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Prostate cancer prevalence in New South Wales Australia: A population-based study

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ABSTRACT

Background: Information on the current and future numbers of Australian men living with prostate cancer is limited. We describe a method for estimating complete prevalence of prostate cancer to provide a measure of the burden of prostate cancer in Australia.
Methods: Prostate cancer data from the New South Wales (NSW) Central Cancer Registry were used with PIAMOD (Prevalence and Incidence Analysis MODel) software to estimate future prostate cancer prevalence in NSW. We first fitted parametric incidence and survival models then used the modelled incidence and survival estimates to calculate complete prevalence. The estimated and projected prevalence incorporate past observed trends and take into account different assumptions about future survival trends. These models were validated against observed prevalence from the counting method.
Results: Based on data for 1996–2007, the number of men living with prostate cancer in NSW was estimated to rise by 59% to 73%, from 38,322 in 2007 to 60,910–66,160 in 2017. The increasing incidence rates and the ageing population were the major contributors to this estimated increase. Validation suggested that these projections were reasonable, as the estimated prevalence in 1996–2007 was in good agreement with the corresponding prevalence calculated using the direct counting method, and the incidence models were supported by the recent data on prostate-specific antigen testing.
Conclusions: As the number of men living with prostate cancer is expected to increase dramatically in the next decade in Australia, representing a significant challenge to the health system, careful planning and development of a healthcare system able to respond to this increased demand is required. These projections are useful for addressing the challenge in meeting the cancer care needs of men with prostate cancer.

1. Introduction

Prostate cancer has become the most frequently diagnosed cancer among men in developed countries around the world [1], and will likely remain so in the foreseeable future [2]. It is a major burden on health services in most high income countries, although it can be difficult to accurately assess the full extent of this burden. While it is fortunate that most prostate cancer patients live with the disease for many years after diagnosis, this does mean that the traditional cancer surveillance measures of incidence and mortality, which cover only the two extreme ends of the disease spectrum (diagnosis and death), are insufficient measures of the true magnitude of the disease burden in a given population. In this regard, cancer prevalence – defined as the number or proportion of people alive in a population at a given date who have been diagnosed with the disease – provides information that is crucial to

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the planning and provision of health services required by patients in the period following primary treatment and before death from prostate cancer.

There are, however, some significant challenges in determining the true prevalence of prostate cancer. Population-wide data used to estimate prevalence usually lag 3 to 5 years behind the current year due to the time required for data collection, compilation, and dissemination [3]. Moreover, prevalence estimates using observed data from cancer registries can only provide limited duration prevalence (e.g. 1-year prevalence or 5-year prevalence), as the majority of population-based cancer registries in the world have not been established long enough to capture all prior cancer diagnoses [4]. Thus, an estimate of the complete prevalence is often derived from observed data using statistical models, which can also be extended to estimate future prevalence.

Estimating future prostate cancer prevalence is particularly complicated due to the changes in patterns of incidence and survival that have occurred since the introduction of prostate-specific antigen (PSA) testing in the late 1980s [5]. These marked changes mean that historical data are a relatively unreliable foundation for modelling prevalence. In a recent report comparing the four most widely used age–period–cohort (APC) models to project cancer incidence in Canada, none of the approaches was found to work well for prostate cancer [6]. As a result of this, some authors avoided including prostate cancer [7] when they predicted future cancer incidence for major cancer types due to the uncertainty in the projections.

In this study, we used a valid PIAMOD (Prevalence and Incidence Analysis MODel) method [8] and data from an Australian population-based cancer registry to estimate the future prevalence of prostate cancer in the state of New South Wales (NSW).

2. Methods

The software we used in this study, PIAMOD [8], estimates and projects cancer prevalence as a function of modelled incidence and survival estimates. A more detailed description of the methods for using PIAMOD software to estimate future cancer prevalence can be found in previous publications [9,10]. In brief, the process of using the software to estimate prevalence involves three principal steps: modelling incidence (by fitting APC models to obtain incidence projections), modelling survival (by fitting a mixture cure model), and then the estimation and projection of complete prevalence. These steps are illustrated in Fig. 1, and the data and methods involved in each of these steps will be described in detail below.

