Mortality is Not Increased with Diabetes in Hospitalized Very Elderly A multi-site Review.

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Research article

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Abstract

Objective: As there is little data about hospital outcomes in people with diabetes aged beyond 75, this study aimed to explore the association of diabetes with hospital outcome of patients aged greater than 65 years.

Design: A retrospective review was conducted of all presentation of patients age 65 years or more admitted to 3 Sydney teaching hospitals over a 6 year period (2012-2018) exploring primarily the outcomes of in hospital mortality and secondarily the outcomes of length of stay, the development of hospital acquired adverse events and unplanned re-admission to hospital within 28 days of discharge. Demographic and outcome data, the presence of diabetes and co-morbidities was determined from ICD10 coding within the hospital's electronic medical record. Logistic and negative binomial regression models were used to assess association of diabetes with outcome.

Results: Of the 139130 separations included, the mean age was 80 years (range 65 to 107 years); 51% were female, 49% had comorbidities. 26.1% had a diagnosis of diabetes.

When compared to people without diabetes, diabetes was not associated with increased odds of mortality (OR: 0.89 SE(0.02), p<0.001). Further, because of a significant interaction with age, diabetes was associated with decreased odds of mortality beyond 80 years of age. While diabetics overall had longer lengths of stay (10.2 days SD (13.4) v 9.4 days SD (12.3), p<0.001), increasing age was associated with shorter lengths of stay in people aged more than 90 years. Diabetes was associated with increased odds of hospital acquired adverse events (OR: 1.09 SE (0.02), p<0.001) and but not 28 day readmission (OR: 0.88 SE(0.18), p=0.523).

Conclusion: Diabetes has not been shown to have a negative impact on mortality or length of stay in the hospitalized very elderly from data derived from hospital administrative records.

Background

In the US, there are 30 million people diagnosed with diabetes, with a prevalence of 9.4% in 2015 [1]. There is a prevalence of 6% with approximately 3.5 million suffering the disease in the UK [2]. In 2012 there was a prevalence of 5.4% in Australia, or about 1 million people with diabetes [3].

Diabetes is associated with increased risk of morbidity and mortality. Diabetes UK report increased cardiovascular, renal, ophthalmic, peripheral vascular, neurological and psychiatric disease in poorly controlled diabetes with increased risk of mortality and reduced life expectancy [4]. In Australia, the Australian Institute of Health and Welfare (AIHW) report death rates being between 1.6 and 2 times as high for those with diabetes than the general population [5].

Hospitalisations in people with diabetes are both more likely and more frequent as well as being longer admissions [6–8]. Similarly, the prevalence in Australia of people hospitalised for any reason who have

diabetes ranges between 8.9 and 35.1% [9, 10].

Ageing is strongly associated with the development of diabetes [11]. It is likely that the interplay between genetics, environmental factors and normal ageing is the cause [12]. The prevalence of diabetes increases with age with 3–5 times the prevalence of diabetes in people aged 65 years [1, 3]

However, there is little data about hospitalisation or outcome in people with diabetes aged beyond 75 years with results often grouped as 65 + or 75+[13]. Anecdotally, experienced geriatricians feel that diabetes does not confer increased morbidity or mortality in the very elderly (those aged over 85 years).

This study was undertaken to explore the effect of a diabetes diagnosis and age on hospital mortality of patients aged over 65 years using hospital administrative data. In addition the hospital outcomes of length of stay (LOS), the development of hospital acquired adverse events and unplanned re-admission to hospital within 28 days of discharge will be examined.

Methods

Study design

A retrospective study of patients aged 65 years and older admitted for 24 hours for acute care in the South East Sydney Local Health District (SESLHD) over a 76-month period, from 1 July 2012 to 30 September 2018. Patients presenting for day only intervention, outpatient reviews, routine renal dialysis ambulatory care and psychiatric management were excluded. Subjects were flagged if they had an admission in the 7 years prior to the study period. It was expected that patients may have multiple admissions over the 6-year period.

