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NSW GOVERNMENT

cancer institute NSW

Spotlight on Measurement

Emergency department utilisation by people with cancer

NSW public hospitals
Cohort diagnosed between 2006 and 2009

BUREAU OF HEALTH INFORMATION

Level 11, Sage Building, 67 Albert Avenue
Chatswood NSW 2067
Australia
Telephone: +61 2 9464 4444
bhi.nsw.gov.au

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Setting the scene

The *Spotlight on Measurement* series explores indicators and analyses that are new to the Bureau of Health Information (BHI). It describes the investigation and development of specific performance measures that are under consideration for public reporting; outlines key decision points and analytic stages; considers potential future contributions and wider applications of the measures; and discusses ongoing challenges in their use.

This edition describes the analytic approach and methods developed in the course of a project that explored the use of public hospital emergency departments (EDs) by people with cancer in NSW.

The work is developmental in two key ways. **First** it represents the first time that data from the NSW Central Cancer Registry (CCR) has been linked with data from the Emergency Department Data Collection, allowing new insights to be developed about cancer patient journeys and flows in NSW. **Second**, it introduces a novel approach to gauging performance in cancer care – namely a risk-standardised utilisation ratio (RSUR). This measure, based on established methods for risk-standardised mortality ratios (RSMRs) and risk-standardised readmission ratios (RSRRs), uses statistical modelling to calculate an expected rate of ED visits within 28 days of cancer hospitalisation discharges for each hospital, given its case mix.[1,2,3] This expected rate is compared to the observed rate and expressed as a ratio that is significantly higher, significantly lower, or no different to expected.

A collaborative project involving the Cancer Institute NSW and BHI, this work brought together expertise on cancer epidemiology and treatment, statistical analysis, research design, public reporting and the communication of complex healthcare information.

Spotlight on Measurement reports are usually released with an edition of *The Insights Series*, which applies the measure developed to report on the extent of variation in the NSW healthcare system. Detailed metadata and analytic specifications are available on BHI's website.

About the Spotlight on Measurement series

Spotlight on Measurement is a series of reports that reflects on methodological developments made in the course of BHI analyses.

It represents the main vehicle for BHI to share these important developments with academic and governmental institutions and provides an opportunity to explore, in a transparent way, the relative strengths and limitations of measures used to report on various aspects of performance.

Setting the scene

Context and background

Cancer is a group of diseases characterised by the uncontrolled growth and spread of abnormal cells.

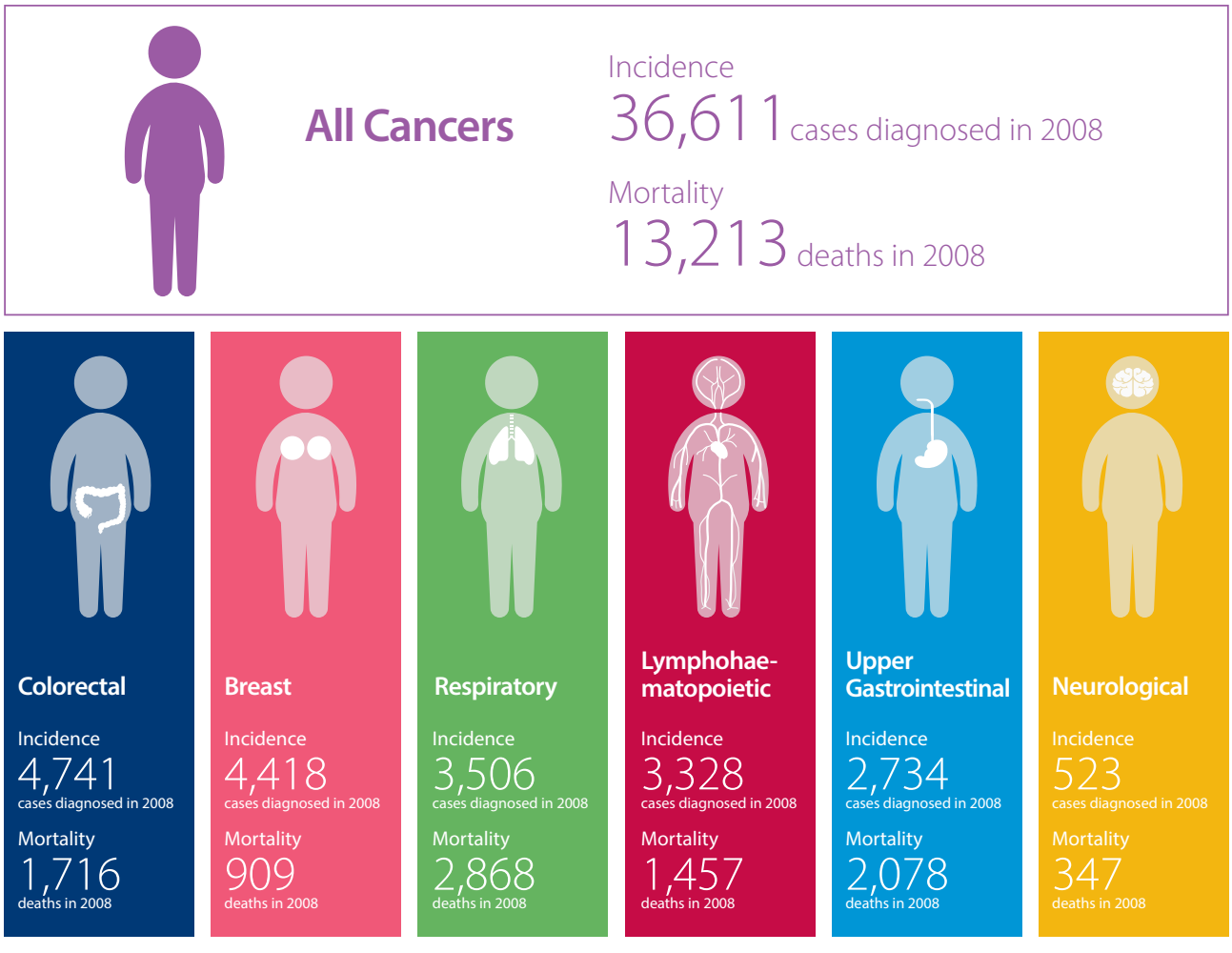
There are around 100 different types of cancer, most of which are named for the organ or type of cell in which they start. For example, cancer that originates in the breast is called breast cancer; cancer that begins in leucocytes (white blood cells) is called leukaemia. The types of cancer featured in this report and the accompanying edition of *The Insights Series* are those thought most likely to lead to emergency department (ED) visits and are shown in Figure 1.[4]

People with cancer typically have a treatment plan tailored to their type and stage of cancer. There are three main types of treatment, often used in combination: surgery, drug therapies (including chemotherapy) and radiotherapy. Cancer treatment can also include allied health and palliative care services.

In addition to these planned treatments, people with cancer may also attend hospital for unplanned visits to the ED, before or after their cancer diagnosis.

While there is an abundance of information about cancer epidemiology, clinical care and treatment modalities, there are very few population-based studies of ED utilisation by people with cancer and none specific to NSW.

Figure 1 Different cancer types featured in this report, NSW, incidence and mortality, 2008[5]



Cancer facts

Incidence

- Australia/New Zealand has the highest aged-standardised cancer incidence rate in the world for men, and second highest for women.[6]
- In Australia and NSW, the risk of developing a cancer by the age of 85 is 1 in 2 for men and 1 in 3 for women.[7,8]
- In NSW, 36,611 people were diagnosed with cancer in 2008.[5]
- The five most commonly diagnosed cancers in NSW are: prostate, colorectal, breast, melanoma and lung.[8]

Survival

- The overall five-year relative survival from cancer in Australia is 66%, which is on par with the best healthcare systems in the world.[12]

Mortality

- Cancer is the number one cause of death worldwide. Cancer has surpassed ischaemic heart disease (excluding stroke) as the leading cause of death globally, with 8.2 million cancer deaths reported in 2012.[6,9,10]
- In Australia and NSW, the risk of dying from cancer by the age of 85 is 1 in 4 for men and 1 in 6 for women.[5,7]
- In NSW, cancer was responsible for 13,213 deaths in 2008, equivalent to 28% of all NSW deaths in 2008.[5,11]
- The five cancers causing the most deaths in NSW are: lung, colorectal, prostate, breast and pancreatic.[5]

People with increased risk

- Aboriginal people are more likely to die from cancer. In NSW, the standardised mortality ratio for all cancers in Aboriginal people is 1.7, compared with the total NSW population.[13]
- People living in rural areas are more likely to have advanced cancer at diagnosis. In NSW, the odds of presenting with localised cancer range from 4% lower for people in remote areas to 14% lower for very remote areas, compared with other areas.[14]

Setting the scene

What do we know already about ED use among cancer patients?

There are relatively few studies describing why cancer patients visit the ED. A rapid review of the literature conducted in 2013[15] and subsequent supplementary searches identified a small number of studies. Most were descriptive accounts, relatively small in scale and based on medical record review,[16] single data source searches,[17] or prospective recruitment of cancer patients presenting to an ED.[18] One study drew on linked administrative data to describe the use of ED by cancer patients in the last year of life.[19]

This report outlines the approaches developed by BHI to explore four project questions regarding the use of ED by people with cancer in NSW. The approaches draw on linked data from cancer registry and administrative databases for the state; analysing and reporting descriptive statistics together with results from regression modelling.

Project questions

This study sought to explore the use of NSW public hospital EDs by cancer patients. It focused on four key questions (Figure 2):

1. How often do people with cancer visit an ED and why?
2. Do results for ED timeliness indicators differ for people with cancer compared to all NSW ED patients? Do results vary across hospitals?
3. What patient level factors are associated with people with cancer visiting an ED?
4. Is there variation in the use of EDs by people with cancer following hospitalisation?

Answering these questions requires conceptualising emergency ED visits made by cancer patients in different ways.

First, ED visits can be used as a measure of utilisation. Providing descriptive information, utilisation data can reveal patterns of visits across hospitals and across cancer types; and show different reasons for visiting the ED.

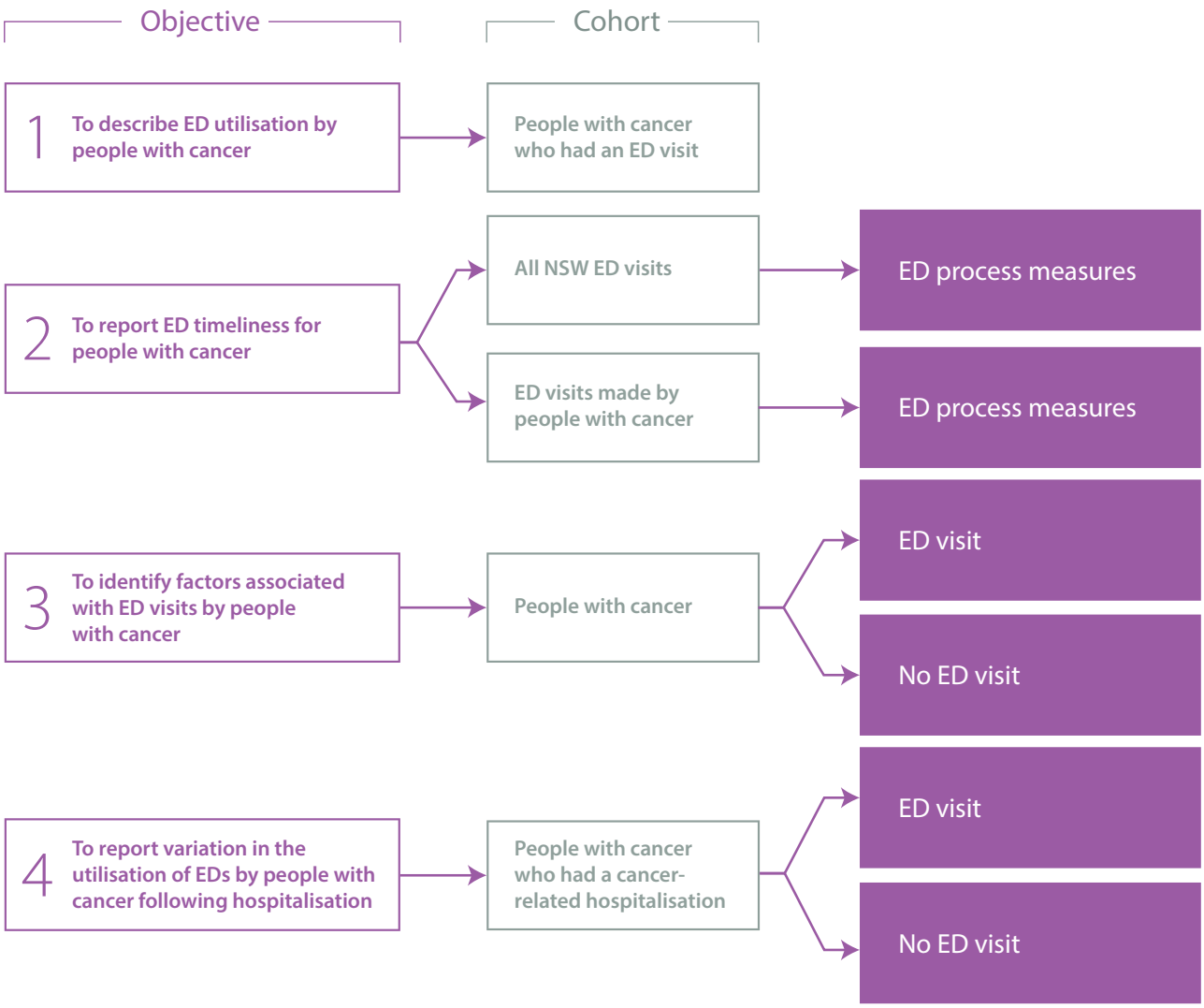
Second, ED visits can be examined in terms of specific process measures. For example, how quickly were cancer patients seen and treated when they presented to the ED? Did they leave the ED within the recommended time period?

Third, ED visits can be used as outcome measures. The project also conceptualised ED visits as events that are affected both by patient characteristics and by the quality of cancer care. To explore ED visits as an outcome, the analysis:

- Developed a statistical model to identify those patient characteristics associated with visiting an ED
- Used this information to calculate, for each NSW public hospital, an expected rate of ED visits, given its cancer patient case mix and compared that to the actual rate that occurred.

Setting the scene

Figure 2 Project questions addressed in this report



Setting the scene

What do we know already about methods for measuring hospital performance in specific clinical areas?

There is a substantial body of research on, and performance reporting experience in, outcomes such as mortality and readmissions.

BHI recently published data on 30-day mortality following hospitalisation for five clinical conditions (acute myocardial infarction; ischaemic stroke; haemorrhagic stroke; pneumonia; hip fracture surgery), using risk-standardised mortality ratios (RSMRs).[20]

Founded on research undertaken by a team at Yale University in the US on behalf of the Centers for Medicare & Medicaid Services (CMS),[1,21] RSMRs express for each hospital a ratio of the 'observed' number of deaths to the 'expected' number of deaths. A hierarchical logistic regression model draws on the total patient population's characteristics and outcomes (in the BHI work, the NSW population) to estimate the expected number of deaths for each hospital, given its case mix.

