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The role of comorbidities on the uptake of systemic treatment and 3-year survival in older cancer patients

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Background: Older patients are notably absent from clinical trials. Thus, observational studies are the primary avenue for understanding the role of comorbidity in cancer care and survival. We examined the impact of comorbidity on systemic treatment initiation and 3-year survival in a cohort of older cancer patients.

Patients and Methods: Our cohort comprised 2753 Australian veterans aged ≥65 years with full health coverage and a cancer registry notification for colorectal (CRC), breast, prostate or non-small-cell lung cancer (NSCLC). We established comorbidities based on drugs prescribed in the 6 months prior to cancer diagnosis.

Results: Patients with higher comorbidity burden were more likely to receive systemic treatment for prostate cancer [adjusted odds ratio 1.21, 95% confidence interval (CI) 1.05–1.39] but less likely for NSCLC (0.63, 95% CI 0.45–0.86). After adjusting for receipt of treatment, increased comorbidity resulted in shorter survival for CRC [adjusted hazard ratio (aHR) 1.16, 95% CI 1.07–1.26] and breast cancer (aHR 1.23, 95% CI 1.02–1.48). However, we did not demonstrate significant improvements in 3-year survival for patients receiving systemic treatment.

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Conclusion: Comorbidity influences systemic treatment uptake and adversely affects survival, with impact dependent upon comorbidity and cancer type. Clinical trials should be undertaken in older patients to better understand the risks and benefits of cancer treatments.

Key words: cancer, chemotherapy, comorbidity, observational study, outcomes assessment

Introduction

Older patients carry the greatest burden of illness from many common cancers. Latest figures from the National Cancer Institute indicate that 54% of all cancer patients are diagnosed after the age of 65 years, with median age at diagnosis being 61 years for breast cancer, 67 years for prostate cancer, 70 years for colorectal cancer (CRC) and 71 years for cancer of the lung and bronchus [1]. Further, approximately two-thirds of patients aged 65 years or older have coexisting diseases (multimorbidity) and are taking, on average, four prescribed medications daily to manage these conditions [2].

Chemotherapy is the mainstay of treatment for many cancers. There is strong evidence that chemotherapy improves progression-free and overall survival in the neoadjuvant, adjuvant and metastatic settings [3–5]. Current treatment guidelines are underpinned by data from clinical trials which often exclude older patients and those with multiple morbidities [6–9]. The absence of an evidence base for this patient group poses important challenges to clinicians when considering cancer treatment and management.

More than 30 observational studies have been conducted in North America and Europe examining the impact of comorbidity on the uptake of chemotherapy and cancer outcomes. A recent systematic review of these observational studies demonstrates that comorbidity exerts a detrimental influence on the uptake and outcomes of cancer treatments across a range of tumour sites and stages of disease [10]. However, most studies have focussed exclusively on the use of chemotherapy or survival as the primary outcome of interest and very few have examined issues in the elderly population. Further, the majority of studies have used global measures of comorbidity, most commonly the Charlson comorbidity index (CCI) [11, 12] rather than assessing the impact of a range of individual comorbidities on outcomes.

We will address gaps in the existing literature regarding older patients using data from Australian clinical practice. Specifically, we will examine the impact of overall comorbidity burden and individual comorbidities on systemic treatment (i.e. chemotherapy, hormone therapy or targeted therapy) initiation up to 2 years after cancer diagnosis and on 3-year survival. We will also examine the association between receiving systemic treatment and 3-year survival.

Methods

Setting

Australia has a universal publicly funded health care system. The Pharmaceutical Benefits Scheme (PBS) and Repatriation Pharmaceutical Benefits Schemes (RPBS) are national programs providing subsidised access to prescription drugs for the Australian general population and clients of the Department of Veterans’ Affairs (DVA), respectively. The majority of prescribed drugs in Australia are subsidised by the PBS. The RPBS subsidises all PBS items plus additional items only available to veterans [13, 14].

Study cohort

Our cohort was derived from DVA clients: aged ≥65 years; with a first primary invasive CRC, breast cancer, prostate cancer or non-small-cell lung cancer (NSCLC) diagnosis between 1 January 2005 and 31 December 2007 (inclusive); holding full DVA health care entitlements so as to ensure complete capture of all pharmaceuticals and health services utilised; and who were alive at least 3 months after their date of cancer diagnosis so as to exclude patients with a very poor short-term prognosis who would not have been considered for chemotherapy.

