Background
High-income countries face challenges in providing care to an ever-increasing population of patients with cancer\(^1,2\). To support policy development towards achieving the best value for money and efficient resource allocation at a population level, information about the cost of cancer care is important\(^1\). Surprisingly, there is limited evidence regarding the cost of cancer care over and above that of routine health care in communities. Current evidence is commonly based on a limited number of patients managed in small numbers of hospital sites or on predicted pathways of care\(^3\). Other studies have used aggregated utilisation and cost data which may affect the accuracy of estimates and limit the scope for analysis\(^4,5\). The paucity of economic studies to inform this planning. To inform planning we sought to move beyond incidence estimates and take a utilisation approach by examining trends in hospital admission for gynaecological cancer.

Methods: Data were obtained from the Australian Institute of Health and Welfare (AIHW) and Australian Cancer Database (ACD) for admission for primary gynaecological malignancy between 1998 to 2015 (inclusive). Population estimates for each year of the study were obtained from the Australian Bureau of Statistics (ABS). Regressions were performed to calculate R- and p-values.

Results: There were significant increases in admission for endometrial cancer in all groups apart from the 45-54 year group. There was a significant fall in hospital admission for ovarian cancer across all age groups. For cervical cancer there was no change in the rate of hospital admission in the 25-44 year age group, but significant falls in all other age groups. For all other primary gynaecological cancers there was no change in rates of hospital admission over the study period.

Conclusion: The most expensive single component of a cancer patients care remains inpatient care. This study provides national data for inpatient admission for Gynaecological cancer in Australia. With the burden of cancer increasing, this, in conjunction with demographic projections, may provide a useful adjunct method to assist planning of cancer care resources.

Keywords: Gynaecological Cancer; cancer economics, inpatient, cancer incidence; ovarian, cervical; endometrial

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Corresponding Author: Leon Foster: tl_foster@outlook.com [preferred - more accessible] (If unable, please utilise leon.foster@act.gov.au). Centenary Hospital for Women and Children, 77 Yamba Drive Garran ACT 2605 Australia.
decisions on the financial scope of health interventions\textsuperscript{10}. Gynaecological cancers account for more than 16% of all malignancies in women. Evolving patterns of incidence and mortality make planning of cancer services challenging: new cancer diagnoses in Australia increase by more than 3% each year. Australian women have among the highest cancer survival rates in the world\textsuperscript{7}. In addition to mortality, cancer is the single largest contributor to disability-adjusted life years (DALYS) lost in Australia and this burden of disease is increasing\textsuperscript{16}. As the population and proportion of older Australians rises there will be associated increases in cancer incidence and health service utilisation\textsuperscript{8,9}. An ageing population with increased cancer survivorship will create increasing demand for cancer care, ongoing treatment, and palliative care\textsuperscript{10}. Treatment for gynaecological malignancies is complex and may be associated with adverse events. An Australian study reported that at least 26% of hospital admissions are associated with at least one adverse event\textsuperscript{11}. Patients who have adverse events during hospital admission incurred an extra AU$12,780 (USD $10,050) on average, adjusted for age, co-morbidities, ovarian cancer, major or minor complications, surgical complexity, presence of malignancy and abdominal surgery.

Cancer survivors are more likely to have co-morbidities and associated complex health needs that amplify the demands made on primary, specialist, and allied health services: the development of sustainable cancer treatment services is essential to meet the changing requirements of these patients\textsuperscript{12}. Total expenditure on cancer – by governments, private health insurers, individuals, and households – has more than doubled over the last decade in Australia\textsuperscript{13}. The greatest proportion of spending is for hospital-admitted patient services\textsuperscript{13}. In view of this; planning of cancer services at a population level that integrates public and private systems must be informed by evidence and make optimal use of resources, including the health workforce\textsuperscript{12}. To inform community-wide planning we have sought to move beyond incidence estimates and take a utilisation approach by examining trends in hospital admission for each type of gynaecological cancer by age group.

Methods

In Australia, registration of all cancers (excluding basal and squamous cell carcinomas of the skin) is a legal requirement of each state and territory. Information on newly-diagnosed cancers is collected by individual mandated cancer registries in each state and territory. Data from the individual cancer registries is migrated to the national Australian Institute of Health and Welfare (AIHW) and are used to compile the Australian Cancer Database (ACD). In addition, data regarding all hospital admissions (as separations) also are collected by

the AIHW under the auspice of the Australian Health Ministers’ Advisory Council (AHMAC), through the National Health Information Agreement. The National Minimum Data Set is compiled relating to hospitals and day procedure facilities comprising pooling data supplied by Australian state and territory health authorities. Validation studies of the AIHW dataset have reported 99.5% agreement with “true” morbidity in a female population (kappa 0.86)\textsuperscript{10}.

From this dataset we obtained data regarding cancer diagnoses and hospital admissions where the primary reason for admission (as coded at time of discharge) was a primary gynaecological malignancy. Data were obtained for the period 1998 to 2015 (inclusive) in financial years in ten-year age bands (from 25-34 years to 75-84 years at the time of separation). To provide relevant denominators, point-estimates of the population of women in Australia in each age band for each year of the study were obtained from the Australian Bureau of Statistics (ABS). Regressions were performed to calculate R- and p-values. This study received prospective approval from the Australian National University Human Research Ethics Committee (protocol 2015/347).

Results

Cervical cancer

Over the study period there was no change in the rate of hospital admission for cervical cancer in the 25-34 year (p =0.64) and 35 to 44 year (p =0.94) age groups, but significant falls in all other age groups (p < 0.01 for all older age groups) (Fig. 1).