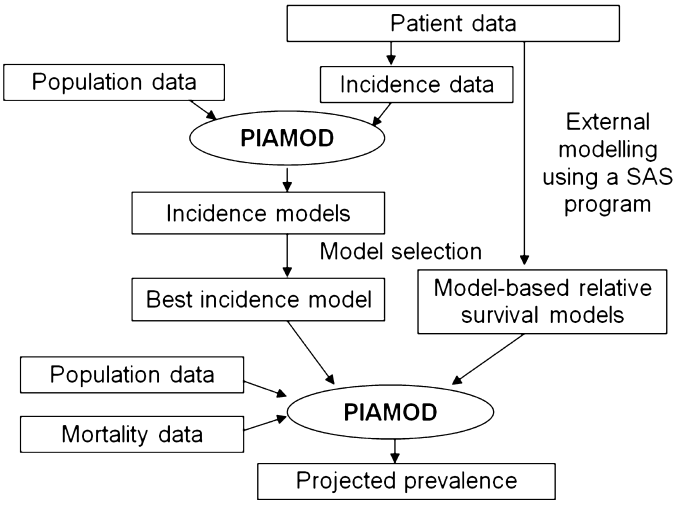

Fig. 1. Flow chart showing the use of PIAMOD for estimating future cancer prevalence.

2.1. Data

Incidence data for first primary prostate cancer (ICD-O3 C61) [11] diagnosed in 1972–2007 were extracted from the NSW Central Cancer Registry database. The Registry covers a population of 7.2 million people, approximately one-third of the national population of Australia, and maintains a record of all cases of cancer diagnosed in NSW residents since 1972 [12]. The Registry generally has high standards of data completeness and quality, and the data are accepted by the International Agency for Research on Cancer for publication in Cancer Incidence in Five Continents [13,14]. We included cases aged 18–84 years at diagnosis and excluded cases who were reported to the registry through death certificate only (DCO), or who were first identified post-mortem. The proportion of DCO cases in the Registry, an indicator of the quality of the cancer registry, is generally low (1.0% for 1993–1997 [15] and 0.9% for 2004–2008 [16]). Other input data required by the PIAMOD software were obtained from the Australian Bureau of Statistics (ABS): all-cause mortality data for NSW by single year of age and year (1972–2007), and the corresponding mid-year NSW residential male population data by single year of age and calendar year. Data on PSA tests performed (1996–2012) from Medicare Australia were used as a complementary validation for the fitted incidence models [17].

Cases were followed up for survival status to 31 December 2007 through record linkage of the cancer cases in the Cancer Registry with the death records from the NSW Register of Births, Deaths and Marriages and the National Death Index. 2007 was the most recent year for which follow up data were available. This significant lag was caused by the ABS reviewing its processes for release of its data including cause of death (http://www.cancer-institute.org.au/data-and-statistics/accessing-our-data/availability-of-nsw-central-cancer-registry-data#death-why-2008).

2.2. Ethics statement

This study involves analysis of routinely collected data and the records were de-identified (name, address, date of birth had been removed) before being provided to the research team. As a large proportion of the individuals would likely have moved or died since their diagnosis of cancer, which could have been up to 40 years ago, it would have been impracticable to seek consent, and thus the NSW Population and Health Service Research Ethics Committee waived the conditions for consent and approved the study (reference number: 2009/03/139).

2.3. Modelling incidence

Incidence rates are one of the main factors in predicting future cancer prevalence. Prostate cancer incidence changed dramatically in Australia with the introduction of PSA testing in the late 1980s. A sharp initial increase in the early 1990s (which peaked in 1994 at 187 cases per 100,000 men) was followed by a fall of 10% per year to a minimum of 126 per 100,000 men in 1998, and then another increase during 2001–2005 [18]. This incidence pattern poses a statistical challenge in terms of accurately projecting future incidence trends. While incidence data are available for 1972 onwards we chose to follow the approach used by previous researchers [19] and modelled incidence using data from 1996 to 2007. Selecting this period potentially helps reduce some of the impact of the introduction of PSA testing on our incidence models.