Data sources

We obtained data from the following sources to undertake our study:

- DVA client database (1994–2007) contains information on DVA clients’ sex, dates of birth and death and entitlement level. We obtained data for all clients residing in New South Wales (NSW), the largest Australian state.
- RPBS (July 2004 to June 2009) contains data on dispensed pharmaceutical items (RPBS item code, name and strength, date of supply, quantity supplied and number of repeats) plus client entitlement at the time of dispensing. We mapped RPBS item codes to Anatomical Therapeutic Codes (ATC) [15] for the purposes of our analysis.
- NSW Central Cancer Registry (CCR) (1994–2007) contains records of all cancer cases diagnosed in NSW residents since 1972. The registry is run according to the International Association of Cancer Registries rules [16] and is one of the few Australian Cancer Registries to record degree of spread at the time of first diagnosis for all solid malignant tumours [17]. Degree of spread is assigned by the NSW CCR into one of four summary stages (localised, regional, distant or unknown) [18]. We used International Classification of Diseases for Oncology, Third edition (ICD-O-3) [19], codes to identify cases of CRC (C18–C21), breast cancer (C50), prostate cancer (C61), and NSCLC (C34 and M82503, M80123, M80463, M905_3, M807_3, M814_3 and M824_3). In situ cancers were not included in the study.

Data linkage

Data linkage was undertaken by a third party, the NSW Centre for Health Record Linkage (CHeReL) using best practice privacy preserving protocols (http://www.cherel.org.au/confidentiality.html). The DVA client file (including the name and address history of each client) was sent to the CHeReL. Using probabilistic linkage, they identified all records from the APDC and CCR relating to those clients. They then assigned unique identifiers (or project person numbers, PPNs) to the DVA client file, and APDC and CCR data files. The client file was sent to the DVA with the PPNs and the DVA extracted RPBS records for the cohort. We received
comorbidity index
We used the RxRisk [20, 21] comorbidity index to determine pre-existing comorbidity which is generated using pharmaceutical drug dispensing. We calculated RxRisk using counts of up to 42 general drug categories (not including cancer drug categories) using pharmacy claims data within 6 months prior to a patient’s cancer diagnosis. Previous observational studies have used other global measures of comorbidity, most commonly the CCI [11, 12], a diagnosis-based measure of up to 17 conditions. The CCI is, however, likely to underestimate a person’s comorbidity in Australia as there is no systematic recording of diagnoses in the outpatient setting [22, 23]. Therefore, only conditions that necessitate hospitalisation and those that are likely to impact on the treatment of that condition are recorded. In our cancer cohorts, e.g. 84% of patients have a CCI score of zero (calculation does not include cancer diagnoses). The RxRisk has been validated in Australian veterans and has been shown to be at least comparable to the CCI for predicting 1-year mortality [22, 23]. From the RxRisk model, we also identified individual comorbid conditions [e.g. cardiovascular disease (CVD), psychological illness and airways disease].

outcome measures and statistical analyses
Our primary outcomes were systemic treatment initiation within 2 years of diagnosis and 3-year overall survival. We defined systemic treatment as evidence of at least one RPBS dispensing record for cytotoxic chemotherapy (ATC L01D and L01XA), hormone therapy (ATC L02BA, L02BB and L02BG) or targeted therapy (monoclonal antibodies and protein kinase inhibitors; ATC L01XC and L01XE, respectively) after the cancer diagnosis. We used date of death as recorded in the DVA client database to estimate survival.

We first used bivariate analyses to examine a range of potential factors associated with receiving systemic treatment. Next we used multivariable logistic regression to calculate adjusted odds ratios (aORs) with statistical significance at the $P < 0.05$ level. Covariates included age at diagnosis, gender, year of diagnosis, degree of cancer spread, surgical resection, the number of hospital separations in the 12 months preceding diagnosis, overall comorbidity burden (RxRisk score) and up to 42 individual RxRisk comorbidities ensuring that the convergence criterion of each regression model was satisfied. We examined the interactions between the RxRisk score and individual morbidities. Separate models were used for each cancer of interest.

