The costs of identifying undiagnosed prostate cancer in asymptomatic men in New Zealand general practice

Chunhuan Lao\textsuperscript{a,\*}, Charis Brown\textsuperscript{a}, Zuzana Obertová\textsuperscript{a}, Richard Edlin\textsuperscript{b}, Paul Rouse\textsuperscript{c}, Fraser Hodgson\textsuperscript{a}, Michael Holmes\textsuperscript{d}, Peter Gilling\textsuperscript{e} and Ross Lawrenson\textsuperscript{a}

\textsuperscript{a}Waikato Clinical School, The University of Auckland, Hamilton. \textsuperscript{b}School of Population Health, The University of Auckland, Auckland. \textsuperscript{c}The University of Auckland Business School, The University of Auckland, Auckland. \textsuperscript{d}Urology Department, Waikato Hospital, Hamilton and \textsuperscript{e}Department of Urology, Tauranga Hospital, Tauranga, New Zealand.

\*Correspondence to Chunhuan Lao, Waikato Clinical School, University of Auckland, Peter Pothwell Academic Centre, Private Bag 3200, Hamilton 3240, New Zealand; E-mail: clao731@aucklanduni.ac.nz

Received 6 May 2013; Revised 24 July 2013; Accepted 30 July 2013.

Background. Screening for prostate cancer (PCa) using the prostate-specific antigen (PSA) test is widespread in New Zealand.

Aim. This study estimates the costs of identifying a new case of PCa by screening asymptomatic men.

Methods. Men aged 40+, who had PSA tests in 31 general practices in the Midland Cancer Network region during 2010, were identified. Asymptomatic men without a history of PCa were eligible for this study. A decision tree was constructed to estimate the screening costs. We assumed GPs spent 3 minutes of the initial consultation on informed consent of PCa screening.

Results. About 70.7% of the estimated costs were incurred in general practice. The screening costs per cancer detected were NZ$10 777 (€5820; £4817). The estimated costs for men aged 60–69 were NZ$6268 compared to NZ$1 1 272 for non-Māori. The costs for men without PSA testing history in 2007–09 were NZ$8887 compared to NZ$13 870 if the men had PSA tests in 2007–09. If we assumed a PSA test involved a full 15-minute general practice consultation, the estimated costs increased to NZ$26 877 per PCa identified.

Conclusions. Screening of asymptomatic men for PCa is widely practiced. Most of the costs of screening were incurred in general practice. Calls for men to receive increased information on the harms and benefits of screening will substantially increase the costs. The current costs could be reduced by better targeting of screening.

Keywords. Diagnostic tests, health economics, primary care, prostate cancer, screening, urology.

Introduction

Prostate cancer (PCa) is the most frequently diagnosed cancer and the third most common cause of cancer death for men in New Zealand (NZ).\textsuperscript{1} To detect PCa cancer at an early stage, general practitioners usually screen men aged 40 years and older, using the prostate-specific antigen (PSA) test. The argument for PCa screening can be supported by evidence from the European Randomized Studies of Screening for Prostate Cancer (ERSPC) and the Göteborg study.\textsuperscript{2,3} These studies indicated that screening could reduce the PCa-specific mortality rate for men aged <70. However, other research demonstrated no difference in the overall or PCa-specific mortality between the screened and unscreened groups.\textsuperscript{4}

Though PCa screening is not recommended by the Ministry of Health (MoH), it is widespread in NZ with >345 000 PSA tests ordered in 2010.\textsuperscript{5} Approximately 80% of the PSA tests were carried out on asymptomatic men.\textsuperscript{6} The pattern of PSA testing differs from country to country. GLOBOCAN 2008 identifies NZ as having one of the highest age-standardized incidence rates worldwide, in excess of both the USA and UK (99.7 versus 83.8 and 64 per 100 000, respectively), which appears to be related to a high rate of PSA testing. The NZ incidence rate appears similar to Canada and Australia (101.5 and 105), which may provide the closest comparisons among the Organization for Economic Cooperation and Development (OECD).\textsuperscript{7}

PCa screening has triggered a series of problems, including increasing medical costs. The published
screening costs are outdated and vary widely. Often, which medical resources were included and how they were valued was not clearly reported.\textsuperscript{8} This study estimates the costs of identifying a new case of PCa by age group, ethnicity and former PSA testing history, using data from general practice in the NZ Midland Cancer Network. The Midland Cancer Network is one of four cancer networks in NZ, coordinating health services related to cancer for three health boards with a combined population of ~691,000 people. The Midland Cancer Network has a mix of urban and rural areas and a relatively high Māori population. The PSA testing rate (22.1\%) in this region was similar to the rate (22\%) across the whole country.\textsuperscript{5} While NZ has a state-funded public hospital system, GPs, while receiving a capitation payment for each patient, are also entitled to charge patients a fee.

