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Earlier cancer diagnosis in primary care: a feasibility economic analysis of ThinkCancer!

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Abstract

Background: UK cancer survival rates are much lower compared with other high-income countries. In primary care, there are opportunities for general practitioners (GPs) and other healthcare professionals to act more quickly in response to presented symptoms that might represent cancer. ThinkCancer! is a complex behaviour change intervention aimed at primary care practice teams to improve the timely diagnosis of cancer.

Aim: To explore the costs of delivering the ThinkCancer! intervention to expedite cancer diagnosis in primary care.

Design: Feasibility economic analysis using a micro-costing approach.

Setting: Nineteen general practices in Wales, UK.

Methods: From an NHS perspective, we used micro-costing methodology to determine whether it was feasible to gather sufficient economic data to cost the ThinkCancer! intervention. Due to the Covid-19 pandemic, ThinkCancer! was mainly delivered remotely online in a digital format. Budget impact analysis and sensitivity analysis were conducted to explore the costs of face-to-face delivery of the ThinkCancer! intervention as intended pre-COVID-19.

Results: The total costs of delivering the ThinkCancer! intervention across 19 general practices in Wales was £25,030, with an average cost per practice of £1,317 (SD: 578.2). Findings from the budget impact analysis indicated a total cost of £34,630 for face-to-face delivery.

Conclusion: Data collection methods were successful in gathering sufficient health economics data to cost the ThinkCancer! intervention. Results of this feasibility study will be used to inform a future definitive economic evaluation alongside a pragmatic randomised controlled trial.

Trial registration: ClinicalTrials.gov NCT04823559.

Keywords: Primary health care, General practice, Feasibility study, Health economics, Early cancer diagnosis
How this fits in:

For many cancers, earlier diagnosis is associated with greater survival and better patient quality of life and experience. Cancer survival is lower in the UK compared with other comparable countries. The need for interventions such as ThinkCancer! which aims to improve the timely diagnosis of cancer within primary care teams are increasingly important. Lessons learnt from this feasibility trial have important practice implications to ensure cancer diagnoses are as timely as possible.

Main text

Introduction

Between 2017 and 2018, cancer investigation and treatments accounted for 7.1% of the total NHS expenditure in Wales, this was the fourth highest expenditure category, with a resultant cost of £463 million.¹ There are also wider societal costs of cancer such as direct patient costs including loss of income, travel costs to regular medical appointments and increased household bills such as heating. Research from Macmillan Cancer Support found that almost a third of people living with cancer in the UK have experienced a loss of income due to their cancer diagnosis with the average income lost at £860 per month.²

Previous international studies have shown that Wales is at the bottom of international comparators with respect to cancer survival and have underlined later diagnosis as a leading cause.¹ If cancer is diagnosed early, treatment is more likely to be curative, less intensive and less costly.³ The Welsh Government has outlined a number of challenges with respect to earlier cancer diagnosis including difficulties among GPs and other healthcare professionals in identifying cancers that present with vague or non-specific symptoms.³ A previous study in Wales demonstrated the cost-effectiveness of a rapid diagnosis centre (RDC) for patients presenting with vague or non-specific symptoms of cancer through referral from primary care.⁴ Our present study of ThinkCancer! aims to address the gap in diagnostics in primary care and targets the entire general practice team.

The aim of this study was to conduct a feasibility economic analysis of the ThinkCancer! intervention. The ThinkCancer! intervention is a complex behaviour change intervention targeting general practice teams, aiming to improve earlier cancer diagnosis in primary care. Preliminary estimates of cost-effectiveness in feasibility studies with small sample sizes may
risk negative outcomes, therefore the focus should be limited to developing and refining methods for data collection, including health economics data.\textsuperscript{5}

The specific objectives of the ThinkCancer! feasibility economic analysis were as follows:

1. To explore the feasibility of gathering sufficient economic data including costs of the intervention to inform a future definitive economic evaluation alongside a RCT
2. To conduct a budget impact analysis and sensitivity analysis to explore the costs of face-to-face delivery of the ThinkCancer! intervention as intended pre-COVID-19.

