20	0.9	107	2.1	178	3.4	240	4.7	287	5.6	346	6.8
60-64	376	6.2	5	1.3	18	4.8	36	9.6	50	13.3	53	14.1	59	15.7
65-69	476	7.8	6	1.3	15	3.2	36	7.6	58	12.2	74	15.5	79	16.6
70-74	469	7.7	13	2.8	32	6.8	56	11.9	78	16.6	89	19.0	104	22.2
75-79	472	7.8	9	1.9	34	7.2	66	14.0	87	18.4	99	21.0	114	24.2
80-84	487	8.0	15	3.1	56	11.5	85	17.5	110	22.6	129	26.5	141	29.0
≥ 85 years	576	9.5	27	4.7	69	12.0	122	21.2	162	28.1	183	31.8	210	36.5
Prioritised ethnicity														
European	4198	69.1	74	1.8	214	5.1	368	8.8	505	12.0	583	13.9	661	15.7
Māori	931	15.3	11	1.2	27	2.9	56	6.0	85	9.1	96	10.3	118	12.7

Pacific	460	7.6	8	1.7	19	4.1	31	6.7	40	8.7	47	10.2	53	11.5
Asian	369	6.1	4	1.1	11	3.0	21	5.7	23	6.2	25	6.8	27	7.3
Other	116	1.9	1	0.9	5	4.3	12	10.3	12	10.3	16	13.8	19	16.4
Specialty of index stay														
Medicine	2621	43.2	81	3.1	220	8.4	380	14.5	511	19.5	581	22.2	654	25.0
Surgery	2490	41.0	101	0.6	532	2.1	103	4.1	148	5.9	181	7.3	217	8.7
Procedure	963	15.9	2	0.2	3	0.3	5	0.5	6	0.6	6	0.6	7	0.7
Admission type of index stay														
Acute admission	4117	67.8	89	2.2	249	6.0	433	10.5	582	14.1	661	16.1	749	18.2
Arranged admission	1093	18.0	9	0.8	25	2.3	46	4.2	60	5.5	74	6.8	84	7.7
Admission from waitlist	864	14.2	0	-	2	0.2	9	1.0	23	2.7	33	3.8	45	5.2
Any record of cancer (this or prior hospital stay)														
No	4778	78.7	62	1.3	142	3.0	240	5.0	330	6.9	386	8.1	448	9.4
Yes	1296	21.3	36	2.8	134	10.3	248	19.1	335	25.8	382	29.5	432	33.2
Deprivation quintile (NZDep06) **														
Q1 (most deprived)	1584	26.1	28	1.8	76	4.8	133	8.4	180	11.4	207	13.1	235	14.8
Q2	1434	23.6	19	1.3	68	4.7	107	7.5	155	10.8	181	12.6	210	14.6
Q3	1257	20.7	14	1.1	46	3.7	92	7.3	132	10.5	157	12.5	185	14.7
Q4	945	15.6	26	2.8	51	5.4	91	9.6	115	12.2	129	13.7	141	14.9
Q5 (least deprived)	809	13.3	10	1.2	29	3.6	58	7.2	75	9.3	86	10.6	98	12.1

* only publicly funded hospitalisations included

** 45 patients have no deprivation info

Table 2. Diagnoses of index hospitalisation and of prior hospitalisations

	In hospital on 10 April 2013 N = 6074		Died within 7 days N = 98		Died within 30 days N = 276		Died within 3 months N = 488		Died within 6 months N = 665		Died within 9 months N = 768		Died within 12 months N = 878	
	n	col %	n	row %	n	row %	n	row %	n	row %	n	row %	n	row %
All*	6074	100.0	98	1.6	276	4.5	488	8.0	665	10.9	768	12.6	878	14.5
Primary diagnosis of the index stay[#]														
Circulatory (I)	803	13.2	21	2.6	59	7.3	89	11.1	125	15.6	137	17.1	153	19.1
Injury, poisoning and other consequences of external causes (S, T)	788	13.0	10	1.3	22	2.8	40	5.1	51	6.5	61	7.7	79	10.0
Digestive (K)	600	9.9	8	1.3	22	3.7	37	6.2	52	8.7	63	10.5	72	12.0
Cancer (C, D00-D49)	536	8.8	17	3.2	59	11.0	117	21.8	151	28.2	175	32.6	197	36.8
Pregnancy & childbirth (O)	460	7.6	0	-	0	-	0	-	0	-	0	-	0	-
Respiratory (J)	408	6.7	18	4.4	35	8.6	54	13.2	83	20.3	96	23.5	101	24.8
Musculoskeletal (M)	392	6.5	2	0.5	6	1.5	16	4.1	21	5.4	23	5.9	26	6.6
Conditions originating in perinatal period (P)	339	5.6	2	0.6	3	0.9	5	1.5	6	1.8	6	1.8	7	2.1
Other symptoms & signs (R)	312	5.1	2	0.6	14	4.5	23	7.4	33	10.6	38	12.2	46	14.7
Factors influencing health status (Z)	277	4.6	0	-	2	0.7	4	1.4	5	1.8	8	2.9	9	3.2
Genitourinary (N)	264	4.3	5	1.9	9	3.4	19	7.2	27	10.2	32	12.1	37	14.0
Skin and subcutaneous tissue (L)	197	3.2	1	0.5	7	3.6	11	5.6	14	7.1	18	9.1	20	10.2
Endocrine, nutritional &metabolic diseases (E)	196	3.2	2	1.0	12	6.1	26	13.3	37	18.9	44	22.4	52	26.5
Nervous, eye & ear (G, H)	177	2.9	1	0.6	4	2.3	12	6.8	16	9.0	18	10.2	20	11.3
Infectious and parasitic diseases (A, B)	170	2.8	8	4.7	21	12.4	25	14.7	31	18.2	33	19.4	39	22.9
Congenital malformations (Q)	74	1.2	1	1.4	1	1.4	3	4.1	5	6.8	6	8.1	6	8.1
Blood and immune diseases (D50-D89)	39	0.6	0	-	0	-	3	7.7	3	7.7	3	7.7	5	12.8
Mental and behavioural disorders (F)	42	0.7	0	-	0	-	4	9.5	5	11.9	7	16.7	9	21.4
Prior hospitalisation history as at census date[¶]														
Circulatory (I)	2946	48.5	81	2.7	220	7.5	373	12.7	509	17.3	589	20.0	673	22.8