Methods

Data collection

All general practices in NZ use a computer system and all patients have a National Health Index (NHI) number linked to the data used for capitation payments. Information collected on patients' characteristics from the general practices, including ethnicity, age and gender is almost complete. All patients need to provide these data before they are enrolled in the general practices. We linked the electronic patient medical records from 31 general practices to laboratory data using the NHI number to identify male patients aged 40+ who had one or more PSA tests in 2010. The database in the NZ Cancer Registry, a population-based tumour register in NZ, was also linked to the practice data by the NHI numbers to exclude men with a previous PCa history. For all men identified, we also had their PSA records in 2007–09. We excluded men with a previous record of raised PSA values in 2007–09. We also searched all medical records for men with a raised PSA and we noted whether lower urinary tract symptoms or other prostate problems were present at the time of PSA testing. Symptomatic men were excluded, and all other men were considered to be ‘screened’ patients.

For eligible men, we recorded their age, ethnicity, PSA testing histories, PSA tests, referrals to specialists and biopsy results. These data were collected from general practices and relevant community laboratories. Patients who underwent biopsies were followed up to the date of biopsy. Men who had elevated PSA results but did not undergo biopsies were followed up for 12 months since the date of their first PSA test in that year. The raised PSA levels defined in this study were age specific, used by a local laboratory: ≥2.5 µg/l for men aged 40–49; ≥3.5 µg/l for men aged 50–59; ≥4.5 µg/l for men aged 60–69; ≥6.5 µg/l for men aged 70–79; ≥7 µg/l for men aged 80+. Where necessary, missing number of PSA tests for 2011 was imputed by a statistical package, R 2.14.1, using the nearest neighbour imputation approach.\textsuperscript{9}

Cost estimation

This study estimates direct medical costs in 2010 and 2011 from a health service perspective. This perspective includes charges levied by GPs for consultations (with the remainder subsidized by the NZ MoH) but excludes other indirect costs to patients, such as wages foregone and the cost of travel to attend appointments.

A decision tree was constructed to map the screening pathway and to document the costs associated with each node (Fig. 1). Medical resources considered in this

\textbf{Figure 1} Pathway of screening for PCa in New Zealand
Undiagnosed prostate cancer in asymptomatic men 643

study comprised initial GP consultations (the first consultation related to PSA testing), follow-up GP consultations, PSA tests, first specialist assessments (FSAs), follow-up specialist consultations, prostate biopsies, pathology reports of prostate biopsy and hospitalization due to complications after prostate biopsy. The volumes of the PSA tests, FSAs, prostate biopsies and pathology reports were calculated from the data we collected. The number of GP consultations was estimated based on records of PSA tests ordered by GPs. The number of follow-up specialist consultations was estimated from the number of prostate biopsies and PSA tests ordered by specialists. A 2% complication rate and a 4.87-day mean length of hospital stay for complications of prostate biopsy were assumed to quantify the hospitalization after prostate biopsy.

The quantity of health care resources was multiplied with the unit cost of each type of medical resource to generate an aggregate cost. The unit costs of medical resources are provided in Table 1, alongside the sources. The subsidy per GP consultation was estimated by dividing the capitation rate by the average number of GP consultations per patient (Table 1). The unit costs corresponding to different time periods were converted into 2010 values (as the base year of this analysis) by applying the NZ Inflation Calculator developed by the Reserve Bank (the central bank in NZ). All costs were valued in NZ dollars (NZ$). The conversion rates per NZ dollar in 2010 were 0.540 European euro (€) and 0.447 Pound sterling (£), estimated from the prices and purchasing power parities of different currencies provided by OECD.

