Health Economics of Multi-Cancer Blood Testing

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https://www.medicalnewstoday.com/articles/blood-test-can-detect-50-different-types-of-cancer
Introduction

- I have no relevant financial relationships within the last 24 months


- Presentation outline:
  - A short primer on health economics, and the cost-effectiveness of existing cancer screening in the US
  - Potential cost-effectiveness of a Multi-Cancer Blood Test (MCBT)
  - Policy implications – early thoughts
Short primer on health economics

• Cost-effectiveness is widely used in health, to help set priorities
• Depends heavily on the effectiveness of a health intervention
• Most commonly measured by QALYs (quality-adjusted life-years) saved
• Measures additional years of life gained (LYG) by an intervention, adjusted by perceived quality; quality ranges from 0 (worst) to 1 (best)
What is good value for money in health?

• The lower the cost per QALY for an intervention compared to an alternative e.g. “no intervention”, the more cost-effective it is

• Many countries use a “threshold” – interventions costing more than this threshold are unlikely to be funded

• For the United States, $50,000 is often used as a threshold (per capita Gross Domestic Product, GDP currently is around $64,000)

• The World Health Organization previously suggested that interventions costing less than 1 X per capita GDP were “very cost-effective” – subsequently criticized, but this remains a decent rule of thumb across countries
Current US cancer screening programs

• Breast cancer: mammogram every year age 50-54; every two years 55-69 (CDC)

• Colon cancer: Test ages 50-75; various methods: colonoscopy every 10 years; fecal DNA every 1-3 years (CDC)

• Lung cancer: Test ages 50+ with annual low-dose CT with 20 pack-year smoking history (USPSTF)

• Cervical cancer: Test ages 25-65 every 5 years with primary HPV test, or every 3 years with Pap, or co-test every 5 years (ACS)

Estimated annualized cost per person screened of MCBT versus existing cancer screening programs

Annualized cost of per person screened according to guidelines for various cancers, USD

- Breast
- Colorectal
- Lung (highest cost)
- Cervical (lowest cost)
- MCBT

See notes to slide 7. **Cost for MCBT is very preliminary estimate only.**
Cost-effectiveness estimates, existing screening programs, USD (orders of magnitude 2000-2010 $)

Factors causing cost per QALY to increase ↑ or decrease ↓ (become less or more cost-effective)

- higher screening cost;
- screening test less specific;
- screening test less sensitive

- only screen the higher-risk population groups;
- treatment costs higher;
- younger at-risk population
## Common cancers in US ranked by incidence and by deaths, and priority for new screening

<table>
<thead>
<tr>
<th>Incidence</th>
<th>Death</th>
<th>Priority for new screening test?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast (11.1%)</td>
<td>Lung (22.6%)</td>
<td>Pancreas</td>
</tr>
<tr>
<td>Lung (10.0%)</td>
<td>Pancreas (7.8%)</td>
<td>Liver</td>
</tr>
<tr>
<td>Prostate (9.2%)</td>
<td>Breast (7.0%)</td>
<td>Lung</td>
</tr>
<tr>
<td>Colon (4.5%)</td>
<td>Colon (6.2%)</td>
<td>Upper GI</td>
</tr>
<tr>
<td>Melanoma (4.2%)</td>
<td>Prostate (5.3%)</td>
<td>Ovary</td>
</tr>
<tr>
<td>Bladder (3.5%)</td>
<td>Liver (5.1%)</td>
<td></td>
</tr>
<tr>
<td>Non-Hodgkin lymphoma (3.2%)</td>
<td>Upper GI (Oesophagus + stomach) (4.5%)</td>
<td></td>
</tr>
<tr>
<td>Kidney (3.0%)</td>
<td>Leukemia (3.9%)</td>
<td></td>
</tr>
<tr>
<td>Corpus uteri (2.7%)</td>
<td>Non-Hodgkin lymphoma (3.4%)</td>
<td></td>
</tr>
<tr>
<td>Leukemia (2.7%)</td>
<td>Brain, CNS (3.0%)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Column 1 & 2: Globocan2020 USA Fact Sheet; Column 3 author, ranking (% share deaths/% share new cases >2
How sensitive is the MCBT?