Endometrial cancer

There were significant increases in the rate of hospital admissions in the 25 to 34 year (p =0.02) and 35 to 44 year (p <0.01) age groups, but no change in the 45 to 54 year group (p =0.38). There were significant increases in all of the older age groups: 55 to 64 years (p <0.01); 65 to 74 years (p <0.01); and, 75 to 84 years (p <0.01). (Fig. 2)

Ovarian cancer

There were significant falls in hospital admission for ovarian cancer in all age groups: 25 to 34 years (p <0.01); 35 to 44 years (p <0.01); 45 to 54 years (p <0.01); 55 to 64 years (p <0.01); 65 to 74 years (p =0.01); and, 75 to 84 years (p <0.01). (Fig. 3)

Other gynaecological cancers

For primary gynaecological cancers that were not cervical, endometrial, or ovarian there was no change in rates of hospital admission in any age group: 25 to 34 years (p =0.6); 35 to 44 years (p =0.28); 45 to 54 years (p =0.17); 55 to 64 years (p =0.3); 65 to 74 years (p =0.2); and, 75 to 84 years (p =0.9). (Fig. 4)
Fig. 1  Cervical cancer.
Age-stratified rates of inpatient admission to Australian hospitals (separations per 10000 women) for the period 1998 to 2015, by age band (◆ 25 to 34 years, ■ 35 to 44 years, ▲ 45 to 54 years, ■ 55 to 64 years, ■ 65 to 74 years, ● 75 to 84 years). Overall national yearly incidence rate (new diagnoses per 10000 women aged 25 to 84 years) shown as solid black line.

Fig. 2  Uterine cancer.
Age-stratified rates of inpatient admission to Australian hospitals (separations per 10000 women) for the period 1998 to 2015, by age band (◆ 25 to 34 years, ■ 35 to 44 years, ▲ 45 to 54 years, ■ 55 to 64 years, ■ 65 to 74 years, ● 75 to 84 years). Overall national yearly incidence rate (new diagnoses per 10000 women aged 25 to 84 years) shown as solid black line.
Fig. 3  Ovarian cancer.
Age-stratified rates of inpatient admission to Australian hospitals (separations per 10000 women) for the period 1998 to 2015, by age band (◆ 25 to 34 years, ■ 35 to 44 years, ▲ 45 to 54 years, ▼ 55 to 64 years, ▼ 65 to 74 years, ● 75 to 84 years). Overall national yearly incidence rate (new diagnoses per 10000 women aged 25 to 84 years) shown as solid black line.

Fig. 4  All other primary gynaecological cancers.
Age-stratified rates of inpatient admission to Australian hospitals (separations per 10000 women) for the period 1998 to 2015, by age band (◆ 25 to 34 years, ■ 35 to 44 years, ▲ 45 to 54 years, ▼ 55 to 64 years, ▼ 65 to 74 years, ● 75 to 84 years). Overall national yearly incidence rate (new diagnoses per 10000 women aged 25 to 84 years) shown as solid black line.
Discussion

Since the burden of cancer is likely to increase at a national level it is important to use the best available data when planning for future oncology services. The economic burden of cancer in developed countries is substantial and expected to increase markedly in the future. There will be an increased burden of care associated with a growing, aging, and higher risk population, trends in treatment patterns, costs of treatments, as well as cancer survivorship. The cost of cancer treatment begins at diagnosis, and when incidence and prevalence cost calculations and estimates are used it is important to make projections based on likely trends in the incidence of different types of cancer. Incidence costs will change over time according to the specific epidemiology trends and, following this, the prevalence costs – taking into account all patients alive at any given time – also will have different trajectories.

This study evaluated changes in inpatient admission of gynecological cancers between 1998 and 2015. This large national dataset may provide information to assist planning of cancer services: it is possible to look at admitted patient care in age groups for each of the main histological types of primary gynecological cancer and project future trends, planning resource allocation in a rational manner. Resource allocation for gynecological cancer services is complex with a requirement not only for workforce planning, but also adjuvant services such as chemotherapy and radiotherapy, psychological support services, and importantly – access to other services such as psychological, pastoral, fertility preservation, and palliative care.

When cancer survival is short the incidence and prevalence estimates in any given year will be relatively similar because the majority of individuals will have high costs as initial treatment phase and end-of-life costs occur close together. However, for cancers with long survival the prevalence costs each year will be lower than the incidence costs: as the prevalence cost estimate will be predominately composed of survivors in remission, where costs are lowest. Yet while both incidence and prevalence cost measures can provide valuable guidance for resource allocation, policy, and program planning, prevalence costs are favoured in understanding the overall impact of disease at a national level.

Service and resource planning for cancer services is complex compared with other conditions. It is possible to take the approach of dividing cancer care into initial, continuing, and terminal care phases then apply these specific cost estimates to survival probabilities. As the efficacy of cancer treatment improves – and prevention strategies are implemented – the absolute number of cancer survivors will increase and the number of deaths attributable to cancer will decrease. Prediction of costs of treatment are challenging, and estimation is difficult without making assumptions about the independence of estimates across phases of care. Additionally the introduction of targeted therapies have added to the cost burden for the community. Overall, a treatment phase approach is the most commonly-used method and can be combined with population data, cancer incidence data, and cost estimates to assist in planning. This paper provides data on the most expensive element of the cancer treatment journey to enable evidence based and accurate estimates of future requirements.

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