The time spent on discussion about PSA testing in the initial GP consultation differs from general practice to general practice. It is related to the level of informed consent, ranging from almost no time (ticking the box of a laboratory form) to the whole consultation spent on discussing the harms and benefits associated with PCa screening. Three percentages (20%, 50% and 100%) of the cost of an initial GP consultation were assumed to be attributed to PCa screening. The 20% was inferred from a MoH report demonstrating ~80% of PSA tests were GP initiated and only 20% were patient initiated. The 50% was based on an assumption that on average half of the GP consultations were spent on discussion of PCa screening. The 100% was based on a gold standard of PSA testing recommended by the MoH: ‘All men who are concerned about prostate cancer or are requesting a PSA test must be presented with high-quality, culturally appropriate information’ assuming that the delivery of ‘high-quality, culturally appropriate information’ would take a full GP consultation (15 minutes). All the follow-up GP consultations were assumed to be spent on discussion about the PSA testing.

The costs of detecting a new case of PCa were estimated by age group (40–49, 50–59, 60–69, ≥70 years), ethnicity (Māori and non-Māori) and previous PSA testing history (had PSA tests in 2007–09, had no PSA test in 2007–09).

The costs of detecting a new case of PCa were estimated by age group (40–49, 50–59, 60–69, ≥70 years), ethnicity (Māori and non-Māori) and previous PSA testing history (had PSA tests in 2007–09, had no PSA test in 2007–09).

Table 1 The unit costs of medical resources

<table>
<thead>
<tr>
<th>Medical resources</th>
<th>Corrected cost in 2010 (New Zealand Dollars)</th>
<th>Unit cost collected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reported cost</td>
<td>Year</td>
</tr>
<tr>
<td>PSA test</td>
<td>NZ$11.07</td>
<td>NZ$10.44</td>
</tr>
<tr>
<td>GP consultation</td>
<td>NZ$73.54</td>
<td>–</td>
</tr>
<tr>
<td>Charge</td>
<td>NZ$35.88</td>
<td>NZ$36.73</td>
</tr>
<tr>
<td>Subsidy</td>
<td>NZ$3366</td>
<td>NZ$38.69</td>
</tr>
<tr>
<td>First specialist assessment</td>
<td>NZ$268.79</td>
<td>NZ$276.36</td>
</tr>
<tr>
<td>Follow-up specialist consultation</td>
<td>NZ$233.64</td>
<td>NZ$213.09</td>
</tr>
<tr>
<td>Biopsy</td>
<td>NZ$42796</td>
<td>NZ$440.00</td>
</tr>
<tr>
<td>Pathology report of biopsy</td>
<td>NZ$710.02</td>
<td>NZ$730.00</td>
</tr>
<tr>
<td>Hospitalization after biopsy (per bed day)</td>
<td>NZ$405.82</td>
<td>NZ$349.50</td>
</tr>
</tbody>
</table>

All the unit costs of medical resources in hospitals were based on data from public hospitals.


Frette and Pande.

Sensitivity analysis
One-way sensitivity analysis was conducted to assess the uncertainty in the results. Each parameter used in the cost estimation, including the number of cancers detected, the unit cost and the volume of each type of medical resource, was decreased or increased by 20% of the original value (the data we collected) at one time to appraise its impact on the screening costs.

Results
Number of men screened
The general information about the study population has been published. We excluded 1006 men with a previous PCa history, and identified 35,958 men aged 40 years or over, without a PCa history, registered with the 31 general practices. Of the eligible men, 9344 of them had one or more PSA tests in 2010, and 7936 men were considered to be screened (asymptomatic). A very small number (30) of men had missing follow-up data on repeated PSA tests that required imputation.

After the first PSA test, 27 men were referred to the specialists and 146 men were followed up by GPs, of whom 42 men were referred to the specialists in 2010 or 2011. Of the 69 men referred to specialists, 46 men had biopsies, and 29 men were diagnosed with PCa.

The number of asymptomatic men needed to be screened to identify a new case of PCa was 274 for the whole screening group but differed according to patient characteristics. The number of men who needed to be screened was below this average figure (274) for the following groups: those aged 60–69 (127), Māori men (139) and those who had not previously been tested in 2007–09 (188).