Setting

SESLHD is located in south east Sydney, Australia, comprising 3 acute care hospitals: Prince of Wales, St George and Sutherland. These hospitals provide approximately 1420 beds for southeast Sydney with approximately 139,321 people over 65 years living in the district in 2016. The prevalence of diabetes in district is 6.4% and is below the state (NSW) average prevalence of 8.7% [13].

Data

Eligibility was based on coding within the "Patient Information Manager" (iPM), a system handling all the demographic data, discharge diagnostic codes (DRG) and separation data for all admissions. Cases were defined as those with a principal or additional diagnosis of diabetes (ICD-10-AM code: E10 Type 1 diabetes mellitus, E11 Type 2 diabetes mellitus, E12 Malnutrition-related diabetes mellitus, E13 Other specified diabetes mellitus, E14 Unspecified diabetes mellitus) as defined by International Classification of Disease 10th Revision Australian Modification (ICD-10-AM). This included new diagnosis during the admission. Data was also collected from a non-diabetic cohort for the same time period, for

comparison.ICD-10-AM codes were used to generate a modified Charlson Comorbidity Index (CCI) [14, 15]. The CCI was modified by removing the weights associated with diabetes.

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Hospital Acquired Diagnosis (HADx)

The Classification of Hospital Acquired Diagnoses permits the identification of adverse events that have occurred in hospital during an admission [16, 17]. Using a custom written Stata program, a hospital acquired diagnosis (HADx) index was generated. HADx have been included as a possible confounder and outcome in this study.

Unplanned Re-admission

Unplanned re-admission was defined as being admitted within 28 days following a previous separation. Pre-arranged or booked admissions within this time frame were excluded.

Statistical Analysis

Data was analysed using Stata Version 16 (StataCorp, College Station, TX, USA). Variables are described using mean and standard deviation, proportion and range. Each separation was analysed as a unique observation. Age, presence of diabetes and the interaction of these two were the variables of interest. The outcome variables of interest were, primarily, mortality during hospital admission (now referred to as mortality), and secondarily, LOS, hospital acquired disease and readmission rates. The t-test, Chi Square test and Mann-Whitney test were used where appropriate. Logistic and negative binomial regression models were used to assess association for the binary (mortality, 28 day readmission and HADX) and count (LOS) outcomes. All models were adjusted for the potential confounding effects of gender, CCI, HADX, number of admissions prior to the study period. Effect modification (interaction) was assessed between the diabetes and the other variables in the model. A 5% two-sided significance level was used for main effects and 1% for interactions.

Results

Cohort summary

There were 191,201 hospital separations recorded between October 2012 and October 2018 in the district. Of these, 145,090 had a LOS greater than 24 hours. After excluding dialysis and psychiatry, there were 139,130 separations remaining.

Table 1 summarises characteristics of this cohort. 26.1% of the cohort were diabetics. 50% (69,513) had at least one separation recorded in the 7 years prior to the study period. Diabetics had a higher mean number of separations (4.2 (SD 3.9) v 3.5 (SD 3.6), $p < 0.001$). Ages ranged from 65 to 107 years.

Table 1
Cohort Characteristics

		Diabetes		No Diabetes		p[α]
Age (Years, (SD))		78.8	(7.4)	80.4	(8.2)	< 0.001[β]
Female (n, (%))		16026	(44.1)	55030	(53.5)	< 0.001
Number (n, (%))						
Total[¥]		36309	(26.1)	102821	(73.9)	
with Prior Admission		19774	(54.5)	49739	(48.4)	< 0.001
No. of prior admissions ((SD))		3.8	(3.7)	3.1	(3.4)	< 0.001[β]
Individuals[¥]		16832	(23.8)	53760	(76.2)	< 0.001
Separations[£] (n, (%))	1	16208	(44.6)	53192	(51.7)	< 0.001
	2	7609	(21.0)	21729	(21.1)	
	3+	12492	(34.4)	29900	(27.1)	
CCI [€] (n, (%))	0	3361	(49.1)	11427	(57.6)	< 0.001
	1	2481	(36.3)	6450	(32.5)	
	2+	1001	(14.6)	1953	(9.9)	
Hospital Acquired Diagnosis (n, (%))		9955	(27.4)	26354	(25.3)	< 0.001

Percentages are column percentages unless indicated. ¥Percentages are row percentages. £Number of separations by each individual in the 5-year period. €Charlson Comorbidity Index. αP values are from χ2, βP values are from t-test.