Digestive (K)	2759	45.4	67	2.4	193	7.0	334	12.1	453	16.4	520	18.8	593	21.5
Injury, poisoning, external cause (S, T)	2548	41.9	42	1.6	130	5.1	252	9.9	348	13.7	405	15.9	475	18.6
Respiratory (J)	1896	31.2	59	3.1	171	9.0	292	15.4	383	20.2	436	23.0	497	26.2
Cancer	1296	21.3	36	2.8	134	10.3	248	19.1	335	25.8	382	29.5	430	33.2

* only publicly funded hospitalisations included

[#] as defined by ICD-10 Primary diagnosis code

[¶] as any diagnosis code during any prior admission since 2000-01, not mutually exclusive

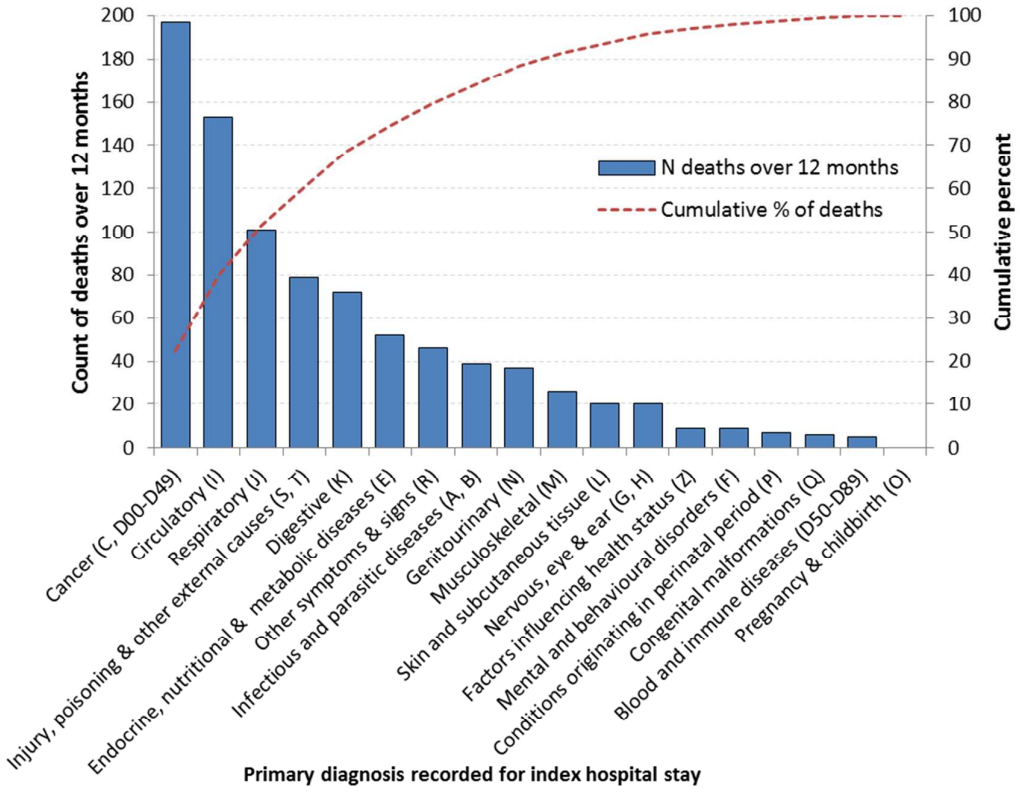
Table 3. Comparison of three predictive models for death within 12 months

