Higher long-term cancer survival rates in southeastern Netherlands using up-to-date period analysis

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Background: The aim was to compare long-term survival rates for different types of cancer estimated by means of up to date period analysis with those from more traditional cohort analysis.

Patients and methods: Data from the Eindhoven Cancer Registry were used. In total 140 137 newly diagnosed patients diagnosed between 1980 and 2002 and followed until 1 January 2005 were included. Five-, 10- and 20-year relative survival rates were calculated.

Results: For total cancer in men and women, childhood cancer, rectal cancer, melanoma in women, breast cancer, prostate cancer and all leukaemias, much higher 10-year survival rates were found with period analyses (differences with cohort analyses were 5.1%, 3.6%, 7.4%, 5.6%, 6.5%, 4.0%, 5.1% and 10.5%, respectively). For laryngeal and bladder cancer the 10-year survival rates estimated with period analyses were about 7.5% lower compared with those estimated by means of cohort analyses.

Conclusions: Period analysis, based on the most recent period of diagnosis, enabled us to show higher survival rates for total cancer, childhood cancer, rectal cancer, melanoma, breast cancer, prostate cancer and acute leukaemia, but also lower rates for laryngeal and bladder cancer. Period analysis should be the preferred tool for showing up-to-date survival rates to cancer patients and their physicians.

Key words: cancer registry, period analysis, survival

Introduction

For clinical practice and policy makers, information about predicted survival of newly diagnosed cancer patients should take into account recent improvements in treatment, although the frequent presence of often still unknown long-term side effects of treatment also play a role. A new method of survival analysis, so-called period analysis, was developed in 1996 [1]. Period analysis of data from the Finnish Cancer Registry and the SEER database have shown higher up-to-date long-term survival rates for cancer patients compared with the more traditional methods [2–4], especially in the event of recent improvements in survival.

We used recent data from the Eindhoven Cancer Registry (ECR) to estimate long-term survival rates by means of period analysis for the most frequent types of cancer and compared them with those calculated with the more traditional cohort method.

Patients and methods

The ECR collects data on all patients with newly diagnosed cancer in the southeastern part of the Netherlands. Since 2000 the registry serves a population of 2.3 million inhabitants. The area offers good access to specialised medical care in 10 general hospitals and two large radiotherapy institutes. Data on vital status, available until 1 January 2005, was obtained from the hospital records and the death registry of the Central Bureau for Genealogy (an institution that registers all deceased in the Netherlands via the municipal civil registries).

Five-, 10-, and 20-year relative survival rates were calculated. Relative survival is an estimation of disease-specific survival. It is calculated as the absolute survival rate among cancer patients divided by the expected survival rate from the general population with the same sex and age structure [5]. Standard errors were calculated according to Greenwood's method [6]. Relative survival rates were computed according to period analysis and the more traditional cohort analysis [1]. For estimating survival rates by means of cohort analyses, all patients diagnosed between 1980 and 2002 were included using complete follow-up information until 1 January 2005 (n = 140 137). In order to provide up-to-date estimates of long-term survival for a recent time period using period analysis, all observations included in the analyses are left-truncated at the beginning of the period of interest in addition to being right-censored at its end. The method of period analysis is described in detail elsewhere [1, 7, 8]. We estimated relative survival rates using period analysis for 2000–2002.

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We chose a time period of 3 years, because that reflects the most recent data available and is large enough to produce rather precise estimates. Relative survival rates were calculated with the SAS computer package (SAS Institute Inc., Cary, North Carolina, USA, 1999), using a publicly available macro [9].

### Results

Five-, 10- and 20-year relative survival rates for the different types of cancer, according to cohort and period analyses, are presented in Table 1. For most tumours, relative survival rates estimated by means of period analyses were higher than those calculated by means of cohort analyses. A large difference in 20-year survival, with small standard errors for both cohort and period analyses, was found for patients with breast cancer. The 20-year relative survival rate, estimated by means of period analysis, was 9.2% higher than that estimated by cohort analysis. For all cancers combined in men and women, childhood cancer, rectal cancer, melanoma in women, breast cancer, prostate cancer and all leukaemias, much higher 10-year survival rates were found using period analyses (differences with cohort analyses were 5.1%, 3.6%, 7.4%, 5.6%, 6.5%, 4.0%, 5.1% and 10.5%, respectively). For laryngeal and bladder cancer the 10-year survival rates obtained with period analyses were lower than those estimated with cohort analyses (differences were 7.5% and 7.8%, respectively), and for women with cancer of the cervix uteri the 10-year survival rate was 3.7% lower.