**Methods**

From a NHS perspective, we conducted a feasibility economic analysis of the ThinkCancer! intervention. The intervention was delivered in workshops delivered as three separate sessions to each practice individually. The intervention as a whole comprised of four main components. The first and second components were educational sessions, one for clinical staff members (the ‘early diagnosis’ session) and the other for patient facing non-clinical staff members (the ‘cancer aware’ session). The third session included the final two components and was delivered as a safety netting session to both clinical and non-clinical staff members. The final two components within this session involved the development of a tailored Cancer Safety Netting Plan and the appointment of a Cancer Safety Netting Champion within the practice. A full description of the intervention is published in the study protocol.\textsuperscript{6} The ThinkCancer! logic model presented in the main feasibility protocol\textsuperscript{6} was developed in accordance with the MRC framework for the evaluation of complex interventions.\textsuperscript{7} The logic model depicts the relationship between the intervention components and the intended outcomes for the main feasibility trial. This logic model has been adapted (Figure 1) to demonstrate the point at which costs were collected for the micro-costing analysis presented in this manuscript. The logic model also details the intended output and outcome from the micro-costing activities (Figure 1). Outcome data from the main feasibility study were not included in this feasibility economic analysis.
Figure 1. Adapted ThinkCancer! logic model
The intervention was delivered in three formats: remote webinars; pre-recorded sessions allowing participants to engage with the materials in their own time; or face-to-face sessions, as originally intended before the Covid-19 pandemic. We used a micro-costing approach to gather sufficient economic data to cost the ThinkCancer! intervention. In micro-costing, each component of resource use is estimated and then combined with its unit cost to allow accurate costing of the intervention.\(^8,9\)

Data on the direct medical costs of the intervention were collected using health economics cost diaries (Supplementary File 1) completed by those delivering the intervention. Costs recorded in the cost diaries included intervention deliverer costs and material costs. We had intended to use workshop feedback forms to cost NHS staff time attending the intervention (Supplementary File 2). However, early on during the study it became apparent that it was unfeasible to use the feedback forms to obtain this data due to incorrect information provided by staff members regarding their attendance at the sessions. Consequently, we did not use any data obtained in the feedback forms. Instead, we used the notes written by the GP educator delivering the workshop to determine the numbers and roles of each staff member in attendance at each of the sessions.