	Model 1 OR (95%CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)
Gender (Male vs female)	1.15 (0.98, 1.35)	1.13 (0.96, 1.33)	1.09 (0.92, 1.28)
p-value	0.076	0.146	0.324
Age group (vs 15-59 years)			
0-14	0.32 (0.19, 0.54)	0.36 (0.21, 0.62)	0.40 (0.23, 0.69)
60-64	2.06 (1.48, 2.87)	1.86 (1.31, 2.64)	1.70 (1.20, 2.43)
65-69	2.18 (1.61, 2.94)	2.19 (1.60, 2.99)	1.92 (1.39, 2.65)
70-74	3.07 (2.32, 4.08)	2.93 (2.17, 3.96)	2.48 (1.82, 3.38)
75-79	3.27 (2.47, 4.32)	3.52 (2.62, 4.73)	2.90 (2.14, 3.93)
80-84	4.12 (3.15, 5.38)	4.03 (3.01, 5.38)	3.48 (2.59, 4.69)
85+ years	5.52 (4.31, 7.07)	6.07 (4.63, 7.96)	4.89 (3.69, 6.47)
p-value	<0.0001	<0.0001	<0.0001
Deprivation quintile (vs Q5, least deprived)			
Q1 (most deprived)	1.54 (1.17, 2.02)	1.45 (1.08, 1.94)	1.34 (1.00, 1.81)
Q2	1.28 (0.97, 1.69)	1.23 (0.92, 1.64)	1.19 (0.89, 1.59)
Q3	1.31 (0.99, 1.74)	1.34 (0.99, 1.80)	1.30 (0.96, 1.75)
Q4	1.24 (0.92, 1.67)	1.26 (0.92, 1.72)	1.22 (0.89, 1.67)
p-value	0.038	0.165	0.364
Specialty (vs surgical)			
Medical	3.16 (2.66, 3.76)	2.57 (2.12, 3.12)	2.37 (1.94, 2.89)
Procedure	0.26 (0.12, 0.57)	0.31 (0.14, 0.69)	0.47 (0.21, 1.07)
p-value	<0.0001	<0.0001	<0.0001
Ethnicity (vs European/NZ)			
Māori		1.62 (1.25, 2.10)	1.52 (1.17, 1.98)
Pacific		1.25 (0.87, 1.80)	1.20 (0.83, 1.74)
Asian		1.02 (0.65, 1.60)	1.02 (0.64, 1.61)
Other		1.67 (0.95, 2.92)	1.91 (1.08, 3.38)
p-value		0.0039	0.009
Admission type (vs acute)			
Wait-listed		0.34 (0.24, 0.48)	0.37 (0.26, 0.52)
Arranged		0.94 (0.71, 1.25)	0.87 (0.65, 1.15)
p-value		<0.0001	<0.0001
Hospitalisation history (Yes vs No)			
Cancer		4.20 (3.53, 4.98)	3.92 (3.29, 4.67)
p-value		<0.0001	<0.0001
Respiratory			1.82 (1.53, 2.16)
p-value			<0.0001
Digestive			1.51 (1.26, 1.80)
p-value			<0.0001
Circulatory **p-value**		<0.0001	1.34 (1.09, 1.64)
p-value			0.0048

Injury, poisoning, external cause				1.08 (0.91, 1.28)
p-value				0.378
Model fit				
	C-index	0.79	0.84	0.85

Note: 45 people were omitted from all models because of missing data for deprivation

Figure 1. Deaths within 12 months of census date by primary diagnosis of hospitalisation



STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	
		(*b*) Describe any methods used to examine subgroups and interactions	6-7
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-7
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	T1
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear	9-10

		which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11-12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	11-12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	n/a

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

Likelihood of death amongst hospital inpatients in New Zealand: prevalent cohort study

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Title: Likelihood of death amongst hospital inpatients in New Zealand: prevalent cohort study

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Abstract

Objectives: 1) To establish the likelihood of dying within 12 months for a cohort of hospital inpatients in New Zealand on a fixed census date; 2) to identify associations between likelihood of death and key socio-demographic, diagnostic and service related factors; and 3) to compare results with, and extend findings of, a Scottish study undertaken for the same time period and census date. National databases of hospitalisations and death registrations were used, linked by unique health identifier.

Participants: 6,074 patients stayed overnight in New Zealand hospitals on the census date (10 April 2013), 40.8% of whom were aged ≥65 years; 54.4% were female. 69.1% of patients were NZ European; 15.3% were Maori; 7.6% were Pacific; 6.1% were Asian; and 1.9% were 'other'.

Setting: All NZ hospitals.

Results: 14.5% patients (n=878) had died within 12 months: 1.6% by 7 days; 4.5% by 30 days; 8.0% by 3 months; and 10.9% by 6 months. In logistic regression models, the strongest predictors of death within 12 months were: age ≥80 years (OR=5.52 [95% confidence interval 4.31, 7.07]); a history of cancer (OR=4.20 [3.53, 4.98]); being Māori; OR=1.62 [1.25, 2.10]); and being admitted to a medical specialty, compared to a surgical specialty (OR=3.16 [2.66, 3.76]).

Conclusion: Whilst hospitals are an important site of end of life care in New Zealand, their role is less significant than in Scotland, where 30% of an inpatient cohort recruited using similar methods and undertaken on the same census date had died within 12

months. One reason for this finding may be the extended role of residential long-term care facilities in end of life care provision in New Zealand.

5 Key words: Hospitals, inpatients, palliative care, mortality, ethnicity.

Word count: 3,021

Strengths and limitations of this study

- First national picture of deaths amongst a cohort of inpatients present on one night in NZ hospitals and close replication of a Scottish study undertaken on the same census date.
- Additional variables modelled for the first time– ethnicity, admission type and history of main hospital-based diagnoses.
- Only those variables collected by the NZ Ministry of Health included
- History of the various conditions, including cancer, based only upon diagnoses from hospitalisations occurring since 2004, so does not include conditions managed entirely within primary care, or hospitalisations prior to 2004.