To determine the effect of pre-existing comorbidity burden and individual comorbid conditions on 3-year survival, we generated propensity scores for each patient from the logistic regression model; this estimated the conditional probability (propensity) of receiving systemic treatment [24, 25]. Median propensity scores (and interquartile range) for each cancer type were not significantly different between those who did and did not have systemic treatment, indicating similar conditional probability for receiving treatment. Our Cox proportional hazard regression models included propensity scores (to reduce potential bias in survival estimates for the effect of receiving systemic treatment or not), receipt of systemic treatment, overall comorbidity burden (RxRisk score) and the following comorbidities: CVD, psychological illness, gastric disease, hyperlipidaemia, pain and airways disease. We examined interactions between each comorbidity and receipt of systemic treatment. Our analyses reported adjusted hazard ratios (aHRs) with statistical significance at the $P < 0.05$ level. Separate models were created for each cancer of interest.

Finally, for each cancer, we also used the Kaplan–Meier product limit method to explore the association between receiving systemic treatment and 3-year survival, stratifying by comorbidity burden. Censoring dates were 3 years from the date of cancer diagnosis, 31 December 2009 (end of study) or date of death, whichever occurred first.

All statistical analyses were performed using SAS software, version 11.2 (SAS Institute Inc., Cary, NC).

results
cohort characteristics
A total of 2753 DVA clients aged ≥65 years with full health care entitlements were diagnosed with CRC, breast cancer, prostate cancer or NSCLC in the years 2005–2007 (Supplemental Table 1, available at Annals of Oncology online). More than 90% of each cancer cohort were ≥75 years and at least one-third were ≥85 years of age. The majority of CRC and NSCLC patients were men. Fewer than 10% of all cancer patients had distant spread at diagnosis. Many of our cohort members did not have their cancer resected surgically (18%, 23%, 59% and 83% for CRC, breast, prostate and NSCLC, respectively). Based on the RxRisk comorbidity index, at least 89% of all patients had at least one comorbid condition and at least 43% had five or more. For each cancer type, the most common pre-existing comorbidities were hyperlipidaemia, CVD and gastrointestinal disease. The majority of our cohort were admitted to hospital between one and five times in the 12 months before their cancer diagnosis (80% CRC, 55% breast, 43% prostate and 95% NSCLC).

systemic treatment initiation
Overall, 39% of cancer patients received at least one cycle of systemic treatment within 2 years after diagnosis. Uptake varied by cancer type with 17% of CRC, 68% of breast, 52% of prostate and 20% of NSCLC patients receiving systemic treatment (Supplemental Table 1, available at Annals of Oncology online). Treatment by hormone therapy alone accounted for 91% of breast and 99% of prostate cancer systemic treatment. The median time to initiation was 79 days after diagnosis (Q1–Q3: 13–713 days) for CRC, 52 days (Q1–Q3: 9–622 days) for breast cancer, 41 days (Q1–Q3: 13–545 days) for prostate cancer and 67 days (Q1–Q3: 4–596 days) for NSCLC. We found significant bivariate associations with systemic treatment initiation for age at diagnosis (in CRC and prostate cancer), degree of spread (all cancers), absence of surgical resection (breast and prostate cancers), comorbidity burden (breast and prostate cancers), pre-existing CVD, diabetes or osteoporosis (breast cancer) and absence of hospitalisation prior to cancer diagnosis (prostate cancer).

Table 1 displays the significant predictors of systemic treatment initiation as determined by multivariate logistic regression. Specifically, in relation to comorbidity, we found that CRC patients with higher overall comorbidity burden were less likely to receive systemic treatment (trend not statistically significant) but did not find any of the individual conditions predictive of systemic treatment uptake in this patient group.
Table 1  Multivariate logistic regression analyses to determine factors associated with uptake of chemotherapy for CRC, breast cancer, prostate cancer and NSCLC