Table 2 Quantity of medical resources for PCa screening

<table>
<thead>
<tr>
<th>Categories</th>
<th>PSA test ordered by GP</th>
<th>Initial GP consultation</th>
<th>Follow-up GP consultation</th>
<th>First specialist assessment</th>
<th>Follow-up specialist consultation</th>
<th>PSA test ordered by specialist</th>
<th>Biopsy</th>
<th>Pathology report</th>
<th>Hospitalization after biopsy (bed days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40–49</td>
<td>1448</td>
<td>1434</td>
<td>14</td>
<td>8</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>0.49</td>
</tr>
<tr>
<td>50–59</td>
<td>2645</td>
<td>2604</td>
<td>41</td>
<td>17</td>
<td>18</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>0.88</td>
</tr>
<tr>
<td>60–69</td>
<td>2492</td>
<td>2407</td>
<td>85</td>
<td>31</td>
<td>41</td>
<td>14</td>
<td>27</td>
<td>27</td>
<td>2.63</td>
</tr>
<tr>
<td>≥70</td>
<td>1548</td>
<td>1491</td>
<td>57</td>
<td>13</td>
<td>9</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>0.49</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>570</td>
<td>557</td>
<td>13</td>
<td>11</td>
<td>17</td>
<td>10</td>
<td>7</td>
<td>7</td>
<td>0.68</td>
</tr>
<tr>
<td>Non-Māori</td>
<td>7563</td>
<td>7379</td>
<td>184</td>
<td>58</td>
<td>61</td>
<td>22</td>
<td>39</td>
<td>39</td>
<td>3.80</td>
</tr>
<tr>
<td>PSA testing history</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Had PSA tests in 2007–09</td>
<td>4643</td>
<td>4545</td>
<td>98</td>
<td>21</td>
<td>21</td>
<td>7</td>
<td>14</td>
<td>14</td>
<td>1.56</td>
</tr>
<tr>
<td>Overall</td>
<td>8133</td>
<td>7936</td>
<td>197</td>
<td>69</td>
<td>78</td>
<td>32</td>
<td>46</td>
<td>46</td>
<td>4.48</td>
</tr>
</tbody>
</table>
costs for men without a PSA testing history in 2007–09 (NZ$8887–19,970). The costs for men aged 40–49 (NZ$24,900–66,472), 50–59 (NZ$30,022–81,089) and 70+ (NZ$10,957–28,501) were 3.9–4.8 times, 4.8–5.9 times and 1.7–2.1 times the costs for men aged 60–69. The costs for non-Māori men (NZ$11,272–28,637) were 1.5–1.8 times the costs for Māori men. The costs per cancer detected for men with a prior history of PSA testing in 2007–09 (NZ$13,870–38,178) were 1.6–1.9 times the costs for men without previous PSA tests in that period.

Sensitivity analysis
The number of cancers detected in the screened men had the strongest impact on the costs per PCa identified, followed by the unit cost/volume of GP consultations and then the unit cost/volume of PSA tests. The variation of other parameters did not lead to significant impact on the costs per PCa detected.

Discussion

Key findings
PSA testing for PCa is widespread in NZ. The screening rate in the 31 general practices in 2010 was 22.1%. Of the men with positive PSA results, only 25.9% had biopsies and 63.0% of the biopsies were positive. These results from general practice are greatly different from the results from the ERSPC trial, in which 85.9% of men with positive PSA tests underwent biopsies, but only 24.1% of the biopsies were positive. There is a clear difference in clinical practice, although it is important to note that the detection rates of cancer in men with raised PSA are broadly similar (16.3% in NZ and 20.7% in ERSPC). It is unclear how much of these differences result from protocol-based care in the ERSPC trial as against routine clinical practice reported in this study and how much depends upon country-specific differences.

The costs of identifying a new case of PCa by screening asymptomatic men were substantial. If on average 3 minutes of GP time (20% of the consultation cost) was spent on discussing PSA testing for each man, the costs per cancer detected were NZ$10,777 (€5820; £4817). The costs increased to NZ$26,877 if every screened man received informed consent (a full 15-minute consultation) for PCa screening. It is difficult to compare the costs of detecting a new case of PCa in NZ with the costs in other countries, due to the various screening strategies, diverse time frames of the studies, and more importantly, the different cost components and unit costs. For example, the cost for a 15-minute GP consultation in the UK in 2010 was £46.5 (NZ$104.0) compared to NZ$73.54 in NZ.

![Figure 2](https://academic.oup.com/fampra/article-abstract/30/6/641/527455)
Some studies have only involved the costs of diagnostic tools,\textsuperscript{8,16} while our study indicates that the costs of physician consultations (including GP consultations and specialist consultations) accounted for 53.6–81.5\% of the total costs. A Canadian study\textsuperscript{17} showed that the costs of identifying a new case of PCa was Can$2420 in 1998 (NZ$4128 in 2010) if only the costs of diagnostic tools were estimated, which is less than half the costs in our study. Most of the screening costs were incurred in general practice (70.7\%). Additional input from GPs providing informed consent would add substantially to the total costs.