Background

New Zealand (NZ), in line with other resource rich countries, is facing an unprecedented demand for palliative care within the short to medium term. Largely as a

result of rapid population ageing, deaths in NZ are estimated to increase by 48% by 2038.[1] Research conducted nationally has established that the acute hospital is a significant site of palliative care management with approximately one in five inpatients meeting Gold Standards Framework prognostic criteria for palliative care need,[2] of whom approximately two thirds will have died within 12 months.[3]

It is within this context that there has been increased interest nationally in hospital-based interventions to support improved palliative and end of life care management, including advance care planning and workforce capacity building.[4,5] Policy makers have also been looking internationally to identify innovations adopted in other countries facing similar challenges. However, international comparisons are limited by a lack of understanding of the comparability of patterns of service use at end of life. For example, previous estimates of the prevalence of palliative care needs amongst hospital inpatients range from 9% in Belgium,[6] to 17% in South Africa,[7] 20% in NZ,[2] 21%–36% in the UK,[8,9] and 35% in Australia.[10] Moreover, methods adopted in these studies differed, as did definitions of 'palliative care need' and no study took a whole country approach.

A 2010 study addressed some of these deficits by reporting that 29% of a cohort of Scottish hospital inpatients on a selected census date died within 12 months.[11] Factors associated with the likelihood of dying included being >85 years, living in an area of high deprivation, and being admitted under a medical specialty (rather than surgical).

The study was replicated in both Scotland and NZ for the same 2013 census date. The 2013 Scottish study produced very similar results to the original Scottish study (30% dying within 12 months), supporting the robustness of the findings.[12] Replicating, and extending, the study within NZ was identified as helpful for national planning, supporting clinicians to respond appropriately to potential palliative care need, and in order to build a better understanding of comparative service use amongst people in the last year of life, internationally.

Aims

- To identify the proportion of a cohort of NZ public hospital inpatients dying within 12 months of a given census date.
- To identify associations between likelihood of death and key socio-demographic, diagnostic and service related factors.
- To compare results with, and extend findings of, a Scottish study undertaken for the same time period and census date.

Materials and methods

The NZ Ministry of Health provided data for all publicly-funded hospitalisations (hospitalisations in public acute hospital and publicly-funded private surgical hospitals) in NZ over the period 20 January 2004 to 10 April 2013 for people in hospital overnight on the census date of 10 April 2013. Data included: demographic information (age,

gender, deprivation of area of residence, prioritised self-identified ethnicity); hospitalisation (admission date and type, discharge date and type, length of stay, specialty of the attending physician at discharge, and diagnosis) and date of death if it occurred during this hospital stay. National death registrations data provided date of death for all deaths within 12 months of census date, and linked by the Ministry of Health to hospital stay record through unique national health identifiers.. Self-reported ethnicity was prioritised, whereby those identifying with more than one ethnic group are classified firstly to Māori, then to Pacific or Asian ethnicity.[13]

For each hospitalisation the patient's primary diagnosis was classified using ICD 10 chapter. To identify prior history of five selected diagnostic groups (cancer, circulatory diseases, respiratory diseases, injury/poisoning/other consequences of external causes, and digestive diseases), all diagnoses coded for all prior hospital admissions over the period 20 January 2004 to 10 April 2013 (including the index stay) of each patient in the index cohort were reviewed and coded with a binary indicator (1=yes, 0=no). The measure of deprivation used was the NZ Index of Deprivation 2006,[14] an area-based deprivation score grouping the NZ population into ten deciles based on place of residence, with decile 1 representing the 10% least deprived areas in NZ and decile 10 the most deprived, collapsed into quintiles.

Three multiple logistic regressions (described below) were used for modelling to investigate associations between potential predictor variables and mortality at 12 months. The c-index (the area under receiver-operating curve) was used to assess the ability of the models to discern those who died from those who were alive at 12 months.

In ***Model 1,*** the response variable was whether the patient died within 12 months. There were four predictor variables in the model: gender (female as referent), age group (0–<15, 15–<60, 60–64, 65–69, 70–74, 75–79, 80–84 and 85+; 15–<60 was used as referent), deprivation quintile (Q1 is the most deprived and Q5 is the least deprived, Q5 was used as referent) and specialty (medicine, surgery or procedure, surgery was used as referent). Of the 6,074 patients recorded as resident in NZ hospitals on the census date 6,029 patients were included for modelling; patients for whom deprivation status was not available were excluded (n=45).

Model 2 was developed from Model 1 by adding three predictor variables: admission type (acute, arranged or wait-listed, acute was used as referent); prioritised ethnicity (European, Māori, Pacific, Asian, and other, European was used as referent); and history of cancer.

Model 3 was further developed from Model 2 by adding four other diagnostic history groupings: circulatory diseases, respiratory diseases, injury/poisoning/other consequences of external causes, and digestive diseases.

MS Excel 2010 and SAS 9.4 were used for all analyses. Ethics approval was obtained from the University of Auckland Human Participants Ethics Committee (ref: 02/11/2015).

Results

In total, 6,074 publicly-funded patients stayed overnight in NZ hospitals on the census date, 46% of whom were men and 54% women. 41% were aged ≥65 years; 17% were aged >80 years (Table 1). Sixty eight per cent were acute admissions, 18% arranged admissions, and 14% wait-listed admissions. Based on NZ death registration records, 878 (14.5%) patients died during the 12-months following the census date: 1.6% by 7 days, and 10.9% by 6 months. One hundred and thirty patients (2.1%) died in hospital during the index stay and these deaths accounted for 14.8% of all deaths within the 12-month follow-up period.