We costed staff time participating in the workshops using Personal Social Services Research Unit (PSSRU) national unit costs.\(^10\) Unit costs for non-clinical staff were calculated using the NHS Agenda for Change annual salaries\(^11\) to derive a cost per hour, as unit costs for non-clinical primary care staff were not available in the PSSRU. A sample unit costs schedule for primary care practice staff costs can be viewed in Table 1. Relevant overheads and on-costs were included in our calculations. As part of their methodology, overheads and on-costs were accounted for in the unit costs provided by the PSSRU.\(^10\) Where no on-cost information was available a flat rate of 30% was applied, based on estimates used in the PSSRU.\(^10\) To avoid double counting, overheads were not applied when costing non-clinical staff as this was assumed to fall within the administration and management support overheads included within the PSSRU clinical staff unit costs.\(^10\) We assessed the upfront costs of developing the intervention to be delivered in an online format (live and pre-recorded sessions), and produced means and descriptive statistics relating to the costs of delivering the intervention across different practices. The follow-up period for outcome measures in the main feasibility study was 6 months, this economic analysis did not include any outcome data; therefore, in accordance with NICE guidelines we did not apply a discount rate as the costs and benefits were not beyond 12 months.\(^12\)
Our base-case analysis explored the cost of ThinkCancer! as it was delivered to 19 general practices in Wales. The analysis presents total costs of intervention delivery which refers to the costs for each of the participating practices to receive one multi-component workshop which consisted of three separate workshops/sessions. Each multi-component workshop was delivered to individual practices separately i.e., one intervention (delivered as three separate workshops/sessions) to each of the 19 practices. Upfront intervention development costs are presented separately and do not come under total costs of intervention delivery. Recruitment of practices occurred in two stages; one practice was recruited prior to the Covid-19 pandemic and then the study was put on hold. Recruitment then resumed in July 2020. The total study recruitment period was between February 2020 and February 2021, and intervention delivery ran from October 2020 and May 2021. Health economics data to cost intervention delivery was collected immediately following each workshop. The majority of workshops were delivered to practices remotely in an online live delivery format; however, using budget impact analysis (BIA) and sensitivity analysis we also explored what the costs would be of delivering the intervention face-to-face as intended pre-COVID-19. BIAs are economic assessments used to explore the financial consequences of implementing a new health technology or intervention and are used to aid in decision making with respect to the allocation and reallocation of resources within specific healthcare settings with finite resources.\textsuperscript{13,14} We conducted a sensitivity analysis to show the difference in costs if the intervention were delivered face-to-face by the GP educator alone, and with the addition of one support role assisting the intervention. We also conducted a separate BIA using published statistics on the number of active general practices in Wales during the time of this study and the findings of our base case analysis to project the cost of delivering ThinkCancer! remotely at scale to practices across Wales.

In a separate BIA, we explored the cost of delivering ThinkCancer! remotely at scale to general practices across Wales based on the average intervention delivery cost per practice from our base-case analysis. According to Welsh Government statistics,\textsuperscript{15} there were 404 active general practices across Wales in 2020. Based on an average cost per practice of £1,317, the estimated total cost of delivering ThinkCancer! online to all general practices across Wales would be approximately £532,000.
Results

Feasibility of gathering sufficient health economics data to cost ThinkCancer!

Cost diaries developed for this feasibility trial successfully captured all of the direct medical costs of the intervention, with no missing data. We had intended to use feedback forms to capture information on the number and roles of staff attending the intervention; however, this method was deemed unfeasible early on in the study due to inaccurate information provided by staff members regarding their attendance. As each workshop was split into three sessions, some staff members attended one of the first two sessions and had then completed the feedback forms with the intention of attending the third session (safety netting session), but then had subsequently not attended. Inaccuracies in the number of staff attending sessions became apparent when the information in the feedback form did not correspond with the GP educator notes on attendance. Consequently, the analysis did not use any information captured in the feedback forms and instead, GP educator notes were used to determine the number and roles of staff attending the sessions. Nevertheless, this sometimes proved difficult due to the online delivery format that was primarily used to deliver the intervention. In some instances, it was difficult to ascertain the number and roles of staff attending the workshops due to factors such as cameras being switched off during the workshops and more than one member of staff watching the workshops over one computer screen. It was also inappropriate and unfeasible to gather information on staff pay bands due to the online mode of delivery adopted, therefore average costs of each staff role were used.

Base-case analysis

The total cost of delivering the ThinkCancer! intervention to the 19 practices was £25,030. This was the total cost for each practice to receive one full workshop (split into three sessions). This cost comprised of materials (including postage costs), staff attendee time and intervention delivery time (Table 1). Nineteen multi-component workshops (each split into three sessions) were delivered in total (one to each practice). Of these, 15 practices received all three of their sessions in a live online delivery format. Three practices out of the 19 practices, received one of their three sessions in a pre-recorded format and the remaining two sessions in a live online format. One practice out of the 19 practices, received two of their three sessions in an online live format but received the third session in a face-to-face format and therefore travel costs were also calculated in this instance.
The mean cost of intervention delivery per practice was £1,317 (SD 578.24, range £431 to £2,498). This was calculated by dividing the total cost of intervention delivery across the 19 practices by 19 (the number of practices that received the intervention). The largest driver of cost was staff attendance at the workshops. The total cost of primary care staff time for attending the intervention for all 19 general practices was £18,773 (Table 1). GP attendance yielded the highest cost, at a unit cost of £2.60 per minute (Supplementary File 3).

