When do I know I am cured? Using conditional estimates to provide better information about cancer survival prospects

Peter D Baade, Danny R Youlden and Suzanne K Chambers

ABSTRACT

Objective: To report the latest conditional survival estimates for patients with cancer in Queensland, Australia.

Design, setting and participants: Descriptive study of state-wide population-based data from the Queensland Cancer Registry on patients aged 15–89 years who were diagnosed with invasive cancer between 1982 and 2007.

Main outcome measure: Conditional 5-year relative survival for the 13 most common types of invasive cancer, and all cancers combined.

Results: The prognosis for patients with cancer generally improves with each additional year that they survive. A significant excess in mortality compared with the general population ceases to occur within 10 years after diagnosis for survivors of stomach, colorectal, cervical and thyroid cancer and melanoma, with these groups having a conditional 5-year relative survival of at least 95% after 10 years. For the remaining cancers we studied (pancreatic, lung, breast, prostate, kidney, and bladder cancer, non-Hodgkin lymphoma, and leukaemia), conditional 5-year relative survival estimates (at 10 years after diagnosis) ranged from 82% to 94%, suggesting that patients in these cohorts continue to have poorer survival compared with the age-matched general population.

Conclusions: Estimates of conditional survival have the potential to provide useful information for cancer clinicians, patients and their carers as they are confronted by personal and surveillance-related decisions. This knowledge may be effective in building realistic hope and helping people manage uncertainty about the future. We suggest that measures of conditional survival be incorporated into routine statistical reporting in Australia.

METHODS

The data required for this study were non-identifiable, so ethics committee involvement was not necessary. The study received no external funding.

De-identified case records were obtained from the population-based Queensland Cancer Registry (QCR) with notification of invasive cancers required by law.13 We restricted our cohort to patients aged 15–89 years at the time they were diagnosed with cancer. Survival status is obtained through routine record linkage of the QCR data with the National Death Index which enables interstate deaths to be identified.

All patients with cancer diagnosed from 1982 through to 2007 were included in the cohort, with follow-up to 31 December 2007. We restricted cancer-specific analyses to the 13 most common types of invasive cancer (Box 1) defined using the International classification of diseases for oncology, third revision,13 and all invasive cancers combined (including cancers other than those 13).

Relative survival

Relative survival is used to approximate disease-specific survival, and is routinely reported by international cancer registries because it does not rely on accurate cause of death coding. We calculated relative survival estimates using actuarial methods and based on period analysis,14 with patients with cancer being considered at risk between 1 January 1998 and 31 December 2007. Expected survival was based on the Ederer II method.15 The survival time of patients who were not known to have died before 31 December 2007 was censored as of that date.

Conditional survival

Conditional survival (CS) is the probability of surviving an additional y years given that the person has already survived x years. It is calculated by dividing the relative survival at (x + y) years after diagnosis by the relative survival at x years after diagnosis.16 Confidence intervals can be calculated with the following variance formula:16

\[ \text{Var}[S(t_j | t_i)] = [S(t_j | t_i)]^2 \sum_{k=1}^{j} \frac{d_k}{r_k(r_k-d_k)} \]

Given m time intervals, \(d_k\) is the number of deaths and \(r_k\) is the number at risk during the \(k\)th interval. The probability of survival past time \(t\) is given by \(S(t)\), so \(S(t_i | t_j)\) is the probability of survival past time \(t_i\) given patients have already survived past time \(t_j\). The 95% CIs are then constructed assuming that the CS rates follow a normal distribution.

RESULTS

Box 1 shows the 5-year relative survival estimates at diagnosis for each of the 13 selected cancer types, along with 5-year CS estimates for patients who have survived 1, 3, 5, 7 and 10 years after diagnosis.

As an example, people diagnosed with stomach cancer have an initial 5-year relative
1 Conditional 5-year relative survival estimates, by type of cancer and number of years after diagnosis, for patients aged 15–89 years at diagnosis, Queensland 1998–2007

<table>
<thead>
<tr>
<th>Type of cancer†</th>
<th>No. of patients§</th>
<th>Survival estimates (95% CI)*†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At diagnosis</td>
<td>1 year after diagnosis</td>
</tr>
<tr>
<td>Stomach cancer</td>
<td>3 188</td>
<td>28.5 (27–30)</td>
</tr>
<tr>
<td>Colorectal cancer</td>
<td>24 728</td>
<td>65.9 (65–67)</td>
</tr>
<tr>
<td>Pancreatic cancer</td>
<td>3 244</td>
<td>6.9 (6–8)</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>16 054</td>
<td>14.0 (13–15)</td>
</tr>
<tr>
<td>Melanoma</td>
<td>25 565</td>
<td>93.9 (93–94)</td>
</tr>
<tr>
<td>Breast cancer (females)</td>
<td>23 742</td>
<td>88.0 (87–89)</td>
</tr>
<tr>
<td>Cervical cancer (females)</td>
<td>1 764</td>
<td>75.2 (73–77)</td>
</tr>
<tr>
<td>Prostate cancer (males)</td>
<td>25 970</td>
<td>85.6 (85–86)</td>
</tr>
<tr>
<td>Kidney cancer</td>
<td>5 058</td>
<td>65.6 (64–67)</td>
</tr>
<tr>
<td>Thyroid cancer</td>
<td>6 883</td>
<td>75.5 (74–77)</td>
</tr>
<tr>
<td>Non-Hodgkin lymphoma</td>
<td>3 124</td>
<td>96.6 (96–98)</td>
</tr>
<tr>
<td>Leukaemia</td>
<td>4 687</td>
<td>58.3 (57–60)</td>
</tr>
<tr>
<td>All invasive cancers†</td>
<td>189 591</td>
<td>67.0 (67–67)</td>
</tr>
</tbody>
</table>