Table 1. Demographics, hospitalisations and mortality of cohort

	In hospital on 10 April 2013* N = 6074		Died within 7 days N = 98		Died within 30 days N = 276		Died within 3 months N = 488		Died within 6 months N = 665		Died within 9 months N = 768		Died within 12 months N = 878	
	n	col %	n	row %	n	row %	n	row %	n	row %	n	row %	n	row %
All	6074	100.0	98	1.6	276	4.5	488	8.0	665	10.9	768	12.6	878	14.5
Gender														
Women	3302	54.4	48	1.5	141	4.3	249	7.5	331	10.0	381	11.5	432	13.1
Men	2772	45.6	50	1.8	135	4.9	239	8.6	334	12.0	387	14.0	446	16.1
Age at discharge														
0-14	949	15.6	3	0.3	5	0.5	9	0.9	13	1.4	14	1.5	17	1.8
15-59	2269	37.4	20	0.9	47	2.1	78	3.4	107	4.7	127	5.6	154	6.8
60-64	376	6.2	5	1.3	18	4.8	36	9.6	50	13.3	53	14.1	59	15.7
65-69	476	7.8	6	1.3	15	3.2	36	7.6	58	12.2	74	15.5	79	16.6
70-74	469	7.7	13	2.8	32	6.8	56	11.9	78	16.6	89	19.0	104	22.2
75-79	472	7.8	9	1.9	34	7.2	66	14.0	87	18.4	99	21.0	114	24.2
80-84	487	8.0	15	3.1	56	11.5	85	17.5	110	22.6	129	26.5	141	29.0
≥ 85 years	576	9.5	27	4.7	69	12.0	122	21.2	162	28.1	183	31.8	210	36.5
Prioritised ethnicity														
European	4198	69.1	74	1.8	214	5.1	368	8.8	505	12.0	584	13.9	661	15.7
Māori	931	15.3	11	1.2	27	2.9	56	6.0	85	9.1	96	10.3	118	12.7
Pacific	460	7.6	8	1.7	19	4.1	31	6.7	40	8.7	47	10.2	53	11.5
Asian	369	6.1	4	1.1	11	3.0	21	5.7	23	6.2	25	6.8	27	7.3
Other	116	1.9	1	0.9	5	4.3	12	10.3	12	10.3	16	13.8	19	16.4
Specialty of index stay														
Medicine	2621	43.2	81	3.1	220	8.4	380	14.5	511	19.5	581	22.2	654	25.0

Surgery	2490	41.0	15	0.6	53	2.1	103	4.1	148	5.9	181	7.3	217	8.7
Procedure	963	15.9	2	0.2	3	0.3	5	0.5	6	0.6	6	0.6	7	0.7
Admission type of index stay														
Acute admission	4117	67.8	89	2.2	249	6.0	433	10.5	582	14.1	661	16.1	749	18.2
Arranged admission	1093	18.0	9	0.8	25	2.3	46	4.2	60	5.5	74	6.8	84	7.7
Admission from waitlist	864	14.2	0	-	2	0.2	9	1.0	23	2.7	33	3.8	45	5.2
Any record of cancer (this or prior hospital stay)														
No	4778	78.7	62	1.3	142	3.0	240	5.0	330	6.9	386	8.1	448	9.4
Yes	1296	21.3	36	2.8	134	10.3	248	19.1	335	25.8	382	29.5	430	33.2
Deprivation quintile (NZDep06) **														
Q1 (most deprived)	1584	26.1	28	1.8	76	4.8	133	8.4	180	11.4	207	13.1	235	14.8
Q2	1434	23.6	19	1.3	68	4.7	107	7.5	155	10.8	181	12.6	210	14.6
Q3	1257	20.7	14	1.1	46	3.7	92	7.3	132	10.5	157	12.5	185	14.7
Q4	945	15.6	26	2.8	51	5.4	91	9.6	115	12.2	129	13.7	141	14.9
Q5 (least deprived)	809	13.3	10	1.2	29	3.6	58	7.2	75	9.3	86	10.6	98	12.1

* only publicly funded hospitalisations included

** 45 patients have no deprivation info

On the census date, the two most deprived population quintiles (Q1 and Q2) contributed 50% of hospitalisations, whereas the two least deprived quintiles (Q4 and Q5) contributed only 29% of hospitalisations. At 12 months from the census date, the two most deprived quintiles contributed 51% of deaths and the two least deprived quintiles contributed 27% of deaths. A much greater proportion of those with a history of cancer had died within 12 months at 33%, when compared with 9% without a history of cancer. 10% of those with a history of cancer had died within 30 days of their admission (Table 2). Patients with one of the five chosen diagnostic groups (cancer, circulatory diseases, respiratory diseases, injury/poisoning/other consequences of external causes, and digestive diseases) as primary diagnosis in the index hospital stay contributed to 69% of all deaths (602 of 878 deaths within 12 months of census date, Figure 1).