Total cost of materials across the practices (including postage costs) was £3,149 (Table 1). The highest costing item was the Red Whale handbook (£21.54 each including Value Added Tax) (Table 2). The total time to deliver the intervention was 37.55 hours (2253 minutes). Table 3 provides a breakdown of the costs of GP educator and support role time to deliver the intervention. The total cost of intervention deliverer time at the 19 general practices was £3,109. Separate upfront intervention development costs were estimated to be £4,385 based on 87 hours of GP educator time to construct and develop the ThinkCancer! intervention.

Table 1. Total costs for intervention delivery at 19 general practices

<table>
<thead>
<tr>
<th>Type of cost</th>
<th>Total</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>£3,149</td>
<td>£166</td>
<td>52.88</td>
</tr>
<tr>
<td>Staff attendee time</td>
<td>£18,773</td>
<td>£988</td>
<td>524.95</td>
</tr>
<tr>
<td>Intervention deliverer time</td>
<td>£3,109</td>
<td>£164</td>
<td>53.37</td>
</tr>
<tr>
<td></td>
<td>£25,030</td>
<td>£1,317</td>
<td>578.24</td>
</tr>
</tbody>
</table>

Table 2. Total costs of materials for ThinkCancer! intervention delivery at 19 general practices

<table>
<thead>
<tr>
<th>Materials</th>
<th>Units</th>
<th>Unit cost (£)</th>
<th>Number of units</th>
<th>Total cost (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Whale handbook</td>
<td>One Red Whale handbook (with Value Added Tax)</td>
<td>£21.54</td>
<td>114</td>
<td>£2,455.56</td>
</tr>
<tr>
<td>SSNAP tool</td>
<td>Per tool</td>
<td>£1.78</td>
<td>72</td>
<td>£128.16</td>
</tr>
<tr>
<td>Feedback form</td>
<td>Per form</td>
<td>£0.15</td>
<td>280</td>
<td>£42</td>
</tr>
<tr>
<td>Participant information sheet</td>
<td>Per sheet</td>
<td>£0.50</td>
<td>570</td>
<td>£285</td>
</tr>
<tr>
<td>Consent form</td>
<td>Per form</td>
<td>£0.10</td>
<td>258</td>
<td>£25.80</td>
</tr>
</tbody>
</table>
Table 3. Total costs of time to deliver ThinkCancer! at 19 practices.

<table>
<thead>
<tr>
<th>Intervention deliverer:</th>
<th>Unit</th>
<th>Unit costs £</th>
<th>Total time of intervention delivery across 19 practices (minutes)</th>
<th>Travel costs (£0.40 per mile)</th>
<th>Total cost (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP educator</td>
<td>Per minute</td>
<td>£0.84</td>
<td>2253</td>
<td>£41.60</td>
<td>£1934.12</td>
</tr>
<tr>
<td>Support role 1</td>
<td>Per minute</td>
<td>£0.34</td>
<td>2193</td>
<td>£0</td>
<td>£745.62</td>
</tr>
<tr>
<td>Support role 2</td>
<td>Per minute</td>
<td>£0.48</td>
<td>894</td>
<td>£0</td>
<td>£429.12</td>
</tr>
</tbody>
</table>

Budget impact and sensitivity analysis

Only one practice received one of their workshop sessions in a face-to-face format. A budget impact analysis (BIA) was conducted to explore what the total costs would be for face-to-face delivery of the ThinkCancer! intervention if all of the 19 general practices recruited in this feasibility study received all of their workshop sessions in a face-to-face format. Table 4 provides a breakdown of additional costs incurred for face-to-face delivery including travel expenses (calculated at £0.40 per mile) and travel time duration (total minutes for return journey to each practice) in order to calculate intervention deliverer time costs for travel. Distances and travel durations between the practices and the research centre were obtained from Google maps.