Subsequent work undertaken in the US, and in NSW by BHI, has used a similar approach to report on risk-standardised readmission ratios (RSRRs).[2, 3, 22]

In order to address project questions in the current study into the use of NSW public hospital EDs by people with cancer, a similar method was applied to the development of risk-standardised utilisation ratio (RSUR).

A ratio less than 1.0 indicates lower-than-expected ED visits, and a ratio higher than 1.0 indicates higher-than-expected ED visits. Small deviations from 1.0 are not considered to be meaningful. Funnel plots with 95% and 99% control limits around the NSW rate are used to identify hospitals with higher and lower than expected ED visits.

What data are available to answer the project questions?

For this project, the NSW Ministry of Health's Centre for Health Record Linkage (CHeReL) assigned a Project Person Number using probabilistic record linkage software to link records across a range of data sources:

- Central Cancer Registry (CCR)
- Clinical Cancer Registry (ClinCR)
- Admitted Patient Data Collection (APDC),
- Emergency Department Data Collection (EDDC)
- Registry of Births, Deaths and Marriages (RBDM)
- Australian Bureau of Statistics' Mortality Data (ABS).

For many epidemiological studies the primary unit of analysis is a cancer type or diagnosis. This report differs in focusing on patients as the primary unit of analysis. It relies on the use of linked data to provide information relevant to understanding patient journeys and pathways.

The data for this project relate to cancer patients diagnosed in the January 2006 – December 2009 period. ED visits up to 12 months before and 12 months after diagnosis were captured.

The study was constrained by delays in creating linkages between CCR and ABS death data. While the data are over five years old, there are still valuable insights to be gained from the analyses. Given the age of the available data, the accompanying edition of *The Insights Series: Emergency department utilisation by people with cancer* does not nominally report hospital level results. It does however, describe the extent of variation across the state's public hospitals.

Not all EDs have systems in place to supply electronic records to the EDDC. While metropolitan and large rural EDs contribute to the EDDC, visits to some smaller EDs are not captured. Data coverage has increased over time from 80.2% in 2005–06 to 90.7% in 2011–12.

The implications of incomplete ED data coverage were investigated for the relevant project questions. Sensitivity analyses showed that there was no substantive impact on the conclusions drawn (see page 22 for details).

The report is structured around the four key project questions, in terms of:

- The issue addressed
- Its importance and relevance
- The analytic objective
- An outline of the approach taken to achieve the objective
- Implication for future work.

Results from relevant sensitivity analyses and investigations are also provided.

How often do people with cancer visit an ED and why?

Issue: There is little information available about patterns of, and reasons for, ED visits made by people with cancer in NSW.

The importance: Patient treatment plans for people with cancer aim to structure care in a patient-centred and predictable way. However many people with cancer also make unplanned emergency visits to the ED and some of these visits may be potentially preventable given appropriate care and community support.

Developing greater understanding about the frequency of ED use by people with cancer; their reasons for visiting an ED; and patterns of utilisation around the crucial times of cancer diagnosis, treatment and death, helps delineate the different patient journeys made by people with cancer. Identifying key stages and circumstances in those journeys where there may be potential to minimise unnecessary ED visits will inform efforts to improve care.

Objective: To describe utilisation patterns for NSW EDs; across cancer types; and presenting reasons for visiting an ED.

Our approach: Key steps in the analysis are described in Table 1 (and depicted schematically in Figure 3).

Implications for future work: The study demonstrates how ED data, when linked with other sources of information, can provide insight into the frequency of, and reasons for, emergency ED visits among particular cohorts.

Limitations of the work include the inability to fully capture patients' journeys due to lack of access to primary care and prescribing data and incomplete records of chemotherapy and radiotherapy data. The work was also hampered by the imprecision in the date of diagnosis in the Central Cancer Registry (month of diagnosis only). This has now been rectified for future analyses but retrospective corrections of the registry are not possible.

Figure 3 Schematic of the approach used

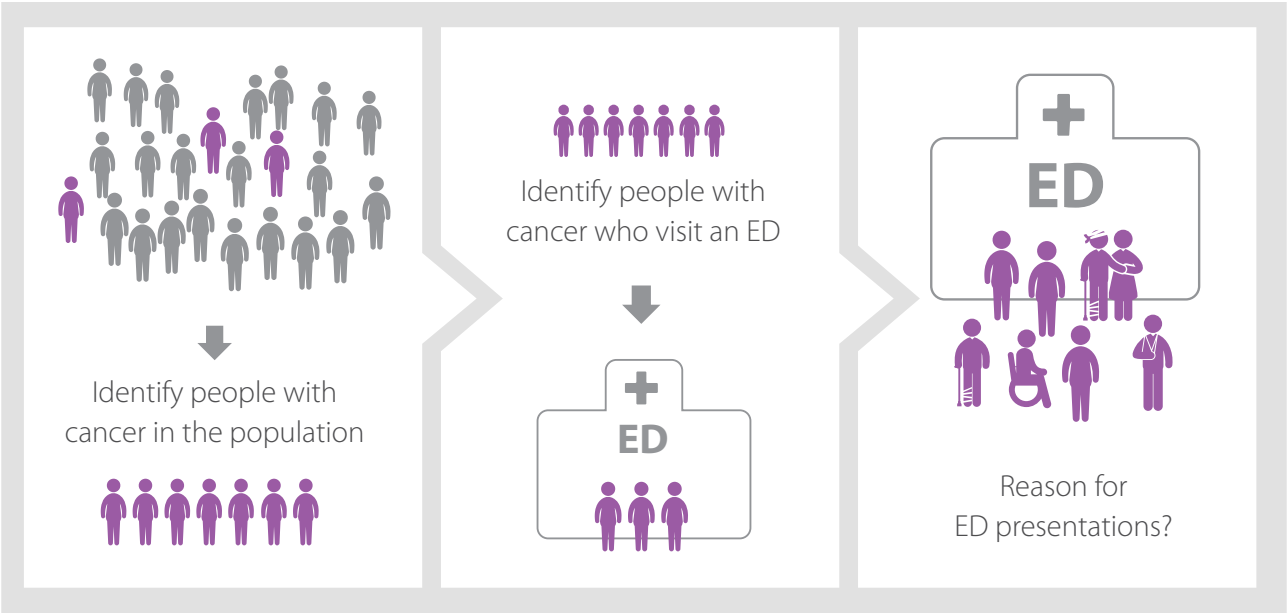


Table 1 Key analytic steps to describe why people with cancer visit an ED

Approach	Rationale & notes
Identify patients diagnosed with invasive cancer between 2006–2009	Data drawn from Central Cancer Registry; linkage key provided by CHeReL
Exclude those with date of death prior to date of diagnosis	Exclusions to remove coding anomalies and cases outside NSW jurisdiction.
Establish month of diagnosis	CCR only records month and year in which the cancer diagnosis occurred.
Identify patients with an ED visit in the 12 months preceding, and the 12 months subsequent to, diagnosis • Exclude those with an ED visit >1 day after date of death • Map presenting complaints from the ED electronic data records	Heterogeneity in ED coding meant that ascertaining the reasons for ED visits among cancer patients was not straightforward at the outset of the project. Clinical information in EDDC is heterogeneous. There are several different computer programs used across the state's hospital EDs. Different programs use different classifications to record the clinical information, including ICD-9, ICD-10, and SNOMED CT. Information about presenting complaints is recorded by medical, nursing or clerical personnel at the point of care rather than by trained clinical information managers. Historically, this has hampered efforts to capture reasons for presentation to ED. This project applied a mapping technique to overcome some of these difficulties. Not all hospital EDs have systems in place to supply electronic records to the EDDC. However, coverage has increased over time. In 2005–06, 80.2% of ED attendances were recorded in the EDDC; by 2011–12, this had increased to 90.7% of visits.
Calculate time from diagnosis to presentation	It was not possible to capture with precision visits immediately around the time of diagnosis, only month and year of diagnosis are available. The 15th of the month was selected as the default date of diagnosis, except if the person died before the 15th, in which case it was set to the 1st of the month.
Compute frequencies of patient presentations to ED	Using linked data provided a temporal picture of patient interactions with the hospital care sector in NSW.
Identify people with cancer in the cohort who died within a year of diagnosis • Determine the number of ED visits in the 30 days, 90 days and 180 days prior to death	Linking ED data with CCR/RBDM allows for focused analysis on ED use in the time leading up to death. At the time of analyses, cause of death data were not available for years after 2007, and fact of death data were used.
Identify people with a colorectal or respiratory cancer • Identify those with an ED visit in the 12 months preceding the month of diagnosis	Drawing on clinical advice, additional analyses were performed for two specific cancers – colorectal and respiratory. These were thought to be the cancer types most likely to present to the ED preceding a diagnosis.

Do results for ED timeliness indicators differ for people with cancer?

Issue: There is a large volume of routinely collected data about ED visits in NSW and in other jurisdictions. However, little is known about performance in ED timeliness measures specifically for people with cancer.

The importance: Describing and understanding characteristics of emergency ED visits made by people with cancer – the acuity of their presenting condition, the speed with which they are seen and treated, the proportion subsequently admitted to hospital from an ED – provides insights into patient pathways and reflects on how performance varies across the state's hospitals, helping to identify opportunities to improve care.

Objective: To determine whether results for ED timeliness indicators differ for cancer patients when compared to all ED patients. Do results vary across hospitals?

Our approach: Key steps in the analysis are described in Table 2 (and depicted schematically in Figure 4).

Implications for future work: This study adopts standard definitions and indicators of ED performance to explore whether timeliness indicators differ for people with cancer compared with all NSW ED patients.

The analysis differentiates between patients who were treated in the ED and discharged home and those who were treated and admitted or transferred to another hospital.

Patients who are treated and discharged provide an indication of care provided in the ED, while those who are admitted reflect care from a 'whole of hospital' perspective and are affected by issues such as bed availability and coordination of care.

Future analyses could explore whether there are discernible patterns in ED timeliness across particular reasons for presentation. For example: do EDs differ in the propensity to admit people presenting with nausea and vomiting? Do median times to treatment vary across EDs for the same presenting complaint?

Figure 4 Schematic of elements of the approach used

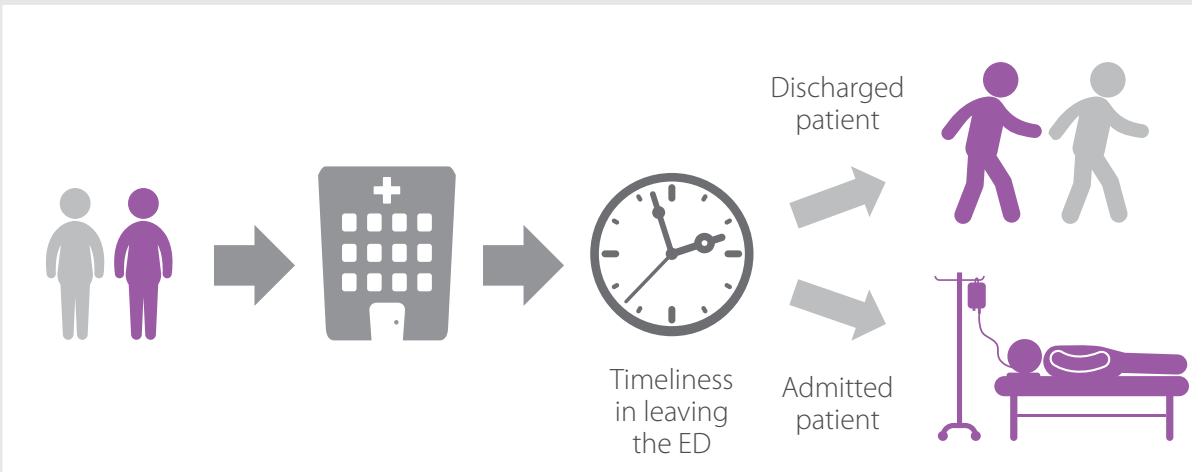


Table 2 Key analytic steps to report timeliness in the ED for people with cancer

Approach	Rationale & notes
Identify patients diagnosed with invasive cancer between 2006–2009	Data drawn from Central Cancer Registry; linkage key provided by CHeReL
Exclude those with date of death prior to date of diagnosis	Exclusions to remove coding anomalies and cases outside NSW jurisdiction.
Establish month of diagnosis	CCR only records month and year in which the cancer diagnosis occurred. This means that ascertaining precise patterns of ED use immediately preceding and following diagnosis is not possible.
Identify patients with an ED visit in the 12 months preceding, and the 12 months subsequent to, diagnosis • Exclude those with an ED visit >1 day after date of death	ED visits made by people with cancer (diagnosed between 2006 and 2009) accounted for approximately 1.5% of all ED visits in the relevant time period. This analysis investigates frequency of ED visits among people with cancer to examine the prevalence and patterns of emergency ED visits among different clinical cancer groups. Over time, EDs in NSW have adopted electronic data collection systems. In 2005–06, 80.2% of ED attendances were recorded in the EDDC; by 2011–12, this had increased to 90.7% of visits. People with cancer who made an emergency ED visit had different age and sex distribution (median age 70.2 years; 58% male) to all NSW people who made an emergency ED visit in 2010 (median age 25.5 years; 51% male). Although age profiles differ, acuity provides a more robust basis for comparing timeliness relative to need and median times to treatment by triage category are presented. These analyses did not differentiate between cancer related and non-cancer related reasons for presentation.
Identify patients within the lymphohaematopoeitic, respiratory, colorectal, upper gastrointestinal and neurological clinical groups and report separately on their ED presentations	The project Advisory Committee identified these five clinical cancer groups to report separately on ED timeliness indicators. Data for these groups are provided; they are also included within the category ‘all cancer’. See Appendix 1 for clinical cancer grouping details.
At state and hospital level compute the suite of timeliness indicators for cancer patients and for all patients visiting the ED	• Triage category (distribution) • Time to start treatment (median) • Time to leaving the ED (median) • Mode of separation (distribution) • Leaving the ED within four hours • Proportion of ED visits that were re-presentations within 48 hours
Explore differences between patients who are treated and discharged and those who are treated and admitted.	It is known that patients who are treated and admitted are less likely to leave the ED within four hours of arrival. The proportion of patients admitted therefore impacts timeliness results and so data are presented separately for the two groups. This approach provides different perspectives on care. The results for people who are treated and discharged reflect mainly on timeliness in the ED. In contrast, results for people who are treated and admitted can be considered to be a reflection of ‘whole-of-hospital’ care – affected by issues such as bed availability, coordination and integration of care.

What patient level factors are associated with people with cancer visiting an ED?

Issue: An important step in reducing unnecessary emergency ED visits is building an understanding of the patient level factors that influence the propensity to go to an ED.