There were 848 separate icd10-am codes in the cohort with the 5 most frequent being: I21 Acute myocardial infarction, I50 Heart failure, I63 Cerebral infarction, J18 Pneumonia, unspecified organism, S72 Fracture of femur. These represent 64% of all diagnoses. CCI ranged from 0 to 12 with a mean of 1.03 (SD 1.63), with 55% having a score of 0, 20% having a score of 1 and a 29% having score of 2 or more.

Diabetics were more likely to have HADx (complication) in the categories of infection, metabolic disturbance, respiratory, genitourinary, and nervous system complications.

Primary Outcome

The mortality rate in diabetics was 8.6% (v 9.6% in non-diabetics) (crude odds ratio 0.89, p < 0.001), see Table 2. When adjusted for age and its interaction with age, the odds ratio was 2.98 and when further confounders were added to the analysis the odds ratio was 3.11. When using the predictive margins generated by the model, mortality in diabetics is lower after age 80 years, see Fig. 1a.

Table 2
Logistic Regression for Mortality

	Unadjusted			**Model 1**			**Model 2**		
	OR	se	p	OR	se	p	OR	se	p
diabetes	0.89	0.02	< 0.001	2.98	0.68	< 0.001	3.11	0.71	< 0.001
age	1.03	0.00	< 0.001	1.03	0.00	< 0.001	1.03	0.00	< 0.001
Diabetes x age				0.99	0.00	< 0.001	0.99	0.00	< 0.001
Female	1.26	0.02	< 0.001				1.18	0.02	< 0.001
Prior Separations(n)	0.94	0.00	< 0.001				0.94	0.00	< 0.001
CCI 1	0.72	0.02	< 0.001				0.69	0.02	< 0.001
CCI 2+	0.86	0.02	< 0.001				0.84	0.02	< 0.001
HADx	1.55	0.03	< 0.001				1.57	0.03	< 0.001
Constant				0.01	0.00	< 0.001	0.01	0.00	< 0.001

Abbreviations: OR, odds ratio; se, standard error; CCI, Charlson Comorbidity Index; HADx, Hospital acquired diagnosis. Models comprise components shown.

FIGURE TITLE

Secondary Outcomes

Diabetics had a significantly longer LOS (10.2 days SD (13.4) v 9.4 days SD (12.3), p < 0.001 Mann-Whitney). As with mortality, there is an interaction with age so the predicted LOS is lower in diabetics beyond the age of 95 years, see Fig. 1b.

There was a small increase in the odds of developing a hospital acquired complication in diabetics (OR: 1.09 SE (0.02), $p < 0.001$). There was no interaction with age or other confounders. The increased odds persisted throughout the age spectrum.

Diabetics had a 14.0% 28 day readmission rate compared to 12.1% in non-diabetics ($p < 0.001$). Diabetes had no effect on 28 day readmission rate in logistic regression when adjusted for age, sex, prior admissions, other comorbidities and HADx (OR: 0.88 SE(0.18), $p = 0.523$).

Discussion

Diabetes was not found to be associated with increased odds of death in people aged over 65 years with an unadjusted odds ratio of 0.89 ($p < 0.001$). Diabetes diagnosis has an interaction with age. Accumulating age reduces its impact to the point that a diagnosis of diabetes may predict a better outcome in the very elderly (aged more than 80 years, see Fig. 1a. This may be due to immortal time bias (only the healthiest diabetics survive to ages beyond 80 years) [18, 19]. At the very least, it confirms that diabetes in the very elderly does not convey a worse prognosis.