Estimated total costs for face-to-face delivery at the 19 general practices would be £34,630 based on the total costs accrued for intervention delivery in our base-case analysis and additional costs for travel expenses (one vehicle shared by the intervention deliverers) and intervention deliverer travel time (Table 4). Estimated total costs for travel expenses were £1,493 (calculated at £0.40 per mile). Total costs of intervention deliverer travel time was £8,107. The number of intervention deliverers in attendance varied between practices but usually there were two roles delivering/supporting the intervention; however, an additional support role was in attendance for some of the workshops. Sensitivity analysis shows that the
total costs of face-to-face delivery by one GP educator (including travel expenses for one vehicle and GP educator travel time) was estimated at £31,232. With the addition of one support role, the total costs for face-to-face delivery (including travel expenses for one shared vehicle and travel time costs) is estimated at £33,138.

In a separate BIA, we explored the cost of delivering ThinkCancer! remotely at scale to general practices across Wales based on the average intervention delivery cost per practice from our base-case analysis. According to Welsh Government, there were 404 active general practices across Wales in 2020. Based on an average cost per practice of £1,317, the estimated total cost of delivering ThinkCancer! online to all general practices across Wales would be approximately £532,000.

In a separate BIA, we explored the cost of delivering ThinkCancer! remotely at scale to general practices across Wales based on the average intervention delivery cost per practice from our base-case analysis. According to Welsh Government, there were 404 active general practices across Wales in 2020. Based on an average cost per practice of £1,317, the estimated total cost of delivering ThinkCancer! online to all general practices across Wales would be approximately £532,000.

Table 4. Estimated travel expenses and travel time costs for intervention delivers for face-to-face delivery format at 19 general practices

<table>
<thead>
<tr>
<th>Total miles for return journeys to the general practice sites</th>
<th>Total cost for travel expenses (calculated at £0.40 per mile)</th>
<th>Total travel time to 19 general practices (minutes)</th>
<th>Total cost of intervention deliverers’ time for travel (based on the number of deliverers at workshops in the base case analysis)</th>
<th>Total cost of face-to-face delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>3733</td>
<td>£1,493.20</td>
<td>5606</td>
<td>£8107</td>
<td>£34,630</td>
</tr>
</tbody>
</table>

Discussion

Summary

The total costs of delivering the ThinkCancer! intervention across 19 general practices in Wales was £25,030. Costs per practice ranged from £431 to £2,498, with an average cost per practice of £1,317 (SD 578.24). The potential budget impact if the intervention were to be delivered face-to-face would be £34,630. Sensitivity analysis revealed that if the intervention were to be delivered by one GP educator, the total estimated cost for face-to-face delivery would be £31,232. With the addition of one support role assisting the GP educator with the intervention delivery, the total cost of face-to-face delivery is estimated to be approximately £33,138.
Strengths and limitations

This feasibility economic analysis provides estimated costs of delivering the ThinkCancer! intervention in primary care settings. ThinkCancer! is a relatively low-cost intervention when compared to the costs associated with later stage diagnosis. For example, treatment costs per patient for early-stage ovarian cancer is £5,328 but increases to £15,081 at its latest stage.\(^1\)\(^6\)

This intervention has the potential to expedite the diagnosis of symptomatic cancer, improve cancer patient outcomes and avoid costs to the NHS associated with later stage cancer treatments.