The importance: Information about patient level factors associated with visiting an ED can be used to highlight potential areas for improvement in care provided to people with cancer – both in terms of accessing support outside of the hospital setting and in terms of providing appropriate care that minimises the need for emergency ED visits.

Objective: Characterise and assess the strength of patient level factors statistically associated with emergency ED visits by people with cancer in the 12 months following diagnosis of cancer.

Our approach: Key steps in the analysis are described in Table 3 (and depicted schematically in Figure 5).

Implications for future work: This study used a competing risk modelling approach. In exploring differences between people with cancer who visited an ED and those who did not visit an ED, it is important to distinguish people who did not use an ED as a result of dying.

This work could inform the development of predictive risk models that are able to prospectively identify patients most likely to present to an ED and put in place appropriate strategies to prevent such unplanned visits.

The study was limited in two key ways. First, imprecision in the date of diagnosis in the Central Cancer Registry (month of diagnosis only) meant that it was difficult to determine patterns of ED use immediately around diagnosis.

Second, while the study encompassed a five-year lookback at hospital records in order to capture as full a comorbidity profile as possible; this work would have been strengthened by access to primary care and prescribing data.

Figure 5 Schematic of elements used in the approach

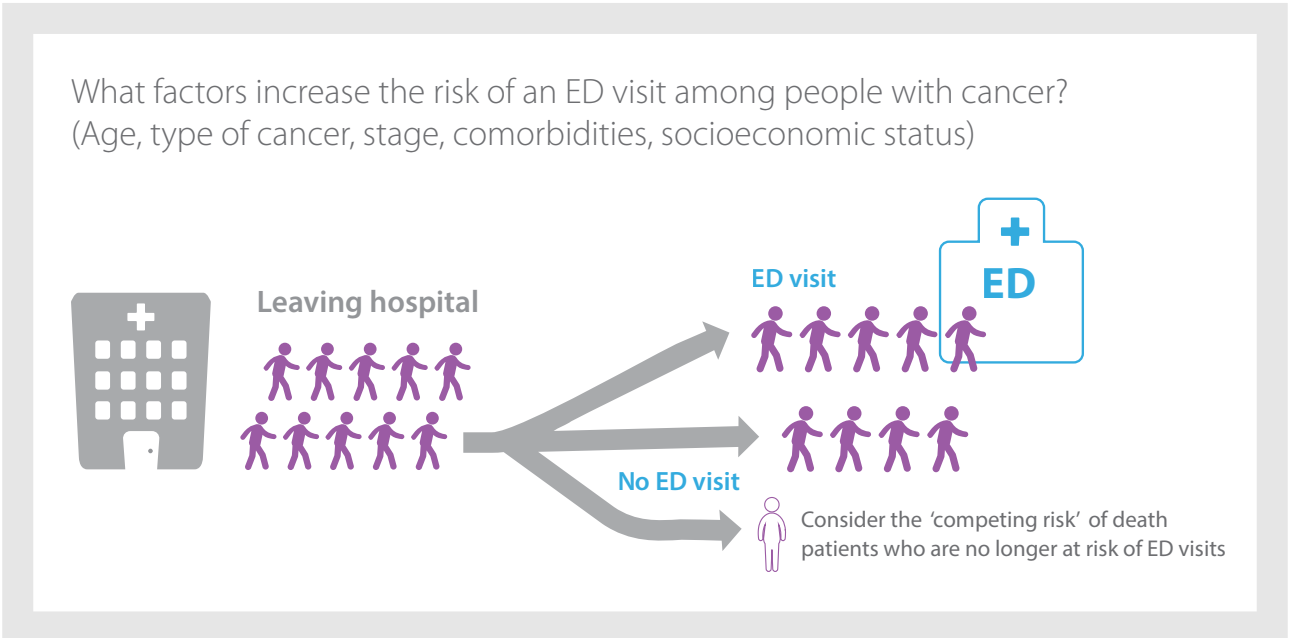


Table 3 Key analytic steps to explore the factors associated with people with cancer visiting an ED

Approach	Rationale & notes
Identify patients diagnosed with invasive cancer between 2006–2009 • Exclude those with date of death prior to date of diagnosis	Data drawn from Central Cancer Registry; linkage key provided by CHeReL. Exclusions to remove coding anomalies and cases outside NSW jurisdiction. CCR only records month and year of diagnosis.
Identify patients with an ED visit in 12 months subsequent to diagnosis • Exclude those with an ED visit >1 day after date of death	During the period of the study, there were some smaller, rural EDs that did not have electronic data and so our dataset is incomplete. To assess the impact of these missing data, a sensitivity analysis was conducted only with patients presenting to major city EDs. Major city EDs have complete electronic data capture and so results for people with cancer who lived in major cities were used to assess whether there were substantive differences between the full data capture subset of people living in major cities and our full cohort. The conclusions drawn were consistent across the two analyses (see page 22 for details).
Investigate comorbidity history of patients	The analysis used a five-year lookback to capture patient comorbidities listed in any hospitalisation in the preceding five years. However 15% of patients had no hospitalisation records in the preceding five years and so no information on comorbidities was available. A sensitivity analysis was conducted which compared our approach (adjusting for those comorbidities for which we have data based on a five-year lookback) with an approach that did not adjust for comorbidities at all. While the sensitivity analysis showed some effects from the inclusion of comorbidities in the model, their exclusion did not substantively change the results. It therefore appears reasonable to include Elixhauser comorbidities with a five year look-back period despite the lack of information about previously unhospitalised patients (see page 21). A lack of access to primary care records precluded more complete comorbidity capture for the entire cohort.
Build a regression model investigating associations between various factors and emergency ED visits	The analysis had to account for the 'competing risk' of death – people who die are no longer at risk of an emergency ED visit. This issue was addressed by using a Fine and Gray competing risk modelling approach (see page 18). Variables included in the multivariable model development were: • Age group at diagnosis • Gender • Indigenous status • Rurality of residence • Socioeconomic status • Cancer clinical group • Extent of disease at diagnosis (stage) • Multiple cancers* • Comorbidities • Year of diagnosis * In the univariate analysis, having a previous cancer was associated with an 18% higher risk of emergency ED visit, however after adjusting for other factors, it was no longer associated with emergency ED visits and was removed from the final model. The final multivariable model is shown in Appendix 3.

Is there variation in the use of EDs by people with cancer following hospitalisation?

Issue: High rates of emergency ED visits can be influenced by a range of factors relating to the appropriateness of care, discharge practices and community services.

The importance: Emergency ED visits within a defined time period (e.g. 28 days) of a cancer hospitalisation can be conceptualised as an outcome measure. Provision of appropriate and effective care both in the hospital and in the community after discharge should minimise the need for ED visits. Not all ED visits following hospitalisation are preventable and many are appropriate. However, wide variations that remain after taking account of patient level factors, can be used to guide efforts to investigate and improve care.

Objective: To ascertain whether, after taking into account patient level factors and case mix, there are NSW hospitals where volumes of ED visits among cancer patients (breast, lung and colorectal cancers only) are significantly different to that predicted by a statistical model.

Our approach: Key steps in the analysis are described in Table 4 (and depicted schematically in Figure 6).

Implications for future work: This study uses a competing risk modelling approach to calculate RSURs, focusing on utilisation of EDs following hospitalisation for cancer. The approach could be applied to a range of conditions and types of service.

Figure 6 Schematic of elements used in the approach

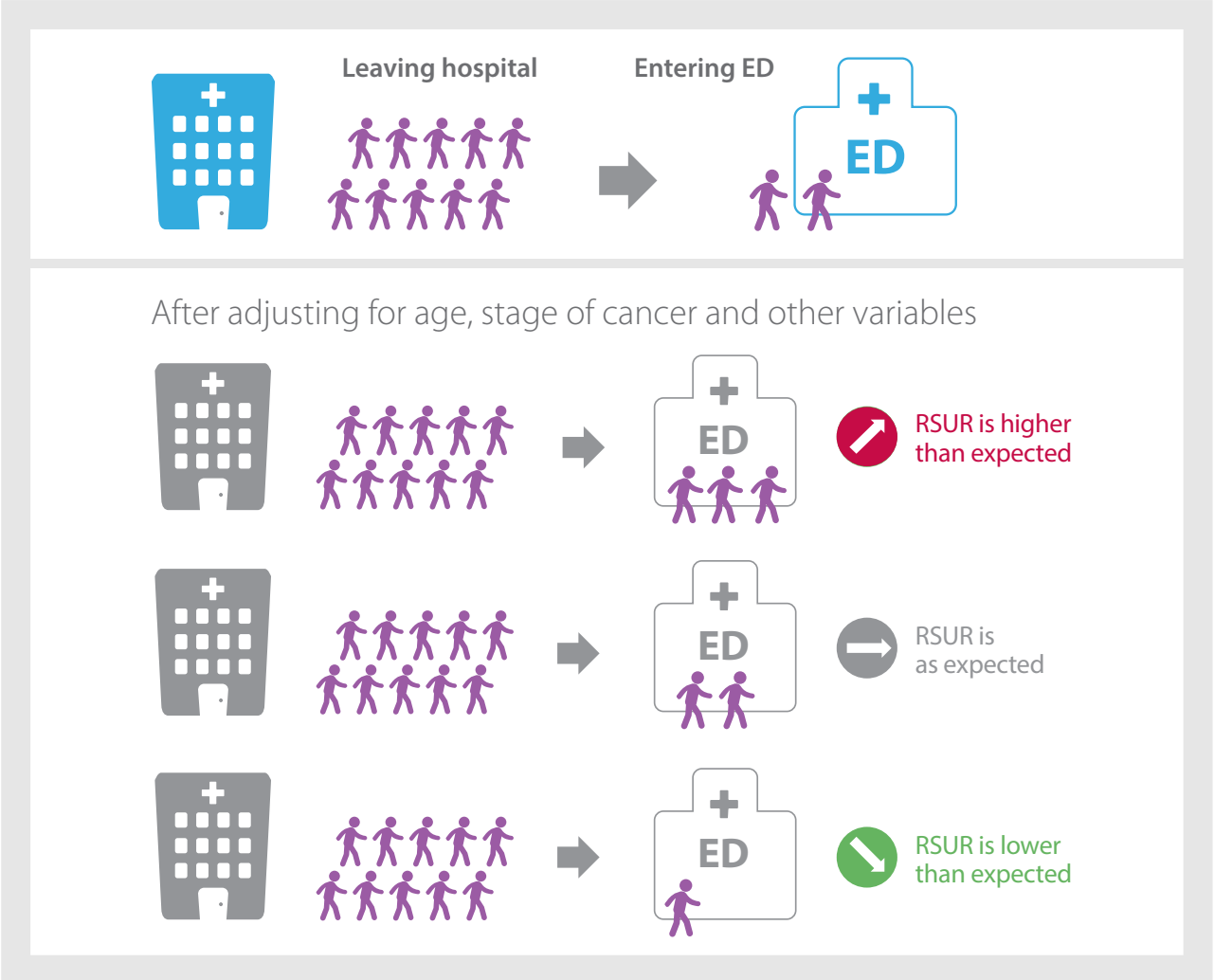


Table 4 Key analytic steps to report RSURs for people with cancer who visit an ED

Approach	Rationale & notes
Identify patients diagnosed with invasive cancer between 2006–2009 • Exclude those with date of death prior to date of diagnosis	Data drawn from Central Cancer Registry; linkage key provided by CHeReL. Exclusions to remove coding anomalies and cases outside NSW jurisdiction (for detailed flowcharts, see Appendices 4–6) CCR only records month and year of diagnosis
Identify patients diagnosed with breast, colorectal and respiratory cancers	The outcome of interest was the first emergency ED presentation within 28 days of discharge from the index admission. Emergency ED presentations that occurred within one year of the cancer diagnosis, as recorded in CCR, were considered. As this analysis sought to reflect on performance of hospitals, it was important to make ED data as exhaustive as possible. During the period of the study, there were some smaller, rural EDs that did not have electronic data and so our dataset is incomplete. Hospitalisation records were therefore used to ascertain patients' route of admission. If admission was through the ED – this information supplemented the electronic ED records. This approach yielded around 200 otherwise unrecorded ED visits for colorectal cancer; around 50 for breast cancer; and around 200 for respiratory cancer.
Assign the emergency ED visit to the discharging hospitals, taking into account transfers and the entire patients' journey within the 28 days	Fine and Gray competing risks regression models were used to find predictors of emergency ED visits within 28 days of discharge. For this, the cohort was randomly divided into a development and a validation sample with two thirds of the cohort in the development sample and one third in the validation sample. The development sample was then used to build the prediction model. The prediction ability of the model was tested in the validation sample. For details on the modelling approach, see pages 18–19. Sensitivity analyses are described on pages 22–23. The final multivariable models are shown in Appendices 4–6.
Calculate a risk-standardised ED visit ratio of observed/expected ED visits	Around 1% of the breast cancer, 6% of the colorectal cancer, and 12% of the respiratory cancer index hospitalisations recorded the stage of diagnosis as 'unknown'. Results from a sensitivity analysis were consistent when exclusion and inclusion of these records was compared. Given this, those with an unknown stage at diagnosis were included in the final model. However records for patients with an unknown stage of diagnosis, as recorded in CCR, were excluded from calculation of specific hospital RSURs (see page 22).
Present results using a funnel plot to take account of different patient volumes	Hospitals with relatively small numbers of patients with a condition may have high or low ratios simply by chance. Funnel plots were used to identify those hospitals that individually have a low probability of being high or low simply by chance.

Attribution and patient flows

This project conceptualises emergency ED visits in three main ways:

- As a service provided (utilisation)
- As a process of care
- As an outcome

When used as an outcome measure, data provide information beyond description to reflect on healthcare performance.

For example, after taking into account case mix, a pattern of high volumes of ED visits in the 28 days following discharge from cancer hospitalisations may raise questions about discharge practices, provision of appropriate patient information, or availability of follow-up and support services.

Hospitalisations are the unit of analysis for this study. An emergency ED visit made by a transferred patient should only be recorded once. The question of which facility the outcome should be attributed to is a decision that is made carefully.

The underlying premise of this area of study is that a proportion of emergency ED visits made in the 28 days following an acute hospitalisation for colorectal, breast or lung cancer are potentially avoidable. Optimal care would keep such visits to a minimum. Not all visits are avoidable, and many are appropriate. However, when they occur they should be a reflection of patient factors, rather than any variation in care provided.

The study is therefore focused on variation in patterns of emergency ED visits – after taking account of patient level factors.

Emergency ED visits are attributed to the discharging hospital – using the assumption that it is that facility's responsibility to ensure that patients are well enough to leave.

Hospitalisations that were defined as 'index admissions' – i.e. those from which discharge represented the 'starting point' for the 28-day period of study were: acute periods of care with a primary diagnosis of cancer of interest (colorectal, respiratory or breast) among patients (aged 18+ years) diagnosed with the cancer of interest between 2006 and 2009 (as recorded in CCR).