The lowest screening costs per cancer detected were for men aged 60–69, the group in whom most cancers were identified. It is noteworthy that the percentage of costs incurred in general practice in total costs for those aged 60–69 was smaller than the percentages in the other age groups. It might be ascribed to the higher referral rate in this age group, resulting in greater costs incurred in hospitals for men aged 60–69. Men aged 70+ were less likely to be referred or to undergo biopsies. These men are unlikely to benefit from PCa screening.\textsuperscript{4} In the age groups 40–49 and 50–59, PCa was rarely found. More men in these age groups needed to be screened to identify a new case of PCa.

For men with a PSA testing history in 2007–09, the costs per cancer detected were much greater in comparison with the costs for men without such a history. Considering the long lead time for PCa, although more cancers can be detected if men are screened more frequently,\textsuperscript{16} the possibility of detecting new cases of PCa at each screening round will be smaller. The costs per cancer detected will increase. Similar results have also been shown by Nordström et al.,\textsuperscript{18} demonstrating retesting men with negative PSA values too frequently would lead to unnecessary harm and costs. Compared with non-Māori, Māori were less likely to be screened and were less frequently screened. The possibility of detecting new cases of PCa in Māori at each screening round was greater and the costs per cancer detected were lower.

\textit{Informed decision making}

PSA-based screening for PCa is not recommended. However, the common use of PSA testing is recognized on the premise that it is an informed decision made by patients.\textsuperscript{19} The American Cancer Society suggested an informed decision should be made based on patient’s preferences and values after the individual has comprehended the uncertainties, potential harms and benefits of screening.\textsuperscript{20} The Prostate Cancer Taskforce in NZ advocated that systems providing ‘high-quality, culturally appropriate information on prostate cancer and PSA testing’ must be developed to facilitate the informed consent process.\textsuperscript{14} This study has provided information on the economic impact of PCa screening, as well as the cost-effectiveness of PCa screening by age, ethnicity and previous PSA testing history to help better decision making for PCa screening. Increasing the emphasis and time spent on informed consent will substantially increase the screening costs. However, informed consent may contribute to better targeted screening and therefore increase the detection rate and decrease the costs per cancer detected.

\textit{Strengths and limitations}

One of the strengths of this study is that it was based on data collected from general practice rather than data from clinical trials. The information reflected the activities in the health care system. The results of studies based on data from clinical trials might not mirror reality. Patients in the clinical trials comply strictly with the protocols set by the researchers.\textsuperscript{16} However, in our study, 104 men with positive PSA records were not referred to specialists. Among the referred patients, 23 patients did not undergo biopsies. Another difference with our study is that the PSA records and patient medical records were examined to identify the reasons for the PSA tests. Only asymptomatic men were included in this study. The detection of symptomatic PCa should not be ascribed to the effect of screening.

This study has several limitations. As the data relate to one area of NZ serviced by an existing network (Midland Cancer Network), the findings are not necessarily generalizable to those in other areas. There are some costs that this study could not cover, namely the indirect costs to patients or society, the costs of initial GP consultation for those patients who decided against PSA testing and the costs of time spent by the health professionals on informing patients the test results and arranging consultations. The total number of PCa identified was relatively small (29), resulting in a lack of precision in the costs per cancer detected in the subgroup analyses. Despite this, we believe these analyses are of interest. Finally, as this analysis considers only the cost of screening without assessing either the cost of subsequent treatment or the benefits arising from that treatment, it can provide at best partial information when informing decision making.

\textit{Conclusions}

Screening of asymptomatic men for PCa is widely practiced in NZ. Most of the estimated costs of screening were incurred in general practice. Calls for men to receive increased information on the harms and benefits of screening will substantially increase the costs per cancer identified. The costs could be reduced by better targeting of screening.
Declaration

Funding: Health Research Council of New Zealand (HRC Partnership Programme grant number 11/082, entitled ‘The costs and complications of screening for prostate cancer’) and New Zealand Ministry of Health (to CL).

Ethical approval: Northern Y Ethics Committee (reference number: NTY/11/02/019).

Conflict of interest: none.

References