<table>
<thead>
<tr>
<th>Variables</th>
<th>CRC</th>
<th>95% CI</th>
<th>(P) value</th>
<th>Breast cancer</th>
<th>95% CI</th>
<th>(P) value</th>
<th>Prostate cancer</th>
<th>95% CI</th>
<th>(P) value</th>
<th>NSCLC</th>
<th>95% CI</th>
<th>(P) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at diagnosis</td>
<td>0.89</td>
<td>0.86–0.93</td>
<td>&lt;0.001</td>
<td>0.98</td>
<td>0.94–1.03</td>
<td>0.43</td>
<td>1.03</td>
<td>1.01–1.06</td>
<td>0.004</td>
<td>0.94</td>
<td>0.88–0.99</td>
<td>0.03</td>
</tr>
<tr>
<td>Gender</td>
<td>1.42</td>
<td>0.95–2.12</td>
<td>0.08</td>
<td>0.10</td>
<td>–</td>
<td>0.15</td>
<td>1.22</td>
<td>1.04–1.41</td>
<td>0.02</td>
<td>1.10</td>
<td>0.76–1.60</td>
<td>0.63</td>
</tr>
<tr>
<td>Year of diagnosis</td>
<td>0.96</td>
<td>0.75–1.23</td>
<td>&lt;0.001</td>
<td>0.74</td>
<td>0.91–1.74</td>
<td>0.08</td>
<td>1.22</td>
<td>1.04–1.41</td>
<td>0.001</td>
<td>0.94</td>
<td>0.76–1.60</td>
<td>0.05</td>
</tr>
<tr>
<td>Degree of spread</td>
<td>0.08</td>
<td>0.04–0.15</td>
<td>0.86</td>
<td>0.22–3.41</td>
<td>0.31</td>
<td>0.17–0.58</td>
<td>0.33</td>
<td>0.14–0.78</td>
<td>0.05</td>
<td>0.85</td>
<td>0.34–2.14</td>
<td>0.05</td>
</tr>
<tr>
<td>Localised</td>
<td>0.53</td>
<td>0.32–0.88</td>
<td>1.89</td>
<td>0.45–7.89</td>
<td>0.57</td>
<td>0.24–1.37</td>
<td>0.85</td>
<td>0.34–2.14</td>
<td>0.05</td>
<td>0.85</td>
<td>0.34–2.14</td>
<td>0.05</td>
</tr>
<tr>
<td>Unknown</td>
<td>0.11</td>
<td>0.04–0.28</td>
<td>1.03</td>
<td>0.25–4.18</td>
<td>0.34</td>
<td>0.19–0.61</td>
<td>0.48</td>
<td>0.22–1.04</td>
<td>0.05</td>
<td>0.85</td>
<td>0.34–2.14</td>
<td>0.05</td>
</tr>
<tr>
<td>Overall comorbidity burden (RxRisk score)</td>
<td>0.82</td>
<td>0.65–1.03</td>
<td>0.09</td>
<td>0.79</td>
<td>0.60–1.03</td>
<td>0.08</td>
<td>1.21</td>
<td>1.05–1.39</td>
<td>0.007</td>
<td>0.63</td>
<td>0.45–0.86</td>
<td>0.005</td>
</tr>
</tbody>
</table>

*Only comorbidities of interest or those with statistical significance are shown in the table. Logistic regression analyses adjusted for tumour site (CRC), degree of spread, age at diagnosis, gender, surgical resection and comorbidity (at least 34 individual RxRisk and 6 grouped categories were included). For prostate cancer, interactions between RxRisk and cardiovascular disease (CVD) and RxRisk and psychological illness were significant at \(P < 0.05\). aOR, adjusted odds ratio; BPH, benign prostatic hyperplasia; CI, confidence interval; CRC, colorectal cancer; NSCLC, non-small-cell lung cancer.

In breast cancer, patients with higher overall comorbidity burden were less likely to receive systemic treatment (trend not statistically significant) and patients with CVD (aOR 2.76, 95% confidence interval (CI) 1.20–6.33), diabetes (aOR 3.83, 95% CI 1.29–11.4) or osteoporosis (aOR 3.44, 95% CI 1.50–7.87) were more likely to receive systemic treatment. Prostate cancer patients with higher overall comorbidity burden (aOR 1.21, 95% CI 1.05–1.39) or benign prostatic hyperplasia (aOR 1.78, 95% CI 1.04–3.05) were more likely to receive systemic treatment. Finally, NSCLC patients with a higher total comorbidity burden were less likely to receive systemic treatment (aOR 0.63, 95% CI 0.45–0.86) whilst comorbid psychological illness (aOR 3.04, 95% CI 1.39–6.67) and hyperlipidaemia (aOR 2.75, 95% CI 1.21–6.26) were associated with systemic treatment initiation.