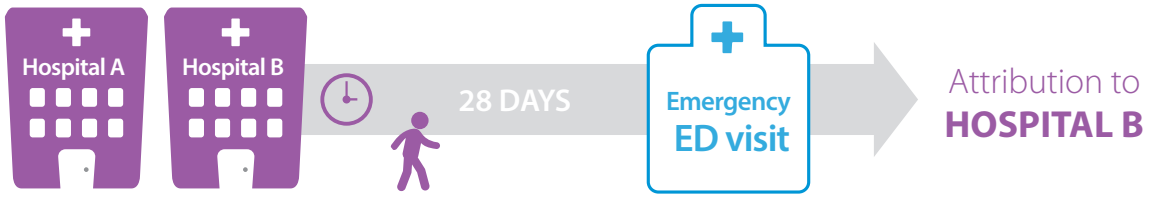
Only those periods of care that occurred within one year of diagnosis of the cancer were included. Appendices 4, 5 and 6 detail the exclusions to the cohorts.

Other attribution decisions were:

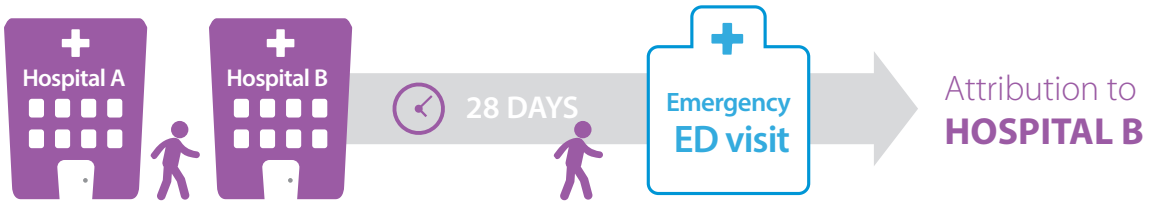
- In the case of transfers, index periods of care and their outcome are attributed to the last hospital that discharged the patient to a non-acute care setting
- If an emergency ED visit occurred in the 28 days following two or more index hospitalisations, the ED visit is attributed to the last index hospitalisation
- When there was a day-only hospitalisation in the 28 days following discharge from the index admission, and preceding the first emergency ED visit, the day only visit is not considered in the analysis
- Where there was a non-index overnight acute rehospitalisation in the 28 days following discharge from the index admission, and preceding the first emergency ED visit, no outcome is assigned to that index admission (Figure 7).

Figure 7 Schematic of attribution decisions

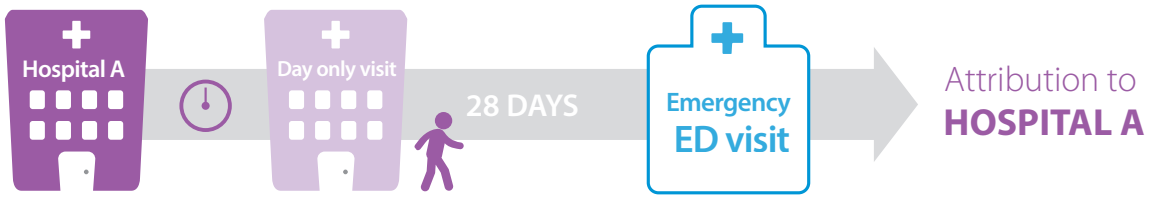
In cases of patient transfers, emergency ED visits are attributed to the hospital from which the index case was discharged.



In cases where an ED presentation occurs within 28 days of two or more index acute hospitalisations, the emergency ED visit is attributed to the last index hospitalisation.



In cases where there was a day-only hospitalisation in the 28 days following discharge from the index admission, and preceding the first emergency ED visit, the ED visit is attributed to the index hospitalisation.



In cases where there is a non-index overnight acute hospitalisation (e.g. non-cancer) within 28 days of discharge from the index admission and preceding a emergency ED visit, no outcome is assigned to that index admission.

Statistical modelling

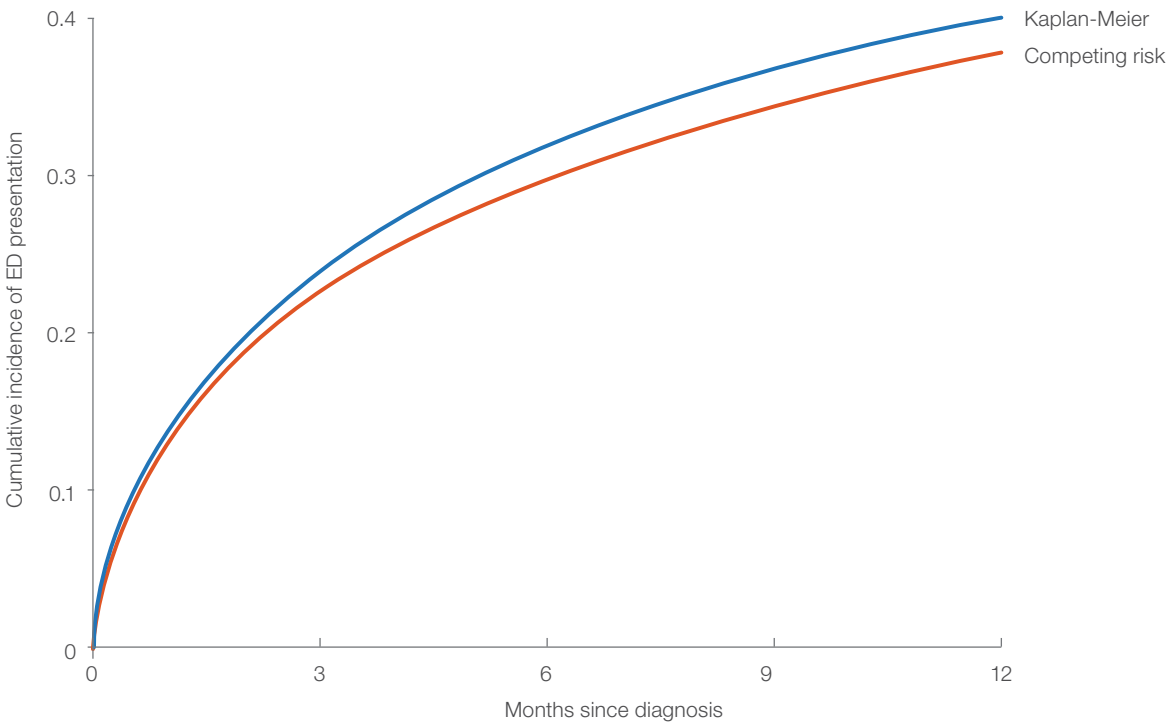
Statistical modelling approaches such as multivariable regression models that estimate associations between patient factors (e.g. age and comorbidities) with an event of interest (e.g. readmission or death) for a population of patients can be used to help inform assessments of hospital performance.

Models can determine the expected number of events for a particular hospital based on the case mix of patients treated there. Insights into performance are revealed when this expected number is compared with the actual number of events that occurred. Hospitals with significantly higher or lower than expected performance can be identified.

Conceptually, the statistical modelling work in this project is a survival analysis. Standard survival analysis is concerned to capture the time to an event of interest (e.g. an emergency ED visit).

A patient who has not experienced the event at the end of the study period is said to be censored. In censoring, the event of interest may still occur, however its occurrence is beyond the time period of study. To determine the risk of an emergency ED visit having occurred by a certain time, a fundamental assumption is that such censoring is not associated with an altered chance of the event occurring at any given moment. If a patient dies however, the censoring assumption is violated (the chance of an ED visit is now zero). Any event which causes censoring and is associated with an altered chance of the event of interest occurring has to be treated as a competing event. Deaths are obvious competing events in this analysis.[23]

Figure 8 Comparing cumulative probabilities of ED presentations in the 12 months following diagnosis of cancer using competing risk methods and standard Kaplan–Meier methods



Dealing with competing risks in statistical analyses

Competing risks are events that prevent an event of interest from occurring. Not taking into account the competing risk of death can cause an overestimation of cumulative incidence.

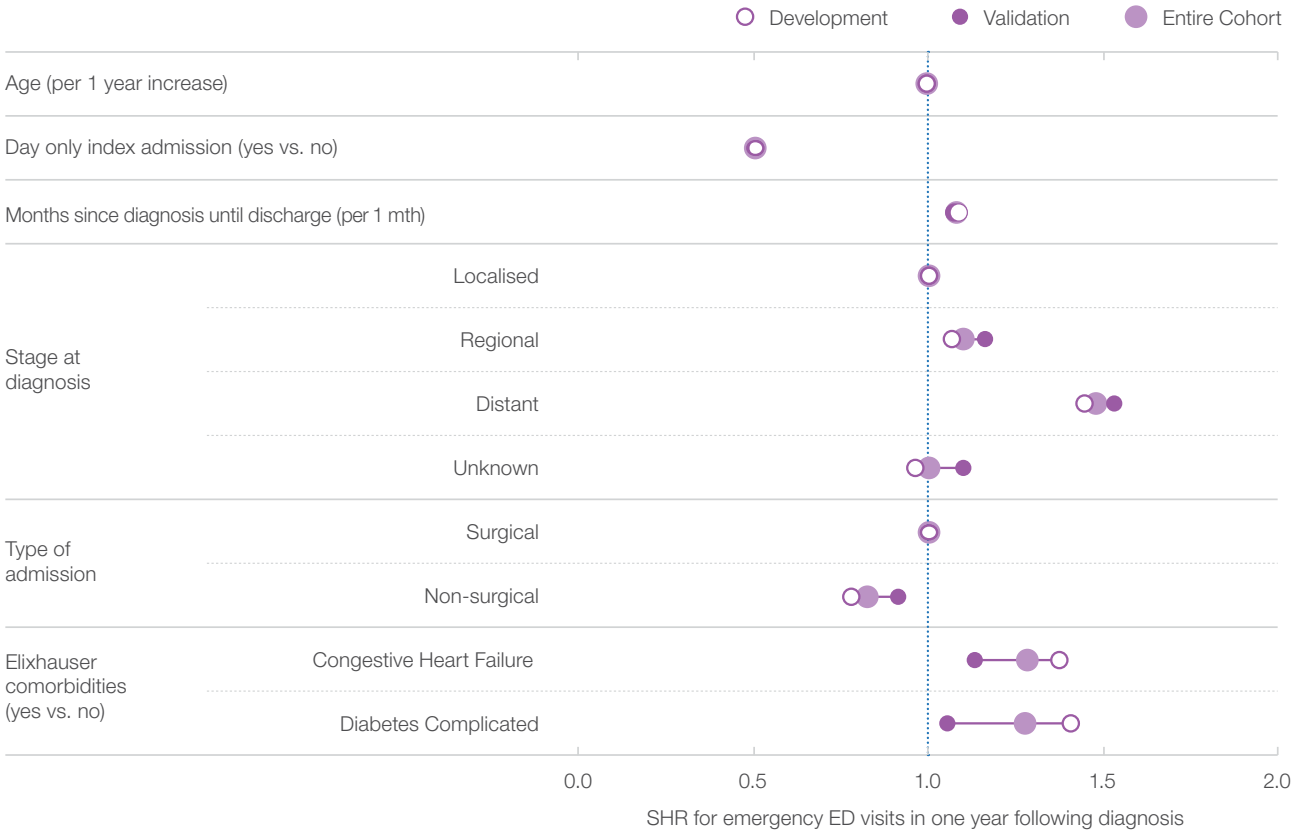
The cumulative incidence function is the probability that the event of interest occurs before a given time. The calculated incidence is conditional on the competing risk not occurring at each time point.

Fine and Gray model[24] computes subhazard ratios (SHR). Covariates affect the subhazard proportionally.[i]

In order to build the competing risks model for RSUR, the total cohort was randomly divided into two groups: two-thirds were used as a development sample and one-third served as a validation sample (for validation analysis, see Figure 9). A backward selection approach was used for building multivariable models for each of three cancer groups of interest: colorectal, breast and lung.

Variables that were significant at 20 percent level were included in the initial analysis. The following factors were considered age, sex, months elapsed between cancer diagnosis and discharge, multiple cancer, stage at diagnosis, type of admission (surgical/non-surgical), day only admission, and Elixhauser comorbidities (excluding metastatic cancer and the cancer under consideration). Only variables with a 2-sided p-value of less than 0.05 in the multivariable model were retained in the final model. Final prediction models for the three cancer groups, showing subhazard ratios and confidence intervals are shown in Appendices 4-6.

Figure 9 Comparing the development sample, validation sample and entire cohort, colorectal cancer



i Competing risks methods limit analysis to time to first event only and are not sensitive to multiple events.

Risk adjustment

The model computes the risk of an emergency ED visit, based on patient characteristics. It has been used in two ways in this project:

1. To identify patient factors associated with increased risk of ED visits by people with cancer
2. To provide a measure of hospital performance where the risk for each hospital's patients are summed and expressed as the 'expected' number of emergency ED visits – to be compared with the actual number of visits.

There are different methods available to adjust for comorbidities such as the Charlson or Elixhauser indices. The Elixhauser Index (Figure 10) with a five year lookback was used in the analysis that sought to ascertain factors associated with ED visits; while a one-year lookback was used in the predictive modelling to reflect on hospital performance.