DETECT-A Trial (AM Lennon et al, Science 349 eabb9601, 2020) concluded that MCBT, in 10,006 women recruited to be followed for 12 months resulted in:

- 26 cases of cancer detected from sequence of 2 blood tests plus follow-up imaging
- Another 24 detected by standard of care screening, and 46 via symptoms
- 17 of 26 were localized/regional disease
- 12 received surgery with curative intent
- 3 false positives that involved minimally invasive follow-up (surgery, bronchoscopy)
- Sensitivity 27-30% (depends on definition)
Detection and site-prediction of surgically resectable cancers

Source: Ahlquist DA Precision Oncol 2018

Light bars are where tumor location was correctly classified as most likely site; dark bars one of two most likely sites
Possible new single-cancer blood tests

• Single cancer tests being evaluated include (among others):
  • Ovarian cancer in high risk women (SE Lentz et al, *Gynecol Oncol* 159:804, 2020)
  • Gastric (stomach) cancer in high risk men (R Kapoor et al, *Value Health* 23:1171, 2020)

• Some of these tests appear cost-effective in high-risk populations: but screening high-risk populations may miss many cases

• What if a single test (MCBT) could test for several such cancers, i.e. spreading the testing costs over more cancers?

Can a Multi-Cancer Blood Test improve on doing several single-cancer tests?

<table>
<thead>
<tr>
<th>Cancer ID</th>
<th>Similar to:</th>
<th>Assumed MCBT test sensitivity</th>
<th>Assumed survival gains if detected early</th>
<th>Estimated cost-effectiveness, single cancer screening test ($/QALY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pancreatic cancer</td>
<td>Low (30%)</td>
<td>Low (&lt;1 yr)</td>
<td>Very poor (&gt;500k)</td>
</tr>
<tr>
<td>2</td>
<td>Uterine cancer</td>
<td>High (70%)</td>
<td>High (&gt;20 yrs)</td>
<td>Good (&lt; $50k)</td>
</tr>
<tr>
<td>3</td>
<td>Lung cancer</td>
<td>Medium (30%)</td>
<td>Medium (7 yrs)</td>
<td>Poor (&gt;100k)</td>
</tr>
</tbody>
</table>

We modelled cost-effectiveness of an MCBT for three “baskets” of cancers with different characteristics, including two with no existing approved test, and one (lung) with an existing test.
Can a Multi-Cancer Blood Test be cost-effective?

• Assumptions:
  • The test is given once at age 50, and we examine a 2-year interval following the test
  • We use a health sector perspective (i.e. costs of healthcare, but not financial costs of lost work, travel costs for patients etc.)

• Results: Given our assumptions, the cost-effectiveness of the MCBT is good (cost per QALY is below that of each of the tests separately, and quite well below the threshold of $50,000)
Cost-effectiveness estimates MCBT versus existing screening programs, USD

See notes to Slide 8 for sources. **MCBT estimate is very preliminary only.**
Limitations of our findings

• The model is complex, even when limited to 3 cancers
• We don’t know as much about cancers which are currently not detected early (e.g. the speed at which they progress)
• For cancers not currently detected early, treatment regimes are likely not well developed and could improve
• Will use of the MCBT make people less likely to adhere to existing screening test guidelines? (bad outcome)
• Or will MCBT increase outreach to those who are not up-to-date with existing screening guidelines (good outcome: in Ontario 1/3 women not up-to-date re breast cancer, 1/3 people not up-to-date re CRC; Litwin, Gastroenterology 2016; Cancer Care Ontario Report 2019)
Limitations (cont.)

• Currently we model a one-time only application of the MCBT: for existing cancer screening, cost-effectiveness tends to decline if the test is repeated more frequently (but depends on the speed of progression of the particular cancer)

• Need to update estimate by sex (incidence and response to treatment for some cancers can differ considerably by sex)

• We haven’t modelled the impact on the cost-effectiveness of existing screening programs: cost-effectiveness of these may decline somewhat if (in effect) the same person is being tested twice in the same year for the same cancer
Policy Implications (my opinion)

• I suspect it is unlikely the MCBT would displace existing screening programs where these already exist:
  • MCBT is less sensitive to pre-cancers than existing tests for breast, cervical and colorectal cancers
  • Cervical cancer screening is evolving with HPV vaccination, and possible evolution to DNA testing
• MCBT is also unlikely to reach low- and lower-middle income countries since access to PET-CT for confirmatory testing is limited, as is treatment capability for cancers in general
• More research – and treatment options – may become possible for early stage cancers e.g. stomach, oesophagus, pancreas, liver, ovary, if MCBT improves detection of these at early stages