* Calculated by period analysis, including patients at risk from selected cancers between 1 January 1998 and 31 December 2007 in Queensland. † Percentage of patients surviving an additional 5 years at the specified number of years after the original cancer diagnosis. ‡ Unless indicated, estimates for males and females are combined. § Number of patients alive at the beginning of the “at risk” period. ¶ Includes cancers not listed here.

DISCUSSION

Conditional survival estimates provide quantitative data for what is often observed anecdotally in clinical settings — that there is a subset of patients who survive beyond what would have been predicted at the time of their diagnosis, and that the long-term prognosis for these patients continues to improve. This is critical information for cancer survivors to receive and understand. One of the most common unmet psychological needs cancer survivors report is fear that their cancer will recur, and fear of cancer recurrence is related to lower quality of life. A clearer understanding that survival after cancer is a conditional event may help patients with cancer derive more hopeful appraisals about the future, and potentially decrease the anxiety that often accompanies post-treatment surveillance.

It has been suggested that when conditional 5-year relative survival exceeds 95% (ie, survival is almost identical to the general population with the same age structure) the excess mortality is negligible. In our study, this was found to occur within 10 years of diagnosis for all cancers combined, along with patients diagnosed with stomach cancer, colorectal cancer, melanoma, cervical cancer and thyroid cancer, similar to the results observed in international studies. Older patients and people diagnosed with other cancers continue to have poorer survival compared with the age-matched general population. Reasons for this continued excess mortality are varied, but would include late recurrences or adverse treatment effects, secondary tumours or increased comorbidities.

The value of the additional information provided by CS estimates is greatest for people diagnosed with cancers associated with an initially poor prognosis. Unfortunately, the proportion of patients with these cancers who live to experience the improved survival outcomes is relatively low. However, for patients who do survive 1, 3 and 5 years after diagnosis, access to updated information for each point of their cancer recovery is important, providing scope for evidence-based optimism as they progress on the survivor’s journey.

Cancer survivors are faced with increased uncertainty about their future at a time when they need to make important life decisions. Overall quality of life among cancer survivors has been shown to be influenced by the domains of control, uncertainty and the future. Levels of anxiety in each of these three domains may be alleviated, in part, by an understanding of the increased likelihood of continued survival over time. Thus, by acknowledging that risk profiles for cancer survivors change.
over time, CS estimates have the potential to be especially relevant for survivors and their families as part of any mid-term to longer-term follow up and support programs.

Current Australian guidelines for the psychosocial care of adults with cancer advise that, when discussing prognosis, clinicians should provide examples of extraordinary survivors to give hope. By contrast, we suggest that it would be better if patients understood that the further they progress from the time of diagnosis, the greater their chance of surviving longer will become. This knowledge may be more effective in building realistic hope and assisting people to manage uncertainty about the future.

A strength of our study was the use of statewide population-based data to calculate CS estimates, with information collected over 26 years. Applying a period analysis allowed us to calculate long-term CS based on the most recent outcomes available (ie, patients at risk between 1998 and 2007), in recognition of improvements...
in cancer survival during the past two to three decades.

Limitations of our study include the lack of stage or treatment data. Stage at diagnosis is known to be an important prognostic factor for survival outcomes.22 However, its impact reduces and can disappear for long-term CS.9 Like all Australian cancer registries, the QCR does not routinely collect information about clinical stage, although the New South Wales Central Cancer Registry does collect some information about the spread of disease. Cancer treatment can potentially have a dual effect on survival as it can bring about remission but may also have long-term adverse effects.23 As is recommended for international cancer registries,9 moves towards standardised collection and recording of stage and treatment data by population-based cancer registries in Australia should be a matter of priority.

Since CS estimates have the potential to provide important information for cancer clinicians, patients and their carers, we suggest that measures of CS be incorporated into routine statistical reporting in Australia.

COMPETING INTERESTS
None identified.

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REFERENCES
2 Australian Institute of Health and Welfare, Cancer Australia and Australasian Association of

3 Conditional 5-year relative survival for every additional year survived after initial diagnosis of cancer, according to age group and cancer type, Queensland, 1998–2007

Survival estimates were calculated by period analysis, including patients at risk from selected cancers between 1 January 1998 and 31 December 2007 in Queensland. Survival curves represent the percentage of patients (y-axis) surviving the specified years after diagnosis (x-axis), given they have already survived a specified number of years. Vertical lines represent the 95% confidence intervals for the conditional survival estimates. Numbers of patients with some cancers (stomach, pancreatic, thyroid and cervical) were not sufficient to provide stable long-term age-specific conditional survival estimates. Not all y-axes begin at the origin.

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