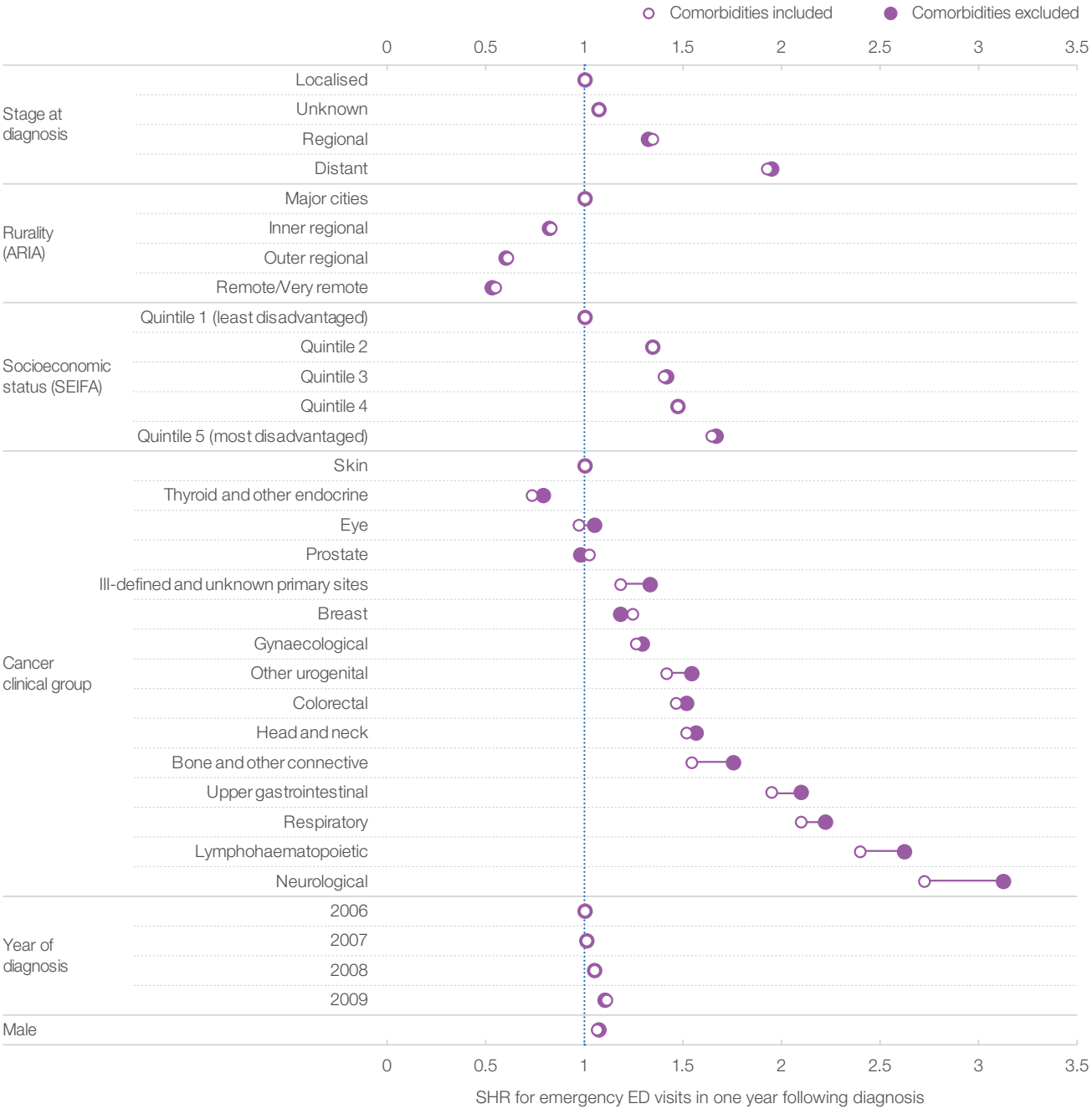
The lookback information includes comorbidities identified from admissions to any NSW hospital prior to and including the date of diagnosis or discharge. Some cancer patients (15%) were not hospitalised in the lookback period and therefore there was no information available regarding their comorbidities. In this case, their comorbidity status was set to unknown.

A sensitivity analysis was performed because of concerns regarding the effect of the incomplete capture of comorbidities that occurred for these patients. The sensitivity analysis sought to compare the model that adjusted for comorbidities for which we have data with a model that did not adjust for comorbidities. While the sensitivity analysis revealed there were some effects from including comorbidities in the model, their exclusion did not substantively change the results. Therefore, it appears to be reasonable to include Elixhauser comorbidities with a five year lookback period despite the lack of information about patients who were not previously hospitalised (Figure 11).

Figure 10 Elixhauser comorbidities

Congestive Heart Failure	AIDS/HIV
Cardiac Arrhythmia	Lymphoma
Valvular Disease	Metastatic Cancer
Pulmonary Circulation Disorders	Solid Tumour without Metastasis
Peripheral Vascular Disorders	Rheumatoid Arthritis/collagen
Hypertension Uncomplicated	Coagulopathy
Hypertension Complicated	Obesity
Paralysis	Weight Loss
Other Neurological Disorders	Fluid and Electrolyte Disorders
Chronic Pulmonary Disease	Blood Loss Anaemia
Diabetes Uncomplicated	Deficiency Anaemia
Diabetes Complicated	Alcohol Abuse
Hypothyroidism	Drug Abuse
Renal Failure	Psychoses
Liver Disease	Depression
Peptic Ulcer Disease excluding bleeding	

Figure 11 Sensitivity analysis including and excluding comorbidities, all cancer hospitalisations



Sensitivity analyses

The four main objectives for this project involved a series of data inclusion decisions. The decisions made are outlined in Tables 1–4.

Three sensitivity analyses that informed decisions are illustrated on these pages. Data are shown for an exemplar cancer cohort in each of the sensitivity analyses – the full suite of graphs for each condition is available on request.

The sensitivity analyses:

1. Investigated the impact of excluding year of diagnosis from the model. Year of diagnosis was excluded in order to avoid adjusting for real changes in care provided by hospitals over time (Figure 12)
2. Investigated the impact of retaining unknown stage of diagnosis in the prediction model (Figure 13)
3. Investigated the likely impact of a lack of electronic ED records in rural EDs on SHRs and conclusions (major cities) (Figure 14).

Figure 12 Sensitivity analysis RSURs – exclusion of year of diagnosis, breast cancer

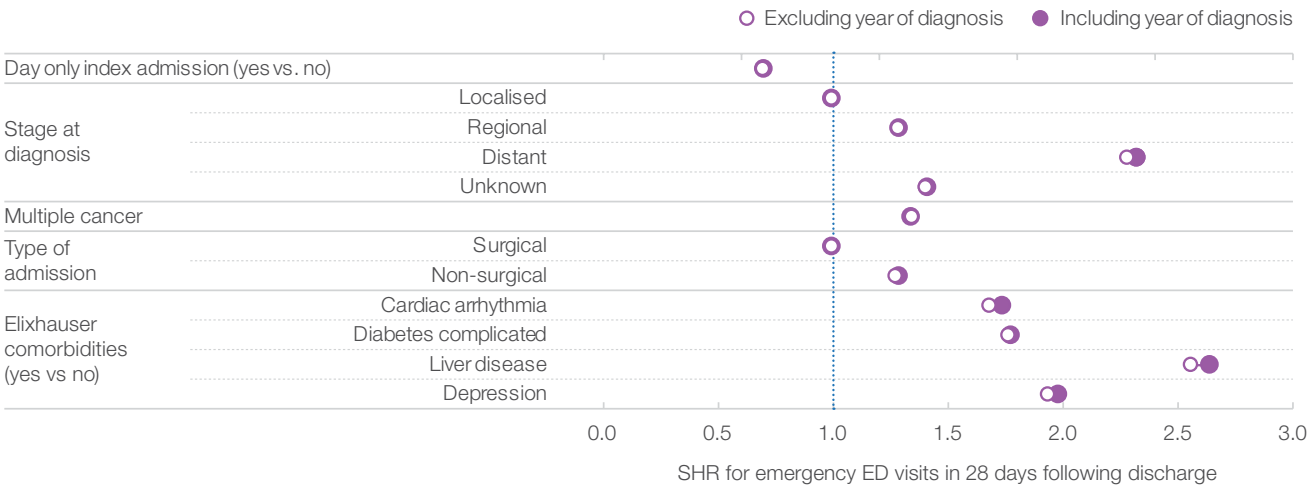


Figure 13 Sensitivity analysis RSURs – inclusion of unknown stage at diagnosis, respiratory cancer

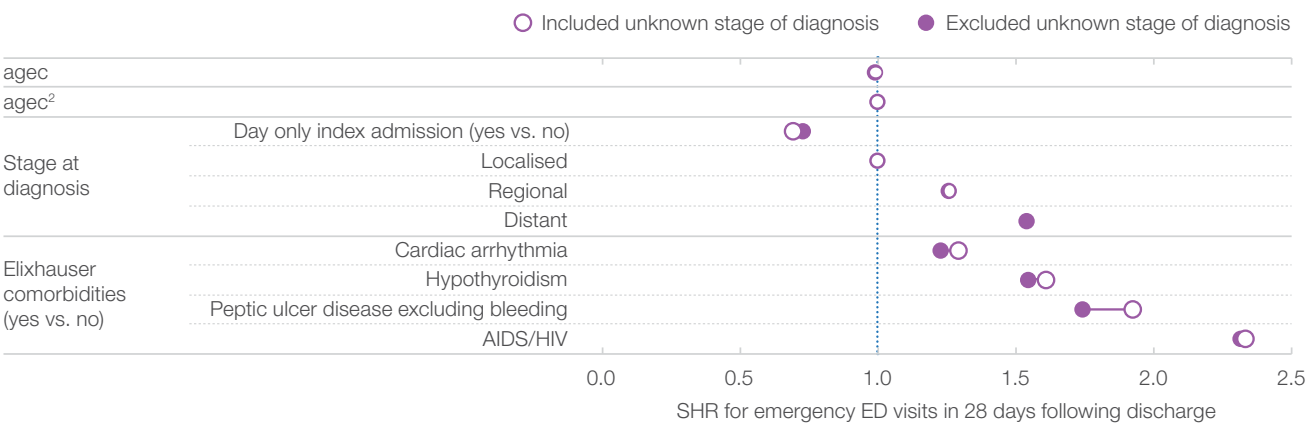
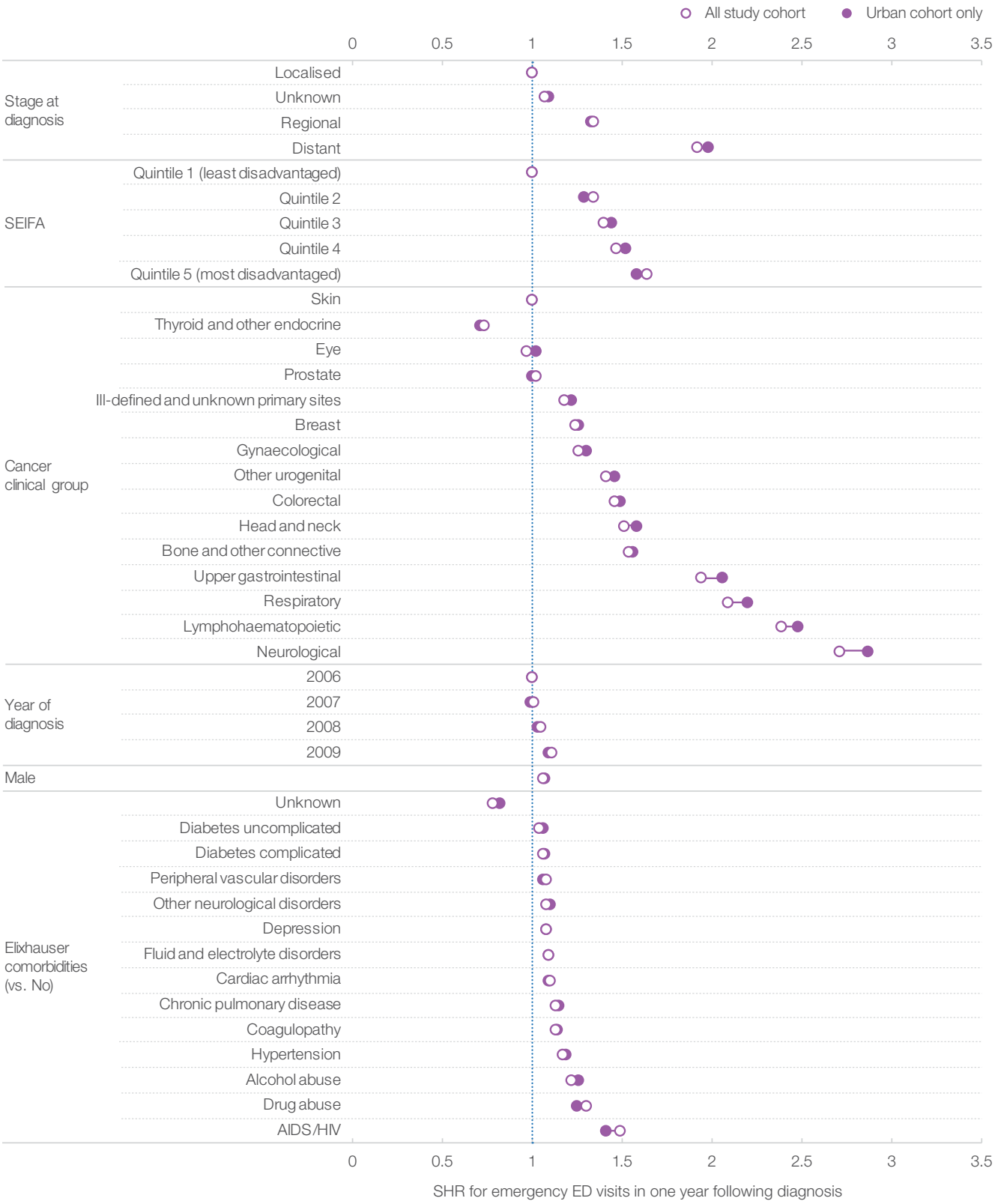


Figure 14 Sensitivity analysis – consistency of SHRs (factors associated with ED visits) for major city residents vs total cohort, all cancers



Public and private hospitals

People with cancer are hospitalised in both public and private hospitals (Figure 15). This report focuses on the performance of public hospitals and the way that people with cancer use public hospital EDs.

Sensitivity analyses suggest that private hospital patients differ from public hospital patients in systematic ways that our adjustment does not capture. These differences would confound our analysis. They include:

- Differences in the proportion of patients that are day only, rather than overnight admissions. For example, for colorectal cancer hospitalisations in public hospitals 17% of admissions were day only compared with 41% of admissions in private hospitals (Figure 16).
- Different coding practices for chemotherapy and radiotherapy. In the NSW public sector, chemotherapy is provided in non-inpatient clinics (approximately 100,000 occasions of service per year) and is generally not captured in the available datasets. Almost all day only hospitalisations for chemotherapy and radiotherapy occur in private hospitals.
- Our data are not sensitive to differences in arrangements for out of hours care across the two sectors – for example we have no data on private hospital ED visits.

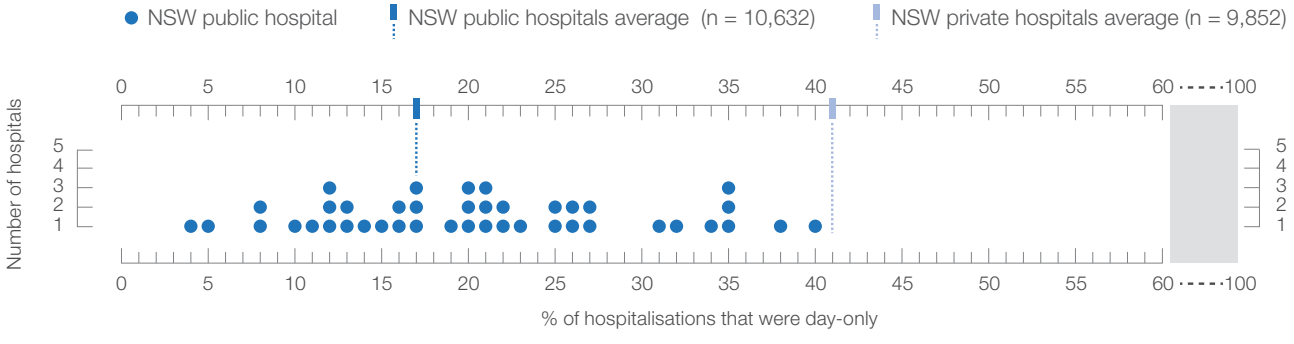
Sensitivity analyses were conducted to assess the impact of excluding private hospital data. Exclusion led to significant changes both in RSURs and in the number of outlier hospitals. This is due to the change in the cohort used as the NSW reference, and recalculation of expected number of ED visits for each hospital based on the new NSW average.