In a population-based cohort of older cancer patients, we investigated the impact of pre-existing comorbidity on the uptake of systemic treatment and 3-year survival in routine clinical care. Most randomised controlled trials have limited generalisability as they restrict their enrolment to younger patients with few, if any, comorbidities. As the number of older cancer patients continues to grow worldwide, so too does the

**Discussion**

In a population-based cohort of older cancer patients, we investigated the impact of pre-existing comorbidity on the uptake of systemic treatment and 3-year survival in routine clinical care. Most randomised controlled trials have limited generalisability as they restrict their enrolment to younger patients with few, if any, comorbidities. As the number of older cancer patients continues to grow worldwide, so too does the...
Table 2  Three-year survival estimates with 95% confidence interval (CI) and median survival time stratified by comorbidity burden for each cancer type

<table>
<thead>
<tr>
<th>Comorbidity burden</th>
<th>Comorbidity burden</th>
</tr>
</thead>
<tbody>
<tr>
<td>median RxRisk score</td>
<td>median RxRisk score</td>
</tr>
<tr>
<td>% (95% CI)</td>
<td>% (95% CI)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th>Median RxRisk score</th>
<th>Cancer Type</th>
<th>Median RxRisk score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorectal cancer (CRC)</td>
<td>51 (40–62)</td>
<td>Breast cancer</td>
<td>80 (71–86)</td>
</tr>
<tr>
<td>No systemic treatment (n = 158)</td>
<td>51 (40–62)</td>
<td>Systemic treatment (n = 225)</td>
<td>82 (68–90)</td>
</tr>
<tr>
<td>No systemic treatment (n = 756)</td>
<td>72 (67–77)</td>
<td>No systemic treatment (n = 107)</td>
<td>76 (62–85)</td>
</tr>
<tr>
<td>Non-small-cell lung cancer</td>
<td>67 (61–73)</td>
<td>Prostate cancer</td>
<td>67 (61–74)</td>
</tr>
<tr>
<td>Systemic treatment (n = 610)</td>
<td>67 (61–73)</td>
<td>No systemic treatment (n = 565)</td>
<td>69 (63–74)</td>
</tr>
<tr>
<td>No systemic treatment (n = 28)</td>
<td>11 (3–23)</td>
<td>Non-small-cell lung cancer</td>
<td>21 (8–37)</td>
</tr>
<tr>
<td>Systemic treatment (n = 265)</td>
<td>22 (15–29)</td>
<td></td>
<td>20 (14–28)</td>
</tr>
</tbody>
</table>

*Median RxRisk score was 4.0 for colorectal cancer (CRC), breast cancer and prostate cancer and 4.5 for non-small-cell lung cancer.

importance of understanding the risks and benefits of treatment in these patient populations. Currently, the evidence base in this domain is limited and probably insufficient to guide clinical decision making [10].

Our study ascertained comorbidity using a model based on pharmaceutical dispensing which provides a more comprehensive measure of both the overall comorbidity burden and individual comorbid conditions than the common CCI method used in previous observational studies. This is particularly the case in Australia where diagnoses are only recorded systematically in the in-patient hospital setting. We demonstrated that <40% of older patients used systemic treatment, ranging from 17% for CRC to 68% for breast cancer. The utilisation of systemic treatment in our study for NSCLC, breast and prostate cancer are comparable to other studies of elderly populations [26–30], but the use in CRC, though comparable to one study [31], is lower by 40% than another [32].

For CRC, breast cancer and NSCLC, our results indicate that a higher overall comorbidity burden reduces the likelihood of receiving systemic treatment, the latter two cancers failing to attain statistical significance. This trend is consistent with prior research reporting less use of chemotherapy with greater comorbidity, regardless of cancer type or stage [26, 32–34]. Although some studies have provided contrasting results suggesting no relationship between comorbidity and chemotherapy initiation for NSCLC and breast cancer [27, 30]. For prostate cancer, our findings are consistent with an earlier study demonstrating that men with increased comorbidity were significantly less likely to undergo prostatectomy and hence more likely to receive radiotherapy and/or hormone treatment [29]. A few particular comorbid conditions were predictive of systemic treatment initiation in some cancer, possibly because alternatives such as surgery were contraindicated in patients with such conditions. No particular comorbid condition consistently predicted systemic treatment uptake for all four cancers.