Figure 1 shows the 20-year relative survival curves obtained by period analyses and cohort analyses for all tumours combined (men and women), childhood cancer, rectal, non-small-cell lung cancer, breast and prostate cancer and non-Hodgkin’s lymphoma. For childhood cancer, rectal, breast and prostate cancer, the differences in relative survival rates between the two methods became larger with increasing duration of follow-up with the largest differences for 20-year relative survival rates.

### Discussion

This study, using data from the ECR, showed that long-term survival rates estimated with period analyses were quite often (differences with cohort analyses were 5.1%, 3.6%, 7.4%, 5.6%, 6.5%, 4.0%, 5.1% and 10.5%, respectively). For laryngeal and bladder cancer the 10-year survival rates obtained with period analyses were lower than those estimated with cohort analyses (differences were 7.5% and 7.8%, respectively), and for women with cancer of the cervix uteri the 10-year survival rate was 3.7% lower.

### Table 1. Relative survival rates for different types of cancer according to cohort* and period analysis, the Eindhoven Cancer Registry, 1980–2002

<table>
<thead>
<tr>
<th>Cancer site</th>
<th>5-year relative survival</th>
<th>10-year relative survival</th>
<th>20-year relative survival</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% (SE)</td>
<td>% (SE)</td>
<td>% (SE)</td>
</tr>
<tr>
<td></td>
<td>Cohort Period</td>
<td>Cohort Period</td>
<td>Cohort Period</td>
</tr>
<tr>
<td>Period estimates higher than cohort estimates&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All sites, men</td>
<td>42.6 (0.2)</td>
<td>48.5 (0.5)</td>
<td>36.6 (0.3)</td>
</tr>
<tr>
<td>All sites, women</td>
<td>60.1 (0.2)</td>
<td>63.4 (0.5)</td>
<td>53.1 (0.3)</td>
</tr>
<tr>
<td>Children (0–14 years)</td>
<td>70.1 (1.7)</td>
<td>75.6 (3.6)</td>
<td>68.3 (1.8)</td>
</tr>
<tr>
<td>Colon</td>
<td>55.5 (0.6)</td>
<td>58.9 (1.3)</td>
<td>53.3 (0.9)</td>
</tr>
<tr>
<td>Rectum</td>
<td>55.0 (0.8)</td>
<td>61.1 (1.6)</td>
<td>48.4 (1.1)</td>
</tr>
<tr>
<td>Lung, non-small-cell</td>
<td>15.4 (0.4)</td>
<td>17.6 (0.8)</td>
<td>11.2 (0.4)</td>
</tr>
<tr>
<td>Melanoma, men</td>
<td>78.5 (1.3)</td>
<td>80.5 (2.3)</td>
<td>74.5 (1.8)</td>
</tr>
<tr>
<td>Melanoma, women</td>
<td>91.6 (0.8)</td>
<td>96.0 (1.3)</td>
<td>89.6 (1.2)</td>
</tr>
<tr>
<td>Breast</td>
<td>80.8 (0.4)</td>
<td>84.3 (0.7)</td>
<td>68.5 (0.6)</td>
</tr>
<tr>
<td>Ovary</td>
<td>40.3 (1.1)</td>
<td>43.8 (2.4)</td>
<td>34.9 (1.2)</td>
</tr>
<tr>
<td>Prostate</td>
<td>76.0 (0.7)</td>
<td>80.9 (1.3)</td>
<td>63.7 (1.4)</td>
</tr>
<tr>
<td>Non-Hodgkin’s lymphoma</td>
<td>54.8 (0.9)</td>
<td>58.8 (1.9)</td>
<td>42.0 (1.2)</td>
</tr>
<tr>
<td>All leukaemias</td>
<td>21.5 (1.2)</td>
<td>29.0 (2.8)</td>
<td>17.9 (1.3)</td>
</tr>
<tr>
<td>Period estimates comparable with cohort estimates&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oesophagus</td>
<td>10.2 (0.9)</td>
<td>9.8 (1.7)</td>
<td>7.4 (1.2)</td>
</tr>
<tr>
<td>Stomach</td>
<td>20.1 (0.7)</td>
<td>20.0 (1.6)</td>
<td>17.3 (0.8)</td>
</tr>
<tr>
<td>Pancreas</td>
<td>3.4 (0.4)</td>
<td>3.7 (0.9)</td>
<td>2.9 (0.5)</td>
</tr>
<tr>
<td>Lung, small cell</td>
<td>3.4 (0.4)</td>
<td>4.0 (0.8)</td>
<td>2.9 (0.4)</td>
</tr>
<tr>
<td>Corpus uteri</td>
<td>81.2 (1.0)</td>
<td>83.1 (2.0)</td>
<td>79.1 (1.4)</td>
</tr>
<tr>
<td>Testis, seminoma</td>
<td>95.6 (1.2)</td>
<td>96.6 (2.2)</td>
<td>95.8 (1.9)</td>
</tr>
<tr>
<td>Testis, non-seminoma</td>
<td>92.9 (1.4)</td>
<td>94.2 (2.7)</td>
<td>91.9 (1.6)</td>
</tr>
<tr>
<td>Kidney</td>
<td>50.0 (1.2)</td>
<td>50.4 (2.3)</td>
<td>42.3 (1.5)</td>
</tr>
<tr>
<td>Hodgkin’s disease</td>
<td>81.0 (1.7)</td>
<td>81.6 (3.5)</td>
<td>75.2 (2.1)</td>
</tr>
<tr>
<td>Period estimates lower than cohort estimates&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larynx</td>
<td>72.9 (1.5)</td>
<td>70.3 (3.2)</td>
<td>61.5 (2.3)</td>
</tr>
<tr>
<td>Cervix uteri</td>
<td>70.4 (1.4)</td>
<td>66.3 (3.3)</td>
<td>65.1 (1.6)</td>
</tr>
<tr>
<td>Bladder (invasive)</td>
<td>36.6 (1.3)</td>
<td>33.4 (2.6)</td>
<td>31.1 (1.6)</td>
</tr>
</tbody>
</table>