The exclusions of private hospital data meant that among public hospitals, fewer were identified as outliers (Figures 17 and 18).

Figure 15 Distribution of hospitalisations for colorectal, breast and respiratory cancers, public and private hospitals in NSW, 2006–2009 (no exclusions)

	Public hospitalisations	Private hospitalisations
Colorectal cancer	12,816 (56%)	10,064 (44%)
Breast cancer	8,447 (44%)	10,924 (56%)
Respiratory cancer	9,294 (74%)	3,239 (26%)

Figure 16 Proportion of hospitalisations that were day only admissions, colorectal cancer, NSW public hospitals, 2006–2009 [a,b]



a. Hospitals with fewer than 50 hospitalisations are not shown.
b. Individual private hospitals are not plotted. The overall proportion for private hospitals is shown for reference only.

Figure 17 Risk-adjusted utilisation ratios (RSURs), ED visits, following discharge from NSW hospitals (public and private), breast cancer

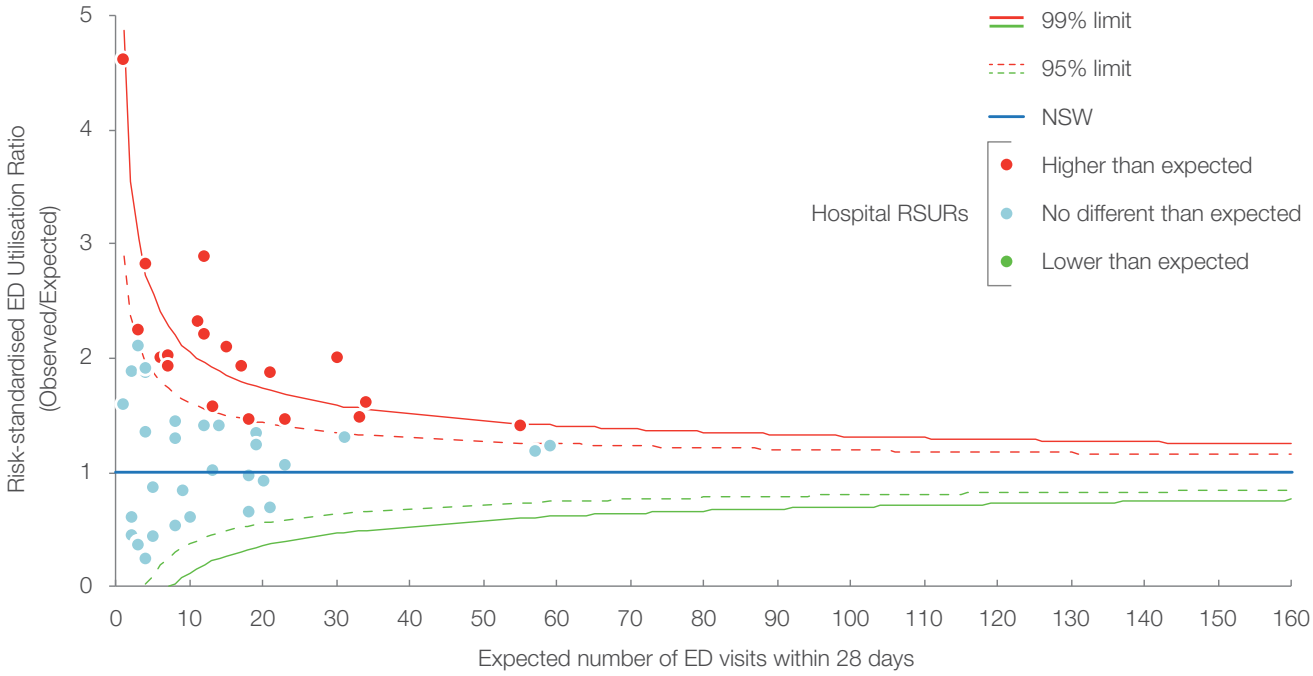
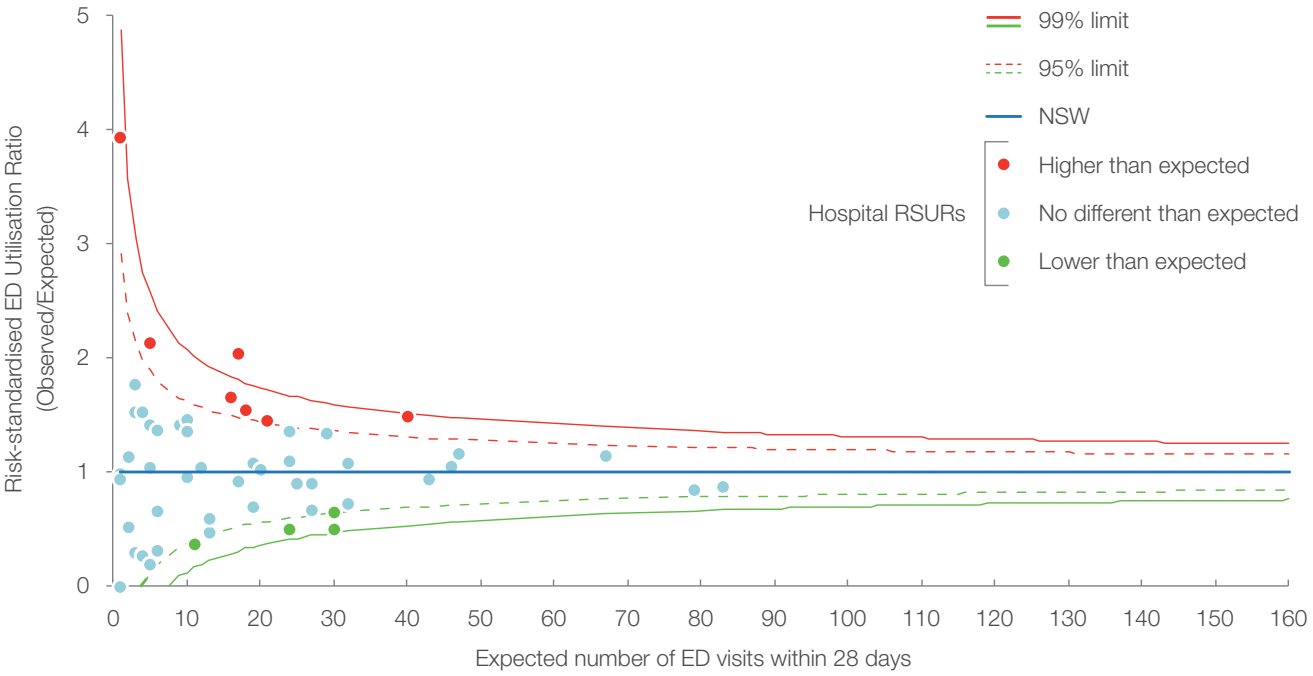


Figure 18 Risk-adjusted utilisation ratios (RSURs), ED visits, following discharge from NSW public hospitals only, breast cancer



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Appendix 1

Clinical groupings

Clinical Group	Report Code	ICD-10AM
Skin	C00, C43, C46	Lip (ICD-O-3 C00), Melanoma of skin (ICD-O-3 C44 and M872-M879), Kaposi's sarcoma (M914)
Head and Neck	C01, C02, C03-C06, C07, C08, C09, C10, C11, C14, C12, C13, C30, C31, C32	Tongue (ICD-O-3 C01,C02), Mouth (ICD-O-3 C03-C06), Salivary glands (ICD-O-3 C07,C08), Oropharynx (ICD-O-3 C09,C10), Nasopharynx (ICD-O-3 C11), Hypopharynx (ICD-O-3 C12,C13), Other oral cavity & pharynx (ICD-O-3 C14), Nose, sinuses, etc (ICD-O-3 C30, C31), Larynx (ICD-O-3 C32)
Upper Gastrointestinal	C15, C16, C17, C22,C23, C24, C25	Oesophagus (ICD-O-3 C15) , Stomach (ICD-O-3 C16), Small intestine (ICD-O-3 C17), Liver (ICD-O-3 C22), Gallbladder (ICD-O-3 C23,C24), Pancreas (ICD-O-3 C25)
Colorectal	C18, C19, C20, C21	Colon (ICD-O-3 C18), Rectum, rectosigmoid, anus (ICD-O-3 C19-C21)
Respiratory	C33,34,C37, C38, C45	Lung (ICD-O-3 C33, C34), Other thoracic organs (ICD-O-3 C37,C38), Mesothelioma (M905)
Bone and other connective tissue	C40, C41, C47, C49	Bone (ICD-O-3 C40,C41), Connective tissue, peripheral nerves (ICD-O-3 C47,C49)
Breast	C50	Breast (ICD-O-3 C50)
Prostate	C61	Prostate(ICD-O-3 C61)
Other urogenital	C60, C62, C63, C64, C66, C67, C68	Testis (ICD-O-3 C62), Other male genital organs (ICD-O-3 C60,C63), Kidney (ICD-O-3 C64-C66,C68) ,Bladder (ICD-O-3C67)
Gynecological	C53, C54, C55, C56, C57, C58, C59	Cervix (ICD-O-3 C53), Uterus, Body & NOS (ICD-O-3 C54,C55), Ovary (ICD-O-3 C56,C57.0-7), Placenta (ICD-O-3 C58), Other female genital organs (ICD-O-3 C51,C52,C57.8-9)
Eye	C69	(ICD-O-3 C69)
Neurological	C70, C71, C72	Brain (ICD-O-3 C71), C72 Central nervous system (ICD-O-3 C70,C72)
Thyroid and other endocrine	C73, C74, C75	Thyroid (ICD-O-3 C73), Other endocrine glands (ICD-O-3 C74,C75)
Lymphohaematopoeitic	C81, C82, C88, C90, C91, C92, C95, M95, M96	Hodgkin's disease (M965-M966), Non-Hodgkin's lymphoma (M959,M967-M972,M974), Multiple myeloma (M973,M976), Acute lymphoblastic leukaemia (M9821), Other lymphoid leukaemias (M9820,M9822-M9827,M994), Acute myeloid leukaemia (M9861), Other myeloid leukaemia (M9860,M9862-8,M987-M988,M9930,M9987), Other specified leukaemias (M984,M985,M989-M993), Unspecifi ed leukaemias (M980), Myeloproliferative disorders, Myelodysplasia (M998)
Ill-defined and unknown primary sites	C26, C39, C48, C76, C80	Other and ill defined digestive organs (ICD-O-3 C26), Other and ill defined respiratory (ICD-O-3 C39), Retroperitoneum and peritoneum (ICD-O-3 C48), Other and ill defined sites (ICD-O-3 C76), Unknown primary site (ICD-O-3 C80)

Appendix 2

Characteristics of patients diagnosed with invasive cancer in NSW, 2006–2009

Characteristics	Total patients %	Patients with ED presentation* %
Total	141461 (100)	56262 (100)
Median age (IQR)	67 (57–77)	69 (58–78)
Sex		
Female	43.27	43.24
Male	56.73	56.76
Year of diagnosis		
2007	23.84	23.84
2008	24.60	24.25
2009	25.39	25.29
2010	26.17	27.00
Cancer clinical group		
Skin	10.71	6.06
Head and neck	2.63	2.88
Upper Gastrointestinal	7.44	10.61
Colorectal	12.97	14.25
Respiratory	9.82	14.79
Bone and other connective	0.64	0.72
Breast	12.2	10.05
Gynaecological	3.98	3.74
Prostate	18.48	12.21
Other urogenital	5.23	5.45
Eye	0.25	0.18
Neurological	1.43	2.19
Thyroid and other endocrine	2.08	1.19
Lymphohaematopoietic	9.25	12.39
Ill-defined and unknown primary sites	2.88	3.29
Stage at diagnosis		
Localised	41.94	32.24
Regional	18.49	20.32
Distant	14.79	22.26
Unknown	24.78	25.18
More than one cancer record	10.04	11.29

Characteristics	Total patients %	Patients with ED presentation* %
Elixhauser comorbidities**		
Unknown	15.31	10.45
Congestive Heart Failure	4.94	6.81
Cardiac Arrhythmia	11.22	14.65
Valvular Disease	2.44	3.27
Pulmonary Circulation Disorders	2.05	2.95
Peripheral Vascular Disorders	3.52	4.88
Hypertension Uncomplicated	23.57	29.86
Hypertension Complicated	0.30	0.44
Paralysis	2.27	3.09
Other Neurological Disorders	3.10	4.33
Chronic Pulmonary Disease	7.49	10.41
Diabetes Uncomplicated	6.59	8.33
Diabetes Complicated	9.05	12.13
Hypothyroidism	1.06	1.44
Renal Failure	4.01	5.70
Liver Disease	2.21	3.15
Peptic Ulcer Disease excluding bleeding	1.48	1.95
AIDS/HIV	0.10	0.16
Rheumatoid arthritis/collagen	1.20	1.55
Coagulopathy	2.23	3.27
Obesity	2.30	2.93
Weight Loss	2.15	2.93
Fluid and Electrolyte Disorders	8.69	11.94
Blood Loss Anaemia	0.77	1.03
Deficiency Anaemia	3.68	4.77
Alcohol Abuse	2.58	3.75
Drug Abuse	0.54	0.84
Psychoses	0.58	0.80
Depression	2.65	3.57
ARIA		
Major Cities	67.63	70.21
Inner Regional	24.08	23.14
Outer Regional	7.74	6.23
Remote/Very Remote	0.55	0.42
Unknown	0.01	0.01
SEIFA		
Quintile 1 (least disadvantaged)	20.52	16.77
Quintile 2	17.72	18.20
Quintile 3	20.50	21.04
Quintile 4	22.69	23.25
Quintile 5 (most disadvantaged)	18.56	20.72
Unknown	0.01	0.01

*Emergency presentations within one year following cancer diagnosis; **using 5 years lookback since 28th of the month of diagnosis

Appendix 3

Factors associated with emergency ED presentation in the year following diagnosis, using Fine and Gray competing risks regression models