Only one of the practices received part of their workshop (one session) in a face-to-face format making it difficult to draw conclusions regarding the feasibility of this mode of delivery. As this was a feasibility study, we did not undertake a cost-effectiveness analysis as it was unlikely that we would have observed a difference in the primary outcome measure due to the small sample size and short follow-up. Nevertheless, the purpose of this feasibility study was to assess whether it was possible to conduct the proposed intervention in the planned way in order to design a future definitive trial.\(^5\) Preliminary estimates of cost-effectiveness in feasibility studies with small sample sizes may risk negative outcomes, therefore the focus of health economics in feasibility studies should be limited to developing and refining methods for data collection, including health economics data.\(^5\)\(^,17\)

The cost diaries designed for this feasibility stage were a successful method of gathering sufficient economic data to cost the ThinkCancer! intervention. However, capturing information on the number and roles of primary care staff who attended the intervention was challenging due to the online delivery format. Consequently, it is possible that some costs may have been underestimated in our analysis as we cannot be certain of the exact numbers of staff who received the intervention remotely. These issues will be discussed and reviewed with the ThinkCancer! research team when planning and designing a future definitive trial.

Comparison with existing literature

There is a lack of evidence relating to the costs of interventions to expedite cancer diagnosis in general practice settings. One UK study from 2020 assessed the cost-effectiveness of a RDC for patients presenting with vague non-specific symptoms suspicious of cancer through referral from primary care. The results found that the RDC yielded more QALYs and was less costly than standard clinical practice when the RDC was running at a capacity of 80% or
more. To our knowledge, the ThinkCancer! study is the first costing study of an intervention to expedite cancer diagnosis within general practice settings that targets the entire general practice team.

A systematic review and meta-analysis of methods for training licensed health care professionals to deliver clinical interventions concluded that future trials should explore the cost effectiveness of online versus alternative methods of training. Due to the Covid-19 pandemic, the ThinkCancer! intervention was mostly delivered in a digital format. Previous studies have explored the cost-effectiveness of e-learning interventions and online continued professional development (CPD) for clinicians in the areas of falls prevention education, suicide prevention and online cancer education for nurses and allied health professionals. To the best of our knowledge, our study is the first of its kind to explore the costs of an online intervention aimed at improving the diagnosis of cancer in primary care, and consequently adds value to the current evidence-base in this area especially since the increased use of online delivery formats since the Covid-19 pandemic.

**Implications for research and/or practice**

Results from this feasibility study will be used to inform a future definitive economic evaluation alongside a pragmatic randomised controlled trial (RCT). The costings from this feasibility economic analysis may be helpful for future economic modelling studies. Moreover, the findings from this study may be useful for researchers who are setting up economic evaluation models of training for earlier diagnosis in other clinical areas such as stroke in primary care.

There has been a large impact from the Covid-19 pandemic on cancer diagnosis and treatment. Primary care interventions that expedite the diagnosis of symptomatic cancer have the potential to reduce large costs to the NHS and improve patient and carer outcomes; as later stage cancer treatments are often longer, more aggressive to patients, with larger associated healthcare costs, compared to earlier stage treatment. The ThinkCancer! intervention has the potential to expedite the diagnosis of symptomatic cancer, improve cancer patient outcomes and may avoid costs to the NHS associated with later stage cancer treatments. Lessons learnt from this feasibility trial have important practice implications to ensure cancer diagnoses are as timely as possible.

**Conclusion**
Methods of data collection utilised were successful in gathering sufficient health economics data to cost the ThinkCancer! intervention. This feasibility study will inform the design of a future definitive economic evaluation alongside a pragmatic randomised controlled trial.

Primary care interventions to expedite the diagnosis of symptomatic cancer have the potential to reduce large costs to the NHS and improve patient and carer outcomes as later stage cancer treatments are often longer, more aggressive to patients, with larger associated healthcare costs compared with earlier stage treatment.

Additional information

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**Ethical approval:** This study has been approved by the Health Research Authority/Health and Care Research Wales (IRAS 256824) and Bangor University (School of Healthcare Sciences, 2019-16498). REC Approval was not required as the study did not involve patients.

**Competing interests:** NHW is a GP principal in Plas Menai Health Centre, Llanfairfechan, which participated in this feasibility study.

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