Table 2. Diagnoses of index hospitalisation and of prior hospitalisations

	In hospital on 10 April 2013 N = 6074		Died within 7 days N = 98		Died within 30 days N = 276		Died within 3 months N = 488		Died within 6 months N = 665		Died within 9 months N = 768		Died within 12 months N = 878	
	n	col %	n	row %	n	row %	n	row %	n	row %	n	row %	n	row %
All*	6074	100.0	98	1.6	276	4.5	488	8.0	665	10.9	768	12.6	878	14.5
Primary diagnosis of the index stay#														
Circulatory (I)	803	13.2	21	2.6	59	7.3	89	11.1	125	15.6	137	17.1	153	19.1
Injury, poisoning and other consequences of external causes (S, T)	788	13.0	10	1.3	22	2.8	40	5.1	51	6.5	61	7.7	79	10.0
Digestive (K)	600	9.9	8	1.3	22	3.7	37	6.2	52	8.7	63	10.5	72	12.0
Cancer (C, D00-D49)	536	8.8	17	3.2	59	11.0	117	21.8	151	28.2	175	32.6	197	36.8
Pregnancy & childbirth (O)	460	7.6	0	-	0	-	0	-	0	-	0	-	0	-
Respiratory (J)	408	6.7	18	4.4	35	8.6	54	13.2	83	20.3	96	23.5	101	24.8
Musculoskeletal (M)	392	6.5	2	0.5	6	1.5	16	4.1	21	5.4	23	5.9	26	6.6
Conditions originating in perinatal period (P)	339	5.6	2	0.6	3	0.9	5	1.5	6	1.8	6	1.8	7	2.1
Other symptoms & signs (R)	312	5.1	2	0.6	14	4.5	23	7.4	33	10.6	38	12.2	46	14.7
Factors influencing health status (Z)	277	4.6	0	-	2	0.7	4	1.4	5	1.8	8	2.9	9	3.2
Genitourinary (N)	264	4.3	5	1.9	9	3.4	19	7.2	27	10.2	32	12.1	37	14.0
Skin and subcutaneous tissue (L)	197	3.2	1	0.5	7	3.6	11	5.6	14	7.1	18	9.1	20	10.2
Endocrine, nutritional &metabolic diseases (E)	196	3.2	2	1.0	12	6.1	26	13.3	37	18.9	44	22.4	52	26.5
Nervous, eye & ear (G, H)	177	2.9	1	0.6	4	2.3	12	6.8	16	9.0	18	10.2	20	11.3
Infectious and parasitic diseases (A, B)	170	2.8	8	4.7	21	12.4	25	14.7	31	18.2	33	19.4	39	22.9
Congenital malformations (Q)	74	1.2	1	1.4	1	1.4	3	4.1	5	6.8	6	8.1	6	8.1
Blood and immune diseases (D50-D89)	39	0.6	0	-	0	-	3	7.7	3	7.7	3	7.7	5	12.8
Mental and behavioural disorders (F)	42	0.7	0	-	0	-	4	9.5	5	11.9	7	16.7	9	21.4

Prior hospitalisation history as at census date¶														
Circulatory (I)	2946	48.5	81	2.7	220	7.5	373	12.7	509	17.3	589	20.0	673	22.8
Digestive (K)	2759	45.4	67	2.4	193	7.0	334	12.1	453	16.4	520	18.8	593	21.5
Injury, poisoning, external cause (S, T)	2548	41.9	42	1.6	130	5.1	252	9.9	348	13.7	405	15.9	475	18.6
Respiratory (J)	1896	31.2	59	3.1	171	9.0	292	15.4	383	20.2	436	23.0	497	26.2
Cancer	1296	21.3	36	2.8	134	10.3	248	19.1	335	25.8	382	29.5	430	33.2

* only publicly funded hospitalisations included

as defined by ICD-10 Primary diagnosis code

¶ as any diagnosis code during any prior admission since 2000-01, not mutually exclusive

Model 1 showed mortality rose steeply with age, for example, patients over 85 were far more likely to die (OR=5.52 [95% confidence interval 4.31, 7.07]), compared to patients between 15 and 59 years (Table 3). Patients in the most deprived quintile were more likely to die (OR=1.54 [1.17, 2.02]) compared to patients in the least deprived quintile. Patients admitted to a medical specialty were also more likely to die (OR=3.16 [2.66, 3.76]) compared to patients admitted to a surgical specialty. Those admitted for a procedure were less likely to die (OR=0.26 [0.12, 0.57]), than those admitted to a surgical specialty. The high c-index (0.79) indicates that almost 80% of the variability was explained by the model.

Table 3. Comparison of three predictive models for death within 12 months

	Model 1 OR (95%CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)
Gender (Male vs female)	1.15 (0.98, 1.35)	1.13 (0.96, 1.33)	1.09 (0.92, 1.28)
p-value	0.076	0.146	0.324
Age group (vs 15-59 years)			
0-14	0.32 (0.19, 0.54)	0.36 (0.21, 0.62)	0.40 (0.23, 0.69)
60-64	2.06 (1.48, 2.87)	1.86 (1.31, 2.64)	1.70 (1.20, 2.43)
65-69	2.18 (1.61, 2.94)	2.19 (1.60, 2.99)	1.92 (1.39, 2.65)
70-74	3.07 (2.32, 4.08)	2.93 (2.17, 3.96)	2.48 (1.82, 3.38)
75-79	3.27 (2.47, 4.32)	3.52 (2.62, 4.73)	2.90 (2.14, 3.93)
80-84	4.12 (3.15, 5.38)	4.03 (3.01, 5.38)	3.48 (2.59, 4.69)
85+ years	5.52 (4.31, 7.07)	6.07 (4.63, 7.96)	4.89 (3.69, 6.47)
p-value	<0.0001	<0.0001	<0.0001
Deprivation quintile (vs Q5, least deprived)			
Q1 (most deprived)	1.54 (1.17, 2.02)	1.45 (1.08, 1.94)	1.34 (1.00, 1.81)
Q2	1.28 (0.97, 1.69)	1.23 (0.92, 1.64)	1.19 (0.89, 1.59)
Q3	1.31 (0.99, 1.74)	1.34 (0.99, 1.80)	1.30 (0.96, 1.75)
Q4	1.24 (0.92, 1.67)	1.26 (0.92, 1.72)	1.22 (0.89, 1.67)
p-value	0.038	0.165	0.364
Specialty (vs surgical)			
Medical	3.16 (2.66, 3.76)	2.57 (2.12, 3.12)	2.37 (1.94, 2.89)
Procedure	0.26 (0.12, 0.57)	0.31 (0.14, 0.69)	0.47 (0.21, 1.07)
p-value	<0.0001	<0.0001	<0.0001
Ethnicity (vs European/NZ)			
Māori		1.62 (1.25, 2.10)	1.52 (1.17, 1.98)
Pacific		1.25 (0.87, 1.80)	1.20 (0.83, 1.74)
Asian		1.02 (0.65, 1.60)	1.02 (0.64, 1.61)
Other		1.67 (0.95, 2.92)	1.91 (1.08, 3.38)
p-value		0.0039	0.009
Admission type (vs acute)			
Wait-listed		0.34 (0.24, 0.48)	0.37 (0.26, 0.52)
Arranged		0.94 (0.71, 1.25)	0.87 (0.65, 1.15)
p-value		<0.0001	<0.0001
Hospitalisation history (Yes vs No)			
Cancer		4.20 (3.53, 4.98)	3.92 (3.29, 4.67)

