Introduction

There is an increasing interest to estimate the potential clinical value and likely cost-effectiveness of diagnostic and therapeutic technologies during early development stages to guide further developments. However, early stages of development are typically characterized by large uncertainty and populating health-economic models with empirical data is not always feasible due to limited availability of data. Elicitation of expert opinions is viewed as an appropriate alternative and may serve as the input for early health-economic models.

Methods

Different methods have been applied to evaluate medical technologies in early stages of development e.g. Analytic Hierarchy Process (AHP) (4), and expert elicitation. Expert elicitation is intended to link an expression of an experts’ beliefs into a statistical formula and has been used in a lot in Bayesian statistics because of the need to formulate priors. We have chosen to use expert elicitation as a method to formulate the knowledge and beliefs of experts about the future performance of PAM and to quantify this information into probability distributions.

Objective

In the present study we explore whether expert elicitation is a valid approach to characterize uncertainty regarding the diagnostic performance of photoacoustic imaging in breast cancer. As PAM is still in the translational stage (figure 1) and the prototype is still in development, there is no clinical information available.

Results

Of the 20 radiologists, two radiologists were unable to attend. One radiologist was excluded due to his lack of compliance with the method.

Conclusions

• Experts estimated the mode of the sensitivity and specificity of PAM to be 75.6% and 66.5%, which is lower than MRI (90.1% and 69.5%).
• Experts expressed difficulties estimating the performance of PAM based on limited data regarding PAM.
• To improve the validity of radiologists’ estimations in this study, it is desirable to elicit priors for specific tumor types, since radiologists indicated to base their estimations on an aggregate expectation about how PAM will perform on average tumor types.
• Further clinical trials should be commissioned to indicate whether these results are valid and expert elicitation could be used in early technology assessment. Before that, the use of the elicited priors in health economic models requires careful consideration.

References


Figure 1: Flowchart of product development [1]

Figure 2: Illustration of tumor characteristics

Figure 3: Elicitation procedure

Figure 4: Probability distribution of estimation of TPR at 16 radiologists

Figure 5: Importance of tumor characteristics and performance MRI and PAM

Figure 6: Distribution of the importance of tumor characteristics and performance MRI and PAM.

Table 1: Expert elicitation

<table>
<thead>
<tr>
<th>What to elicit?</th>
<th>Variable in fixed</th>
<th>Probability Density Function vs Cumulative Distribution Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to examine the patient</td>
<td>Behavior</td>
<td>Mathematical</td>
</tr>
<tr>
<td>What to assess?</td>
<td>What is the expected performance?</td>
<td>What is the likelihood of the expected performance?</td>
</tr>
</tbody>
</table>

Table 2: Calibration factors

<table>
<thead>
<tr>
<th>Years of experience</th>
<th>Average number of MRI examined per week</th>
<th>Examining MRI’s in other areas</th>
<th>Probability distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6-10</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>11-15</td>
<td>3</td>
<td>3</td>
<td>3</td>
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</tbody>
</table>

Table 3: Pooled MRI

<table>
<thead>
<tr>
<th>Test</th>
<th>Disease</th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>263</td>
<td>94</td>
<td>357</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>23</td>
<td>241</td>
<td>264</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>286</td>
<td>235</td>
<td>521</td>
</tr>
</tbody>
</table>

Figure 3: Elicitation procedure

Mathematical approach

Expert panel

• TPR
• FPR
• TNR
• FNR

Presenting experts’ beliefs

• Mode
• Lower bounds
• Upper bounds

Bias

• Provide data in similar way
• Explain uncertainty
• Provide feedback

Calibration method

• Full calibration
• Linear opinion pooling

Synthetic method

• Individual face-to-face interviews
• Pooled data of MRI was provided based on four studies where MRI was used in a diagnostic setting. For this a 2*2 table was used, where it is sufficient to estimate the TPR and FNR as the false positive rate (FPR) and false negative rate (FNR) follow from this.

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