*Survival estimated using complete follow-up information until 1 January 2005.

<sup>c</sup>Too small numbers.

<sup>c</sup>Based on difference between 10-year survival rates.
**Figure 1.** Twenty-year relative survival curves for different types of cancer according to cohort (dashed line) and period analysis (solid line), the Eindhoven Cancer Registry, 1980–2002.
higher than those obtained from the more traditional method for cancer survival (cohort analysis). This has also been demonstrated by a thorough empirical evaluation of period analysis [8]. Period estimates might overestimate long-term survival rates, when advances in early detection and/or treatment do not increase the chance of cure, and cancer death is only postponed (lead-time bias). However, this does not seem to happen in practice [8]. In the case of true survival improvement over time, even period estimates could be too pessimistic.

For tumours with a poor prognosis, such as pancreatic cancer, the numbers of survivors became too small for a reliable 10-year period survival rate (see Table 1). Extending the time period to 1998–2002 (instead of 2000–2002) a 10-year survival rate of 2.9% was estimated with period analysis, equaling the result of cohort analysis.

Improvements in survival over time are caused by earlier detection, improved staging and/or advances in treatment. We found a pronounced difference in survival between both methods for breast cancer. To a large extent this is due to mass screening, introduced in the early 1990s in our catchment area but also due to advances in treatment [10]. The improvement in prostate cancer survival is largely due to early detection of prostate cancer after the introduction of prostate specific antigen (PSA) in the early 1990s. There was an exponential increase in the incidence of low-grade localised prostate cancer in the area of the Eindhoven Cancer Registry (from 25 per 100 000 in 1989 to 80 per 100 000 in 1995) [11]. Improvements in outcome of treatment were seen for rectal cancer [12] and childhood cancer [13]. The increased survival for melanoma of the skin (especially in women) can partly be explained by greater awareness of skin lesions as a result of a higher incidence and health campaigns.

To estimate long-term survival rates, period analysis has now been applied in several countries [4, 14–18], using data on patients diagnosed in the 1990s. In Germany and Sweden, period estimates were based on survival data of patients diagnosed between 2000 and 2002 (same as in our study), whereas cohort analyses were based on data from the 1990s. In our study, patients diagnosed between 1980 and 2002 and followed until 1 January 2005 were included. Therefore, the differences between period analysis and cohort analysis in our study were smaller than those found in previous studies. However, by using the recently developed hybrid analysis [19], which is applied in situations in which recording of incident cases is delayed by a couple of years compared to follow-up (as was the case in our cancer registry), even larger differences between period and cohort analysis could be found.

Period analysis yields much higher long-term survival rates for most types of cancer than previously used traditional methods. Cancer registries should use period analysis for the most recent diagnostic period to provide cancer patients and their physicians with the most up-to-date survival rates.

references