p-value		<0.0001	<0.0001
Respiratory			1.82 (1.53, 2.16)
p-value			<0.0001
Digestive			1.51 (1.26, 1.80)
p-value			<0.0001
Circulatory	**p-value**	<0.0001	1.34 (1.09, 1.64)
p-value			0.0048
Injury, poisoning, external cause			1.08 (0.91, 1.28)
p-value			0.378
Model fit			
C-index	0.79	0.84	0.85

Note: 45 people were omitted from all models because of missing data for deprivation

Model 2 showed Māori were more likely to die (OR=1.62 [1.25, 2.10]), than Europeans, as were patients with a history of cancer (OR=4.20 [3.53, 4.98]) compared to those without. Waitlisted patients were less likely to die (OR=0.34 [0.24, 0.48]) compared to those who came in acutely (Table 3). Including the additional variables improved the c-index considerably, to 0.84. The addition of previous hospital diagnoses in ***Model 3*** showed patients with a history of circulatory diseases were more likely to die (OR=1.34 [1.09, 1.64]), compared to patients without a history of circulatory diseases (Table 3). Those with a history of respiratory diseases were more likely to die (OR=1.82 [1.53, 2.16]), versus those without. Those with a history of digestive diseases were more likely to die (OR=1.51 [1.26, 1.80]), vs. those without. After adjusting for these additional diagnostic groups, history of cancer remained highly significant (OR=3.92 [3.29,

4.67]). The c-index of 0.85 indicates that the model barely improved when including the four additional diagnostic history variables.

Discussion

This study identified that 14.5% of patients resident in NZ hospitals on one day had died within 12 months. This proportion is much lower than that reported by a study of Scottish inpatients conducted using the same method and census date, where 30% had died within 12 months.[12] Similarly, whilst in Scotland 8% of patients died during the index admission (representing 32% of all deaths in this cohort within the 12 month period), the figures for NZ were much lower at 2%, accounting for 15% of all deaths in the cohort over 12 months.

Reasons for the much lower mortality in NZ compared to Scotland are not easily determined, but several interpretations warrant consideration. One important difference to note is the younger age of the NZ inpatient hospital population compared to the Scottish inpatient hospital population – 73% of the Scottish inpatients were ≥60 years, and 32% were ≥80 years,[12] while just 42% of the NZ inpatients were aged ≥60 years, of whom 17% were aged ≥80 years (see Table 1). The younger age in NZ's cohort means fewer deaths would be expected, and reflects the fact that the Scottish and NZ acute hospital populations are different.

There is also evidence that hospitals represent a much more significant place for end of life care and death in Scotland than in NZ. In Scotland 59% of deaths occur in hospital, 18% in residential long-term care and 23% in other settings, which includes home.[15] In

NZ, a much lower percentage die in hospital at 34%, and a much higher proportion die in residential long-term care at 31% and in other settings including home, which account for 35% of all deaths.[15] The argument that, in NZ, high-level residential long-term care facilities may act as 'de facto' hospices is also supported by a recent study by Connolly et al.[16]

Whilst our findings confirm that the proportion of a prevalence sample of hospital inpatients dying within 12 months in NZ is lower than in Scotland, the fact that 14.5% do so is not insignificant. Indeed, when considered alongside our previous NZ research showing that in a cross-sectional inpatient cohort, one in five meets criteria for palliative care needs,[2,3] this study helps build a picture of the acute hospital as a major site of end of life care delivery.

The consistency of predictors of the likelihood of dying within 12 months between NZ and Scotland when the same variables are modelled is interesting, although not unexpected. Indeed, the finding that age is the strongest predictor of death within 12 months reflects the situation in many resource-rich countries where dying in advanced age is now the norm.[17] Similarly, the association between living in an area of high deprivation and mortality rates is well known and holds true for both NZ and Scotland[18, 19, 20] although it is important to note that deprivation of place of residence became non-significant in the NZ models once diagnostic history and ethnicity were adjusted for.