Most of studies that deal with mortality and diabetes are longitudinal studies [20–24]. There only a few studies that explore in-hospital mortality associated with diabetes and these are disease specific [25–27]. Two of the studies show not effect on inpatient mortality [25, 27]. The third showed an odds ratio of 1.31 (1.04–1.65) for mortality in diabetics with foot disease [26]. It is possible that there are disease specific subsets that are at higher risk, but this was not the aim of the present study.

Similar to mortality, diabetes diagnosis had less impact with increasing age with shorter lengths of stay in the very elderly (see Fig. 1b) despite diabetics having overall longer LOS. This is consistent with other studies [25, 27–29]. The present study differs from other works by including only people over 65 years and adjusting for the confounding of disease burden by using the CCI. It remains consistent with the larger body of clinical studies. Furthermore, also consistent with these studies is the magnitude of the effect, which is small.

Hospital acquired adverse events were higher in the diabetic cohort. It was not modified when adjusting for age. This study used a validated but not extensively used method of detection of hospital acquired diagnosis [17, 30–34]. Using this method, Cromarty et al were able to show that 29.3% of diabetics developed hospital acquired events compared to 13% of non-diabetics [30]. The present study found a much higher proportion of HADX overall, probably related to this studies older cohort.

This study demonstrated that the odds of being re-admitted within 28 days of discharge was associated with the diagnosis of diabetes and these odds were not influenced with increasing age. Caughey et al identified older people with co-morbidities as those most likely to be re-admitted within 30 days [35]. The present study adjusted for the presence of comorbidity and found little difference, providing some support for their result. Dungan identified those with poor glycaemic control as those most likely to be re-admitted[36]. Clinical measures were not undertaken in the present work.

The present study did not show why the diagnosis of diabetes did not have an impact on mortality in the very elderly. However it did confirm the anecdotal experiences of experienced geriatricians. Recently, the management of diabetes in the older person has changed with less rigid control goals [37]. There is evidence that rigid control may not have the benefits seen in younger people. A converse viewpoint is that diabetes may not be as harmful in older people and so its control does not need to be as tight.

The current study has limitations. It is a retrospective audit of hospital administrative data. Hospital databases have not been designed for clinical investigations. However, the large amounts of data can be used for association. Several validation studies have been conducted with sensitivities and specificities of up to 95.6% and 98.5% respectively [38]. However, studies also warn about changes in coding rules that occur over time, such as the changes that occurred in the definitions of diabetes in 2011 [39]. This has resulted in a decrease level of reporting. This study commenced in 2012 for that reason.

This study did not use specific clinical measures. Medication usage, glycaemic control and measures of frailty are such measures. Several small works have examined hospital outcome based on these clinical measures [40–43]. The current study used administrative data only, it was beyond the scope of this study to do so. Certainly, prospective studies that explore the effects of glycaemic control and frailty on hospital outcomes are needed.

Conclusion

Diabetes has not been shown to have a negative impact on mortality, LOS, hospital acquired adverse events in the hospitalized very elderly from data derived from hospital administrative records.

Declarations

Ethics approval and consent to participate

The project was approved by the SESLHD Research & Ethics Committee (HREC No: 18/007) Consent to participate was not required in this study. The work was conducted on de-identified hospital administrative data.

Consent for publication

This study contains no details, images, or videos relating to an individual person so consent for publication is not required.

Availability of data and material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interest

The author declares no conflict of interest.

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Author Contribution

The author confirms that he meets criteria for the role of author as suggested by the International Committee of Medical Journal Editors. The author alone was responsible for the design, analysis and preparation of this article.