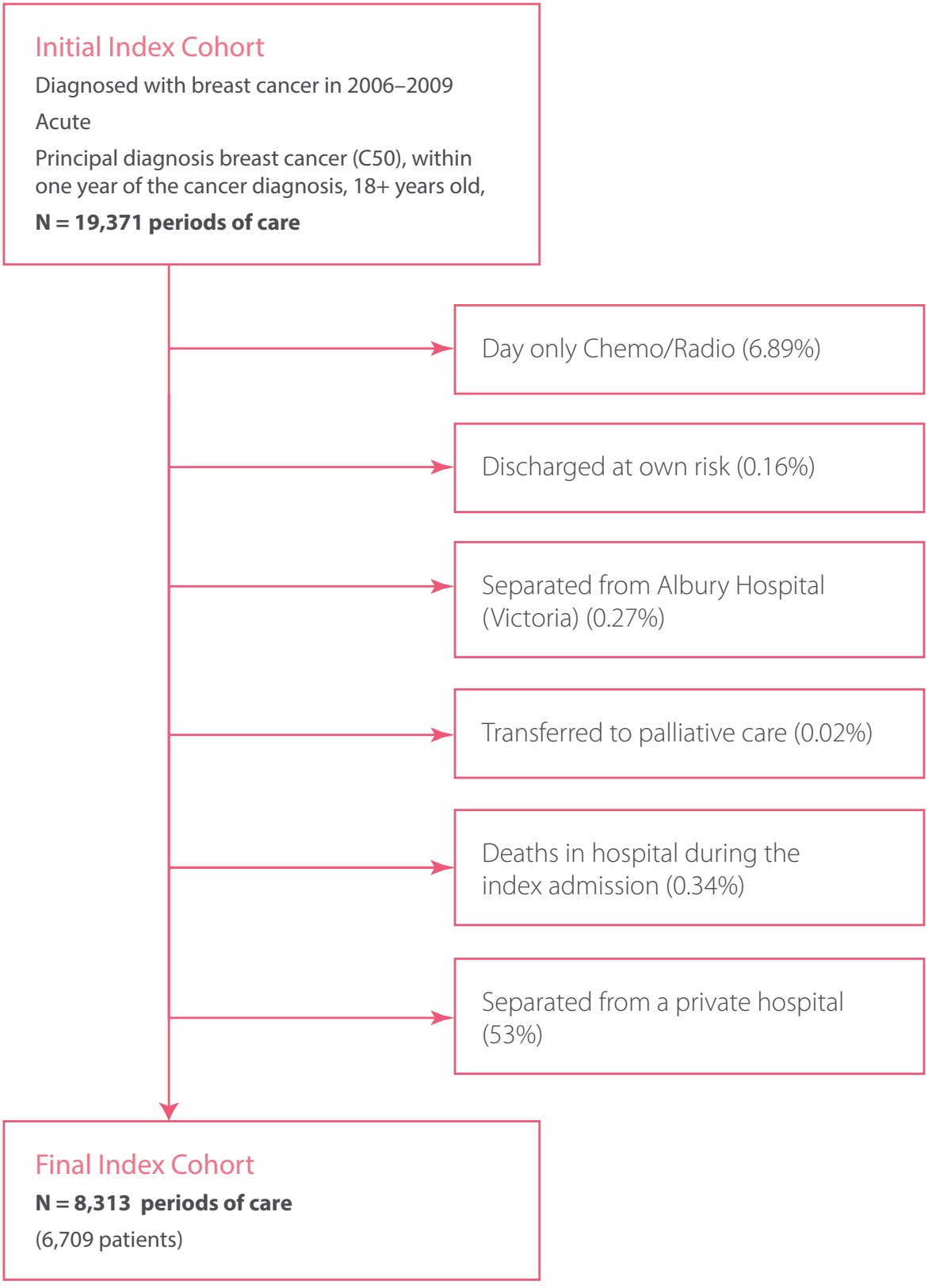
	MULTIVARIABLE ANALYSIS		
Predictor	**Subhazard ratio**	**(95%CI)**	**p value**
Male	1.06	(1.04–1.08)	<0.001
Agec*	1.0001	(0.999–1.001)	0.832
Agec2	1.0002	(1.0002–1.0003)	<0.001
Year of diagnosis			
2006	1.00	–	–
2007	1.01	(0.99–1.04)	0.387
2008	1.05	(1.02–1.08)	<0.001
2009	1.11	(1.08–1.13)	<0.001
Cancer clinical group			
Skin	1.00	–	–
Head and neck	1.51	(1.43–1.60)	<0.001
Upper Gastrointestinal	1.94	(1.85–2.03)	<0.001
Colorectal	1.46	(1.40–1.52)	<0.001
Respiratory	2.09	(2.00–2.19)	<0.001
Bone and other connective	1.54	(1.39–1.70)	<0.001
Breast	1.24	(1.18–1.29)	<0.001
Gynaecological	1.26	(1.19–1.34)	<0.001
Prostate	1.02	(0.97–1.06)	0.457
Other urogenital	1.41	(1.35–1.48)	<0.001
Eye	0.97	(0.80–1.18)	0.794
Neurological	2.71	(2.52–2.91)	<0.001
Thyroid and other endocrine	0.73	(0.67–0.79)	<0.001
Lymphohaematopoietic	2.39	(2.28–2.50)	<0.001
Ill-defined and unknown primary sites	1.18	(1.10–1.26)	<0.001
Stage at diagnosis			
Localised	1.00	–	–
Regional	1.34	(1.30–1.37)	<0.001
Distant	1.92	(1.87–1.97)	<0.001
Unknown	1.07	(1.04–1.09)	<0.001

* age is centred around mean. Results have been adjusted for Aboriginal status

	MULTIVARIABLE ANALYSIS		
Predictor	**Subhazard ratio**	**(95%CI)**	**p value**
ARIA			
Major Cities	1.00	–	–
Inner Regional	0.83	(0.82-0.85)	<0.001
Outer Regional	0.61	(0.59-0.64)	<0.001
Remote/Very Remote	0.55	(0.48-0.62)	<0.001
Unknown	1.05	(0.30-3.63)	0.940
SEIFA			
Quintile 1 (least disadvantaged)	1.00	–	–
Quintile 2	1.34	(1.30–1.38)	<0.001
Quintile 3	1.40	(1.36–1.44)	<0.001
Quintile 4	1.47	(1.43–1.51)	<0.001
Quintile 5 (most disadvantaged)	1.64	(1.59–1.69)	<0.001
Unknown	omitted		
Elixhauser comorbidities (vs. No)			
Cardiac Arrhythmia	1.10	(1.07–1.13)	<0.001
Unknown	0.78	(0.76–0.80)	<0.001
Valvular Disease	1.07	(1.01–1.13)	0.018
Pulmonary Circulation Disorders	1.09	(1.03–1.16)	0.003
Peripheral Vascular Disorders	1.08	(1.03–1.12)	0.001
Hypertension	1.17	(1.15–1.20)	<0.001
Other Neurological Disorders	1.08	(1.03–1.13)	0.003
Chronic Pulmonary Disease	1.13	(1.10–1.17)	<0.001
Diabetes Uncomplicated	1.04	(1.01–1.08)	0.020
Diabetes Complicated	1.06	(1.02–1.10)	0.002
Renal Failure	1.08	(1.03–1.13)	0.001
AIDS/HIV	1.49	(1.16–1.91)	0.002
Coagulopathy	1.13	(1.06–1.19)	<0.001
Fluid and Electrolyte Disorders	1.09	(1.05–1.12)	<0.001
Alcohol Abuse	1.22	(1.16–1.28)	<0.001
Drug Abuse	1.30	(1.17–1.44)	<0.001
Depression	1.08	(1.02–1.14)	0.004

Appendix 4

Cohort and prediction model for risk-standardised utilisation ratio (RSUR) – breast cancer



Emergency ED visits within 28 days following discharge from hospital, breast cancer

Prediction model developed in the development sample, using Fine and Gray competing risks regression models

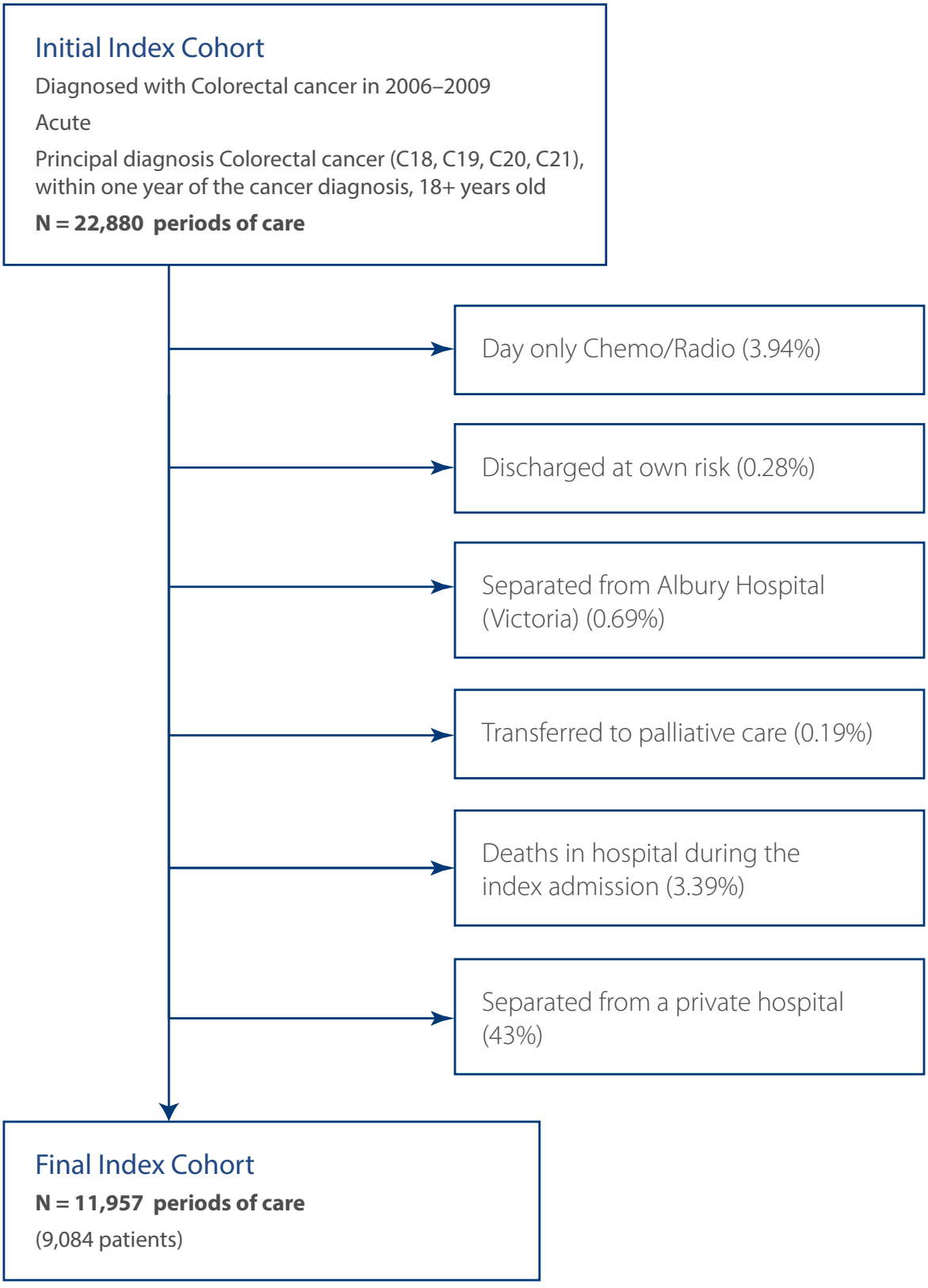
Predictors	Subhazard ratio	(95% CI)	p value
Day only index admission (yes vs. no)	0.61	(0.48-0.77)	<0.001
Stage at diagnosis			
Localised	1.00	–	–
Regional	1.32	(1.13-1.54)	<0.001
Distant	1.60	(1.27-2.02)	<0.001
Unknown	1.18	(0.71-1.95)	0.525
Type of admission [1]			
Surgical	1.00	–	–
Non-surgical	1.30	(1.04-1.61)	0.021
Elixhauser comorbidities (yes vs no)			
Cardiac arrhythmia	1.51	(1.04-2.18)	0.030
Diabetes complicated	1.50	(1.28-1.76)	<0.001
Liver disease	2.13	(1.35-3.38)	0.001
Depression	1.64	(1.05-2.54)	0.029

1. Periods of care with a missing type of admission are excluded

C-statistic: 0.5972

Appendix 5

Cohort and prediction model for risk-standardised utilisation ratio (RSUR) – colorectal cancer



Emergency ED visits within 28 days following discharge from hospital, colorectal cancer

Prediction model developed in the development sample, using Fine and Gray competing risks regression models

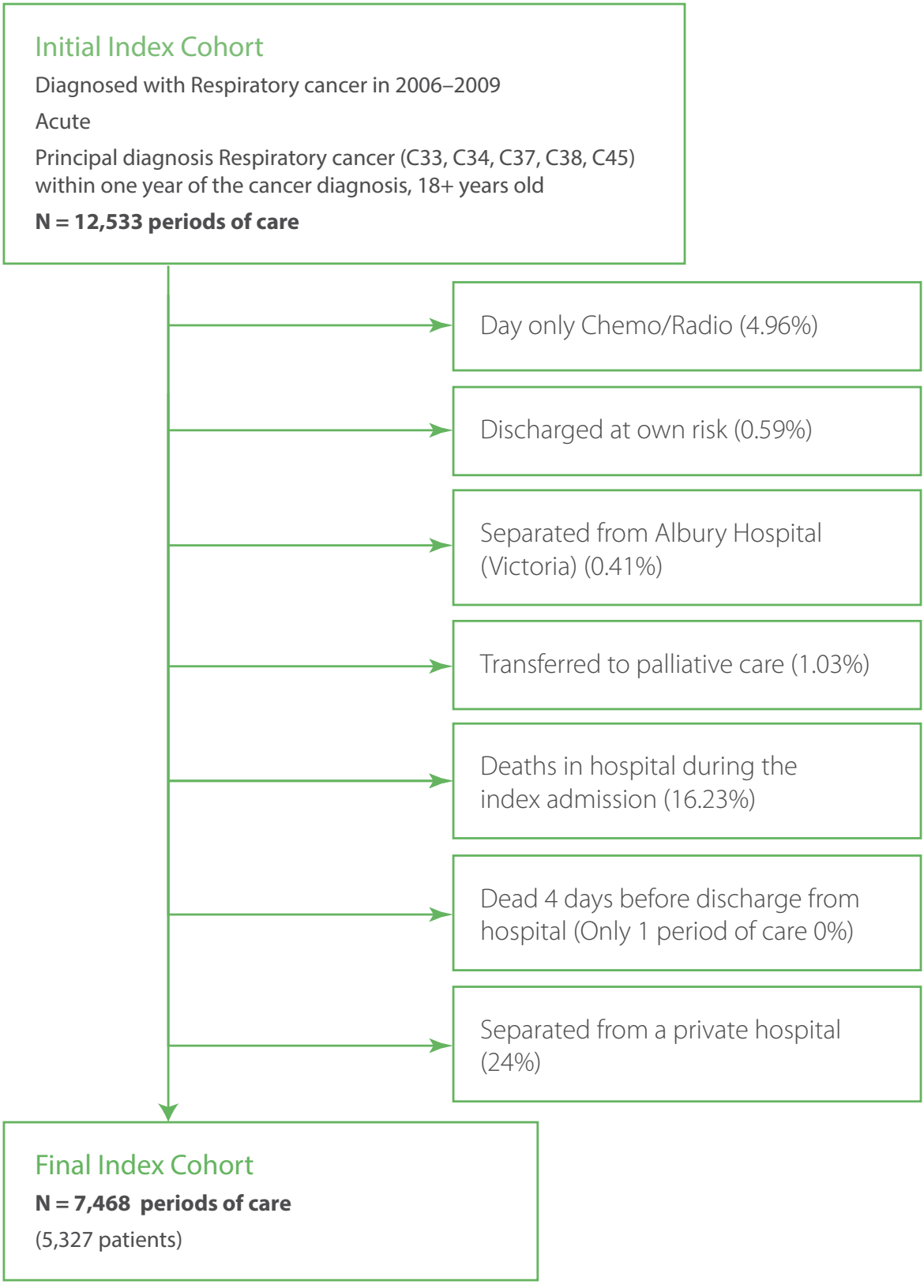
Predictors	Subhazard ratio	(95% CI)	p value
Age (per 1 year increase)	0.99	(0.99-1.00)	0.003
Day only index admission (yes vs. no)	0.51	(0.39-0.65)	<0.001
Stage at diagnosis			
Localised	1.00	–	–
Regional	1.07	(0.95-1.19)	0.266
Distant	1.45	(1.27-1.64)	<0.001
Unknown	0.96	(0.74-1.24)	0.754
Type of admission [1]			
Surgical	1.00	–	–
Non-surgical	0.78	(0.66-0.91)	0.002
Elixhauser comorbidities (yes vs no)			
Congestive heart failure	1.37	(1.11-1.69)	0.003
Diabetes complicated	1.41	(1.23-1.61)	<0.001

