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Relationship between primary care visits and hospital admissions in remote Indigenous patients with diabetes: A multivariate spline regression model

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ABSTRACT

Aims: To determine if access to primary health care (PHC) is associated with reduced hospitalisations for remote Indigenous patients with diabetes.
Methods: Using individual level linked health clinic and hospital data, a retrospective cohort study was conducted to estimate annual hospital admission rate by number of clinic visits in the Northern Territory of Australia, stratified by age group, sex and the presence of comorbidities. A spline regression model was used to describe the clinic-hospital relationship with covariates. An impact index of PHC visits was derived using the first derivative of the quadratic equations evaluated at the parameter estimates.
Results: The relationship between PHC visits and hospitalisations in diabetes care appeared to be a U-curve. Low levels of PHC visits were associated with increased hospital admissions amongst people with diabetes. The overall level of all-cause hospitalisations for patients with diabetes was minimised when the PHC visits were 7.9 per person-year (95% confidence interval 5.8–10).
Conclusions: Using existing empirical data, this study suggests that other things being equal, diabetes patients who had an adequate level of PHC visits are likely to have a lower level of hospitalisations than those with fewer or more PHC visits. This study highlights the importance for remote Indigenous patients with diabetes to have adequate access to PHC.

1. Introduction

Understanding the relationship between primary health care (PHC) and hospital care is imperative in order to allocate health care resources effectively and efficiently for managing diabetes [1]. In Australia, diabetes affects over 4% of the Australian population, 10% of older people and up to 30–40% of Indigenous Australians [2–4]. Diabetes death rates in the Northern Territory (NT) Indigenous population increased by a

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factor of six between 1977–1981 and 1997–2001, and were approximately ten times the Australian rates [5]. In the NT, the Medicare Benefits Schedule per capita payments in Indigenous population were less than 50% of their non-Indigenous peers [6]. This lack of PHC access coincided with an almost 8-fold higher hospitalisation rates in the NT Indigenous population [7], fuelled by high rates of hospital admissions for diabetes related complications [8]. The high hospitalisation rates amongst people from remote Indigenous communities suggest that lower accessibility to PHC services may lead to higher preventable hospital admissions [9].

There was substantial evidence to support negative associations between PHC access and hospitalisation in diabetes care, as the number of PHC visits was linked to lower hospitalisation rates [10–12]. An increase in availability and intensity of PHC was associated with decreased hospitalisations and savings in hospital costs, as a result of improvements in health outcomes. Conversely, several studies indicated improved PHC for patients with diabetes could increase early detection of diabetes related complications, referrals to hospitals and admissions [13,14], yet some studies found no association between the two types of care [15,16]. Explicitly or implicitly, these studies assumed a linear relationship between PHC and hospitalisation. Large scale empirical studies based on linked service data were lacking in this area, while no study investigated the PHC-hospital relationship in remote Indigenous settings.

The remote area of the NT, covering 1.3 million square kilometres, only has approximately 40 medical practitioners providing PHC for about 51,000 Indigenous residents [17], with high rates of diabetes, renal disease and other preventable chronic diseases [4]. In 2012, the funding gap between Medicare/Pharmaceutical Benefits Scheme payment to the NT residents and the amount that would be paid on the Australian average was estimated at $102 million [18]. An average remote PHC clinic was situated 275 km from the nearest hospital and staffed by 3.4 nurses and 1.3 Aboriginal health workers. A district medical officer, located at the nearest major centre, visited these PHC clinics on average 35 times per year [19]. Remoteness and low population density posed a unique challenge for provision of PHC services in the remote Indigenous communities [20]. Majority of hospital services are provided by five public hospitals. Both PHC and public hospital services are provided free-of-charge to public patients. The remote residents are assisted with travel and accommodation costs by the Government for accessing hospital services [21].

The present study was aimed at assessing the relationship between PHC visits and hospitalisations for people with diabetes in remote Indigenous communities. Our primary hypothesis was that there would be an optimal level of PHC services, which would minimise hospitalisations.

2. Methods

2.1. Linked data

This is an observational community-based study on PHC visits and hospitalisations, using deterministic linkage of individual level PHC and hospital data between 1 July 2007 and 30 June 2011, taken from 54 remote PHC clinics and all five public hospitals in the NT. The number of visits to the remote PHC clinics is a proxy measure of access to PHC and the number of public hospital admissions is used as an indicator for utilisation of acute care. A PHC visit is defined as a face-to-face encounter with a medical doctor, nurse, Aboriginal health worker or other type of PHC provider. This study made use of PHC records from the primary care information system (PCIS) and the hospitalisation data retrieved from the hospital information system, linked together by a unique patient identifier—the hospital registration number [22]. The inclusion criteria of the study cohort were (1) Indigenous residents in the remote NT communities; (2) who visited the remote PHC clinics or were admitted to one or more of the five public hospitals; (3) who have been diagnosed with diabetes.

Diabetes and complications were defined through the International Classification of Primary Care (ICPC) in PCIS used by the remote clinics or the Australian Refined Diagnosis Related Groups (AR-DRG) used by the public hospitals. The ICPC codes for diabetes were F83, T87, T88, T89, T90; ischemic heart disease (IHD) K74, K75, K76, K89; renal disease U88, U90, U95. The AR-DRG codes for diabetes are F11A, F11B, F13Z, K01Z, K60A, K60B; IHD F08A, F08B, F14A, F14B, F14C, F12Z, F01A, F01B, F02Z, F66A, F66B, F74Z, F72A, F72B, F05A, F05B, F06A, F06B, F17Z, F18Z; renal disease L65A, L65B, L67A, L67B, L67C, A09A, A09B, L02A, L02B, L60A, L60B, L60C, L61Z. The ICPC coding was accomplished in PCIS systematically during consultations, whereas ICD coding in hospitals were performed by clinical coders based on discharge summary. The ICPC and ICD codes were both validated for this study. This study covered both type 1 and type 2 diabetes. Diagnosis of diabetes was based on the random venous blood glucose levels of more than 11 mmol/l on more than one occasion [23]. Number of PHC visits and frequency of hospitalisations were available at individual level by age group, sex, locality and indicators for the diseases. Same-day haemodialysis separations were excluded, because haemodialysis could not be avoided by improving PHC for patients with end stage renal failure [24]. PHC records with either invalid ICPC or ICPC Component 67 (referral to physician/specialist/clinic/hospital) were excluded from the analysis. Age was derived from date of birth and date of first contact. Accuracy and completeness of the hospital patient demographic data were around 95% [25].

2.2. Spline regression modelling

The number of all-cause hospital admissions per person per year (person–year) was used to describe the hospitalisation risks by PHC visits. A bubble diagram was applied to explore the association between PHC visits and hospitalisations with bubble area representing the number of patients. The relationship between PHC and hospital service was further assessed using multivariate quadratic spline regression models [26].

Let v_i and h_i represent the number of PHC visits and the number of hospitalisations, respectively, for patient i ($i = 1, \ldots, n$), and $\{x_{0i}, x_{1i}, \ldots, x_{pi}\}$ be the corresponding $p+1$ covariates of interest with $x_{0i} = 1$. The covariates are indicators for aged 40 years and over (x_1: 0 = no, 1 = yes), sex

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