Our finding that patients with a higher comorbidity burden had worse overall survival after adjusting for systemic treatment is again consistent with previous studies [27, 29, 31, 35–37]. However, no notable relationship was observed between survival and a particular comorbid condition across the cancer types.

We did not detect survival benefits in patients receiving systemic treatment compared with those who did not, stratifying by overall comorbidity burden. However, due to the observational nature of our study, we are not able to determine if this is due to residual confounding or a real lack of effect of chemotherapy on survival. Previous research found improved survival in CRC and NSCLC patients receiving chemotherapy (with or without comorbidity); however, these prior studies focussed exclusively on adjuvant treatment [32, 33, 38–40]. Our contrasting findings could reflect the large proportion of our cohort with pre-existing comorbidity (89% had at least one comorbid condition) and the relatively low proportion receiving systemic treatment (39%).

Our results confirm that overall comorbidity burden is an important driver in the decision to prescribe systemic treatment and in survival outcomes. This may reflect a reticence on the part of physicians to treat infirm cancer patients with multimorbidities due to the uncertainty about the benefit to risk ratio of systemic treatment in this population [28, 31, 38, 41]. However, we did not identify any particular individual comorbid condition that consistently influenced cancer treatment or survival across four cancers. Clearly, patients may also be driving treatment decisions but this issue was not explored in our analysis [42, 43].

Our study population of older cancer patients with multiple morbidities offers a unique opportunity to assess the impact of comorbidities on cancer treatment. However, this study was not without limitations. Clearly, this study is limited by the nature of secondary health data which form the basis of our analyses. While we are able to identify the way in which treatment practice had occurred in this cohort of cancer patients, we are unable to establish the key drivers of these clinical decisions. From a methodological perspective, sample size may have been an issue for some of our analyses particularly for CRC and NSCLC where the uptake of systemic
treatment was low. As such, our findings should be interpreted in this context. Further, our inclusion criteria requiring patients to be alive for at least 3 months following diagnosis may have had some impact on our findings. For example, distant spread of disease was associated with increased use of systemic treatment for CRC, prostate cancer and NSCLC, but only 10% of the cohort had distant metastases at diagnosis. Those who were not considered for treatment may have been those excluded from our study due to their very limited prognosis.

Our study has demonstrated that overall comorbidity burden exerts a substantive influence of the decision to treat older cancer patients and in the outcomes of their care. Further, our study suggests that benefits of systemic treatment (compared with no drug treatment) should not be assumed in this older population with cancer. This warrants further research especially given the burgeoning number of cancer sufferers in older age groups. Clearly, there would be some merit in studying these groups in the clinical trial setting. The development of randomised controlled trials where patients are stratified according to pre-existing comorbidity burden would quantify the benefits of systemic treatment in older patients with specific comorbidity levels. This is most important for high-intensity systemic treatment where the tolerance, risks and benefits may all be affected substantially by comorbid conditions.

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disclosure

The authors have declared no conflicts of interest.

references

Changes in survival by ethnicity of patients with cancer between 1992–1996 and 2002–2006: is the discrepancy decreasing?

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Background: Patients of minority race/ethnicity have lower survival after diagnosis with most types of cancer. Little data are available concerning changes in disparity over time. Here, we examine changes in survival by race/ethnicity of patients with common cancers in two recent time periods.

Patients and methods: We used modeled period analysis to determine relative survival (RS) for non-Hispanic white (nHw), African–American (AA), and Hispanic patients in the Surveillance, Epidemiology, and End Results database diagnosed with common solid and hematological malignancies.

Results: Five-year RS improved overall and for nHw for each tumor examined, ranging from + 2% points (pancreatic cancer) to + 16.4% points [non-Hodgkin’s lymphoma, (NHL)]. Greater improvement was observed for AA and Hispanics than nHw in breast and prostate cancer and NHL. Less improvement was observed for AA and Hispanics than for nHw for lung and pancreatic cancer. No statistically significant improvement was observed for AA and Hispanics with myeloma or acute leukemia. Survival disparities ranging from 0.5% points (myeloma) to 13.1% points (breast) between nHw and AA remained.

Conclusions: Progress has been made in decreasing disparities in survival between nHw and minorities in breast cancer, prostate cancer, and NHL. Little progress has been made in reducing disparities for the other studied cancers.

Key words: cancer survival, disparity, ethnicity, period analysis

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