1. Periods of care with a missing type of admission are excluded from the analyses

C-statistic: 0.62

Appendix 6

Cohort and prediction model for risk-standardised utilisation ratio (RSUR) – respiratory cancer



Emergency ED visits within 28 days following discharge from hospital, respiratory cancer

Prediction model developed in the development sample, using Fine and Gray competing risks regression models

Predictors	Subhazard ratio	(95% CI)	p value
agec	0.99	(0.99-1.00)	0.008
agec²	1.00	(1.00-1.00)	0.006
Day only index admission (yes vs. no)	0.69	(0.59-0.82)	<0.001
Stage at diagnosis			
Localised	–	–	–
Regional	1.26	(1.06-1.49)	0.008
Distant	1.54	(1.33-1.79)	<0.001
Unknown	1.19	(0.97-1.45)	0.097
Elixhauser comorbidities (yes vs no)			
Cardiac arrhythmia	1.29	(1.08-1.55)	0.005
Hypothyroidism	1.61	(1.24-2.09)	<0.001
Peptic ulcer disease excluding bleeding	1.92	(1.33-2.78)	0.001
AIDS/HIV	2.33	(1.98-2.74)	<0.001

C-statistic: 0.5879

Appendix 7

How to interpret funnel plots

Emergency ED visits are influenced by a wide range of factors that interact in complex ways, meaning there will always be some level of variation in patient outcomes.

The 'funnel' shape that gives the funnel plot its name indicates the tolerance around this variability.

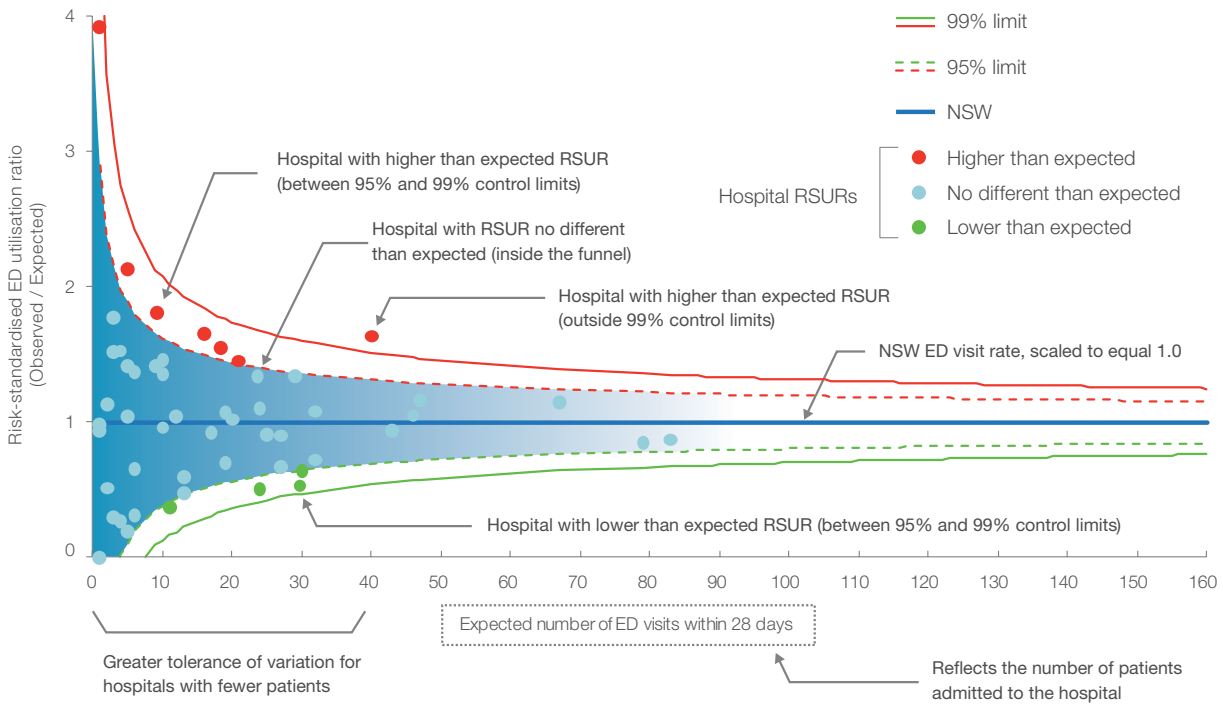
Hospitals with fewer patients (those with lower expected number of ED visits, and appearing towards the left hand side of the plot) will inevitably display greater variability and fair judgements about performance should take this into account.

Therefore the funnel's 95% and 99% limits are wider for hospitals with fewer patients (see example below).

Some hospitals, particularly those with relatively small numbers of patients with a condition may have high or low ratios simply by chance. Therefore funnel plots have been used to identify those hospitals that individually have a low probability of being high or low simply by chance.

Hospitals above the 95% limits of the funnel are considered to have higher than expected emergency ED visits; those below the 95% control limits are considered to have lower than expected emergency ED visits.

For hospitals outside 99% limits, there is greater confidence about their outlier status.

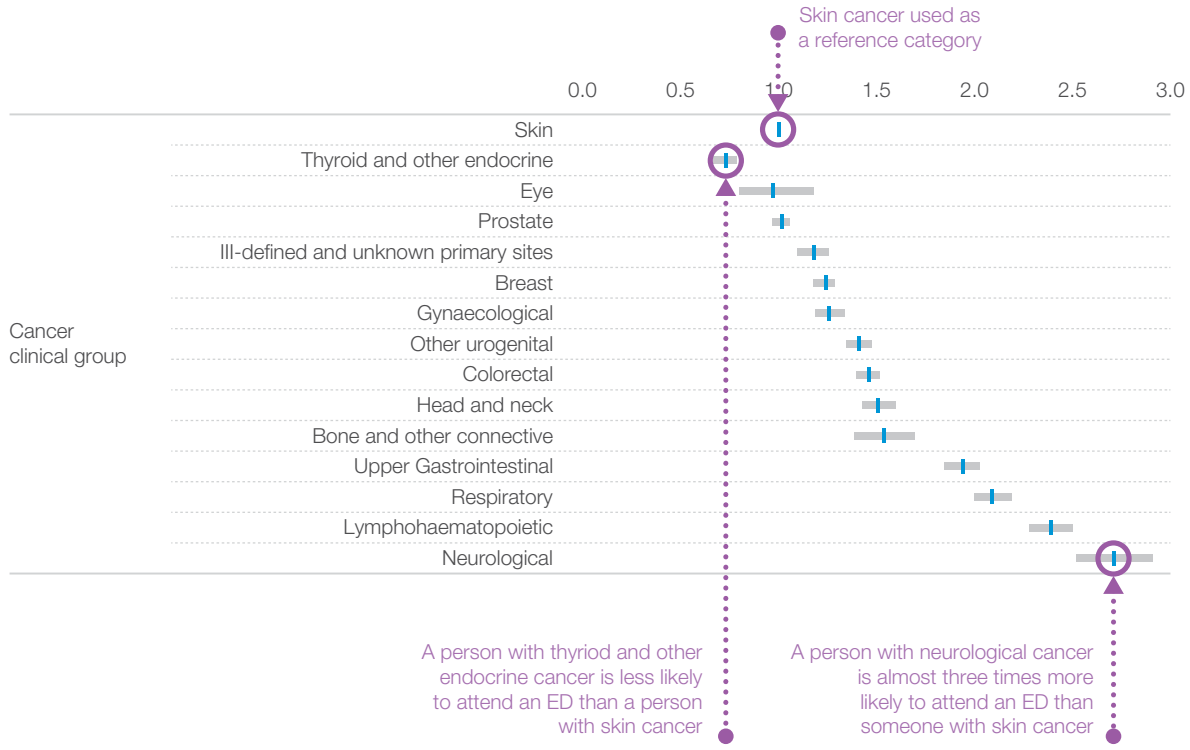


Appendix 8

How to interpret subhazard ratios

A Fine and Gray competing risks hazard model was used to examine the relationship between the risk of ED attendance and various patient characteristics, expressed as a subhazard ratio.[15] Variables with subhazard ratio estimates larger than 1.0 mean that these variables increased the risk of ED attendance, taking into account the competing risk of death. Variables with subhazard ratio estimates less than 1.0 mean that these variables decreased the risk of ED attendance.

For example, the subhazard ratio for the neurological clinical group in the model was 2.71.This ratio indicates that the risk of attending an ED for a person with neurological cancer are almost three times as high as for someone with skin cancer. The subhazard ratio of 0.73 for the thyroid and other endocrine clinical group in the model indicates that a person with thyroid and other endocrine cancer have 27% (1–0.73) lower risk of attending an ED than a person with skin cancer.



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The Bureau of Health Information (BHI) is the main source of information for NSW people about the performance of their public system. A NSW board-governed organisation, BHI is led by Chairperson Professor Bruce Armstrong AM and Chief Executive Jean-Frederic Levesque MD, PhD.

The Cancer Institute NSW is Australia's first statewide cancer control agency, dedicated to lessening the impact of cancer and improving outcomes in cancer diagnosis, treatment, care and ultimately, survival. A NSW Board governed organisation, The Cancer Institute NSW is led by Chairperson The Honorable Morris Iemma BEc LLB and Chief Cancer Officer and CEO Professor David Currow BMed PhD FRACP.

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External Advisors and Reviewers

Professor Sanchia Aranda	Cancer Institute NSW
Deborah Baker	Cancer Institute NSW
Douglas Bellamy	Hunter New England LHD
Dr Heather Bryant	Canadian Partnership Against Cancer
Jo Cryer	St George Hospital
A/Professor Stephen Della-Fiorentina	Macarthur Cancer Therapy Centre
Professor Jason Fine	University of North Carolina
A/Professor Marie Gertdz	Melbourne University
Professor Marc Gladman	Concord Hospital
Juliana Gregory	NSW Ministry of Health
Cassandra Hobbs	St George Hospital
Sarah Hoy	NSW Ministry of Health
Dr Carolyn Hullick	Hunter New England LHD
Dr Winston Liauw	St George Cancer Care Centre
Julie Lieknins	NSW Ministry of Health
Dr Sally McCarthy	Emergency Care Institute
Dr Lucy Morgan	Concord Repatriation General
Margaret Murphy	Westmead Hospital
Professor Dianne O'Connell	Cancer Council NSW
Stuart Purdie	Cancer Institute NSW
Elizabeth Ryan	Prince of Wales Hospital
Dr Patricia Saccasan-Whelan	Murrumbidgee and Southern NSW LHD
Meg Tuipulotu	Western NSW LHD
Richard Walton	Cancer Institute NSW
Leanne Wright	Kempsey District Hospital
Professor Jane Young	University of Sydney

Bureau of Health Information Project Team

Research	Analysis
Ariana Dobrovic (Lead)	Sadaf Marashi-Pour (Lead)
Kim Sutherland	Huei-Yang (Tom) Chen

Design	Communications and Stakeholder Engagement
Adam Myatt	Rohan Lindeman
Efren Sampaga	Anna Sale
Mark Williams	

About the Bureau of Health Information

The Bureau of Health Information (BHI) is a board-governed organisation that provides independent reports about the performance of the NSW public healthcare system.

BHI was established in 2009 to provide system-wide support through transparent reporting.

BHI supports the accountability of the healthcare system by providing regular and detailed information to the community, government and healthcare professionals. This is turn supports quality improvement by highlighting how well the healthcare system is functioning and where there are opportunities to improve.

BHI publishes a range of reports and tools that provide relevant, accurate and impartial information about how the health system is measuring up in terms of:

- Accessibility: healthcare when and where needed
- Appropriateness: the right healthcare, the right way
- Effectiveness: making a difference for patients
- Efficiency: value for money
- Equity: health for all, healthcare that's fair
- Sustainability: caring for the future

BHI also manages the NSW Patient Survey Program, gathering information from patients about their experiences in public hospitals and healthcare facilities.

www.bhi.nsw.gov.au

About the Cancer Institute NSW

The Cancer Institute NSW is Australia's first statewide cancer control agency, established under the Cancer Institute NSW (2003) Act to lessen the impact of cancer in NSW.

The Institute supports and promotes best practice; working to ensure people across the state, no matter where they live, are provided the same high quality treatment and care that is vital to optimising the outcomes and quality of life for people diagnosed with cancer.

Driven by the purpose and objectives of the NSW Cancer Plan 2011–15, the Institute continuously works to:

- reduce the incidence of cancer
- increase the survival rate for people with cancer
- improve the quality of life of people living with cancer
- provide a source of expertise on cancer control for the government, health service providers, medical researchers and the general community.

In order to achieve this, the Institute engages with the community, health professionals, researchers, governments and charity organisations to:

- provide information, resources and advice about preventing cancer
- promote the importance of early detection through cancer screening programs
- provide grants that build research capacity and foster innovation in, and translation of, cancer research
- maintain quality information repositories about cancer in NSW to inform future policy and health planning
- establish partnerships with cancer healthcare professionals to develop and evaluate programs to improve the quality of cancer treatment and care in NSW.

www.cancerinstitute.org.au