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Figures

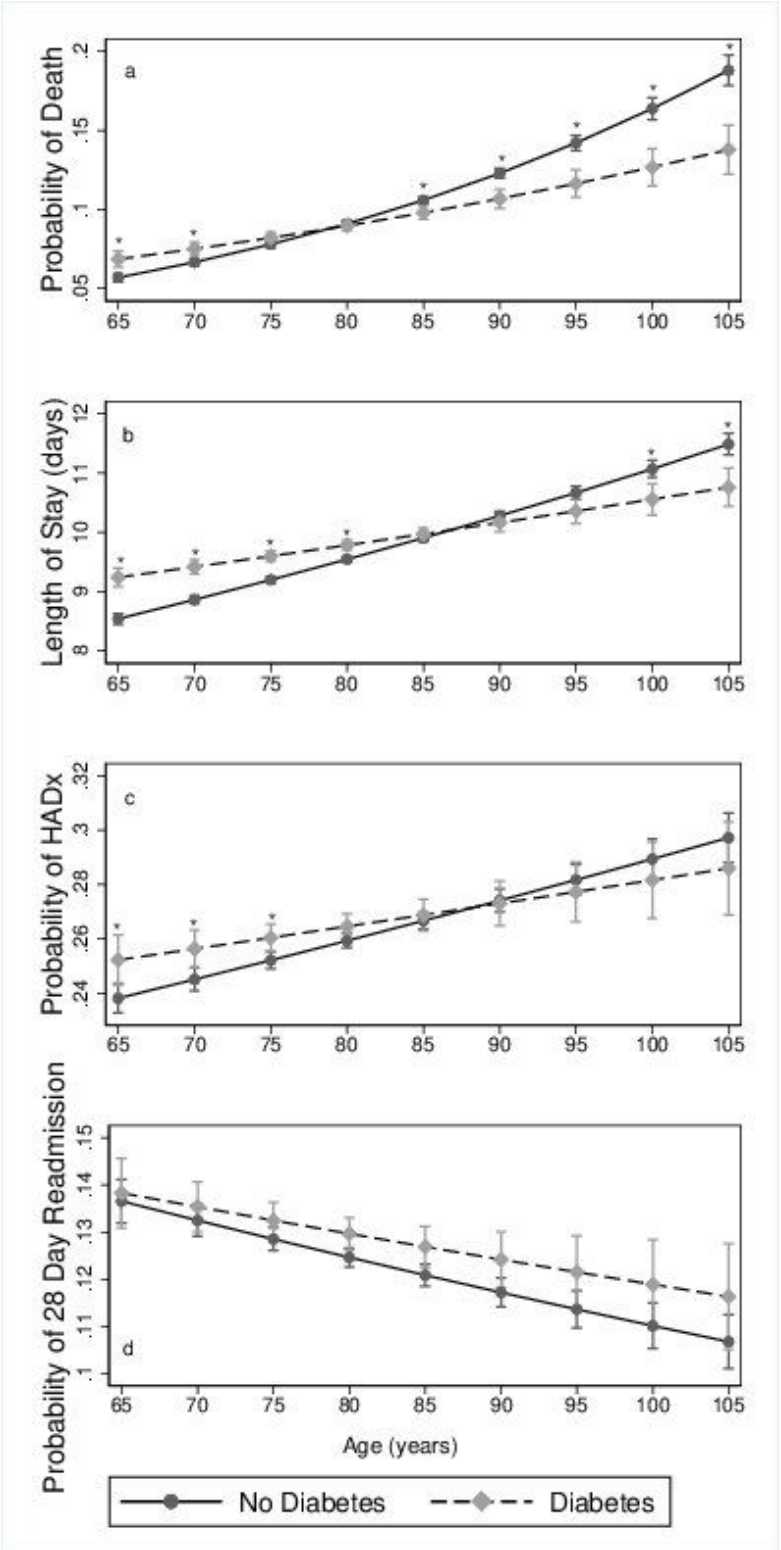

Figure 1

Predictive Margins of Diabetes by Age against various outcomes. Asterisk indicates p<0.001 at the age.