The NZ study also extended the Scottish study by modelling additional variables. This identified that inpatients with a history of cancer were more likely to die than those without a history of cancer, as were those whose admission was acute or who were Māori. This is important because deprivation no longer becomes an important predictor, suggesting that the association of deprivation with death within 12 months is related more to ethnicity (and related factors not measured) than to deprivation itself. These findings confirm known associations between cancer and mortality rates, the nature of acute admissions, and the higher rate of chronic conditions, including cancer, among Māori compared to non-Māori.[21,22]

Strengths and limitations

This study provides a national picture of deaths amongst a cohort of inpatients present on one night in NZ hospitals. It closely replicates a Scottish study undertaken on the same census date (although unlike the Scottish study it did not exclude obstetric patients). It extends that study by modelling additional variables – ethnicity, admission type and history of main hospital-based diagnoses. However, certain limitations must be acknowledged. History of the various conditions, including cancer, is based only upon diagnoses from hospitalisations occurring since 2004, so does not include conditions managed entirely within primary care, or hospitalisations prior to 2004. NZDep, as a measure of deprivation for older people, is a poor indicator of a lifetime deprivation,

especially for those living in long-term care, but the measure is what is available. The problems of length-biased sampling inherent in a cohort assembled from a cross-sectional study mean that patients experiencing longer hospital stays are over-represented in both studies. Our study population was of all those in hospital on a particular date, and not of admissions on that date. Finally, it was possible to include only those variables collected by the Ministry of Health in our modelling.

Conclusion

This study compared the likelihood of death of a cohort of NZ hospital inpatients with a cohort of Scottish hospital inpatients from the same census date over a 12-month period. From the NZ cohort, 14.5% had died within a 12 month period – half that of the Scottish cohort (30%). Whilst the reasons underpinning this finding warrant further research, overall the study points to interesting variations in health service usage between countries and confirms the utility of conducting international comparative studies, of which there are few within palliative care.

A. Contributorship statement: MG made a substantial contribution to study design and interpretation, drafted the majority of the paper and revised following co-author feedback, and acts as guarantor for the paper; JB made a substantial contribution to study design and interpretation, led the analysis, had input into the paper, and approved the final version; XZ contributed to study design, undertook the analysis, and reviewed and approved the final paper; LJ contributed to study design and interpretation, provided input into the paper, and approved the final version; DC made a substantial contribution to study design (he designed the original Scottish study) and interpretation, provided input into the paper, and approved the final version.

B. Competing interests: none declared.

C. Funding: there was no dedicated funding for this study.

D. Data sharing statement: Access to the data analysed for the purposes of this study is via the New Zealand Ministry of Health.

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Figure 1: **Deaths within 12 months of census date by primary diagnosis of hospitalisation**

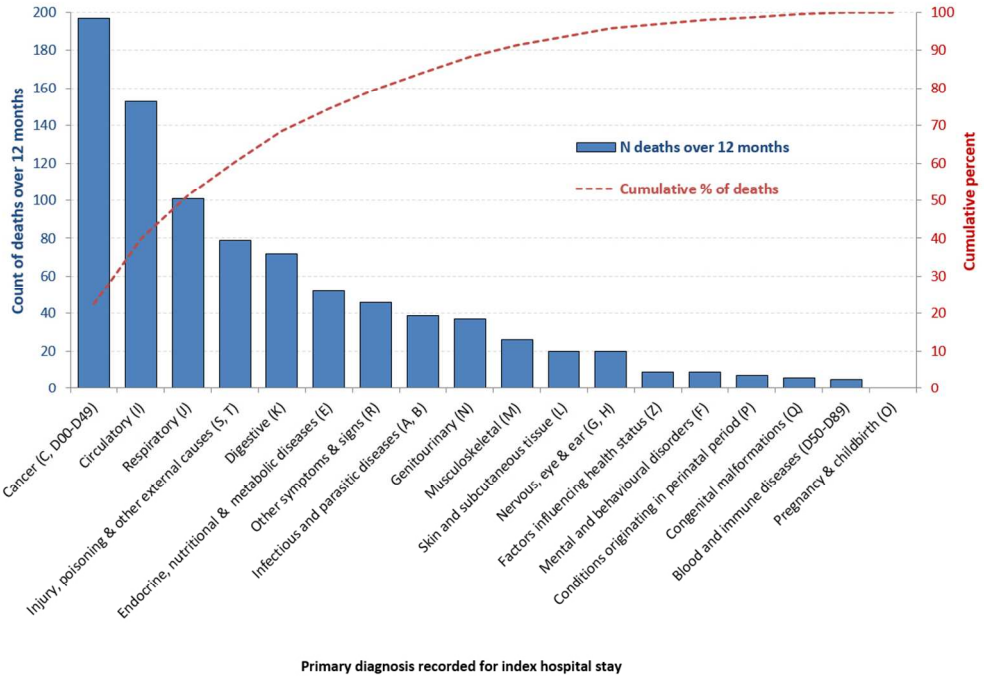

Figure 1: Deaths within 12 months of census date by primary diagnosis of hospitalisation

102x70mm (300 x 300 DPI)

The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported (page)
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1 2	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	2 2 2
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5		
Objectives	3	State specific objectives, including any prespecified hypotheses	5		
Methods					
Study Design	4	Present key elements of study design early in the paper	6		
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6		

Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case	6	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	6 n/a 6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	6	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	6-7, T1
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7		
Bias	9	Describe any efforts to address	n/a		

		potential sources of bias			
Study size	10	Explain how the study size was arrived at	6		
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	6-7		
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	6-7 n/a n/a n/a		
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	6

					6
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	6
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram	6-7 n/a	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	6
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)	T1 T1		
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report	9-10		

		numbers of outcome events or summary measures			
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9-10 T1		
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	9-10		
Discussion					
Key results	18	Summarise key results with reference to study objectives	11		
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13-14	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	13-14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12		

Generalisability	21	Discuss the generalisability (external validity) of the study results	13-14		
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15		
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	15

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.