Introduction
The presented economic model estimated costs and benefits of a novel in vitro diagnostic kit for infective endocarditis (IE), developed by Hutmans Diagnostics AG (Basel, Switzerland). This new product applies molecular diagnostics to detect bacteria in cardiac tissue faster (see Fig. 1). The focus of the model is set on the diagnostic procedures of Endocarditis-Gen® Tissue (Fig. 1) and of the gold standard procedure as benchmark (i.e. is microbial culturing, (MC), with respect to cost relevant parameters. Based on these parameters the model describes the expected areas of cost-saving potentials for the diagnostic and therapeutic procedure with respect to the existing system of IE and estimates expected savings for an individual patient in a standard hospital and scales these numbers up for Switzerland (CH), Germany (GER) and the United Kingdom (UK).

In a bottom-up approach initial results are derived for one patient and three development scenarios for occurring during aetiology of IE in a standard hospital. Hereby country-specific cost structures were taken into considerations. Based on these results and annual statistical data for the expected number of treated patients estimates for the annual costs and potential savings for all three countries are derived.

Methods
Decision tree for aetiology of IE
As the novel kit provides results within 4-6 hours after sampling instead of 2-3 days by MC, the following three main outcome scenarios (S) for aetiology of IE were investigated by establishing a decision tree:

S1 - Adjusted hospitalisation and treatment: Decreased average hospitalisation and earlier specific antibiotic treatment due to quicker diagnosis.
S2 - Recuperation: Reduction of recuperation frequency.
S3 - Influence on mortality of recurrent and uncontrolled IE: Reduction of mortality due to faster isolation.

Statistics for decision tree
The quantitative model uses statistical data for the decision tree from literature and interviews with clinical experts.

Assumptions for Switzerland:
- Incidence of IE cases of 3.1/100'000 population and year
- Implication of required surgery in about 50% of all IE patients
- Pathogen identification before surgery in about 80% of all cardiac surgery patients
- Average operative mortality of 10%

In conclusion, for these assumptions lead to 67.1 patients on average per year with definitive IE but without diagnosis for a specific pathogen after cardiosurgery by assuming Respective figures for GER and CH and the UK cases in S2 and S3 are depicted in Table 1.

Table 1: Average incidence for IE and prevalent cases without specific diagnosis after cardiosurgery of Switzerland, Germany and UK

<table>
<thead>
<tr>
<th>Country</th>
<th>Incidence of IE [cases per 100'000 population and year]</th>
<th>Relevant population [100'000 population and year]</th>
<th>S1 [cases/country and year]</th>
<th>S2 [cases/country and year]</th>
<th>S3 [cases/country and year]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switzerland</td>
<td>3.1</td>
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<td>275'831</td>
<td>278'838</td>
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<tr>
<td>Germany</td>
<td>6.5</td>
<td>63'890'710</td>
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<td>670'872</td>
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These basic data allow estimating potential cost savings comparing the two diagnostic procedures for the three countries.

Economic parameters
Parameters quantified for both diagnostic procedures were for following:
- Capital costs: includes additional equipment needed.
- Diagnostics: includes labour costs, costs for the related diagnostic method and specific required (e.g. DNA isolation)
- Recuperation: costs for not optimized recuperation.
- Antibiotics: difference in costs for empirical and specific antibiotics
- Hospitalisation: difference in duration of hospitalisation
- Productivity losses: costs due to absence at patients' working places
- Productivity losses YLL: costs due to premature death of patients and the years of life lost (YLL)

The outcome spectra and their economic performance were transferred into potential savings due to Endocarditis-Gen® Tissue.

Results
The potential savings per patient and country for each scenario are presented in Table 2 in all three countries in Euro.

Table 2: Potential savings in main outcome scenarios per patient and country due to the application of Endocarditis-Gen® Tissue

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<td>474.450</td>
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<tr>
<td>S2</td>
<td>687.6</td>
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<tr>
<td>S3</td>
<td>1091'358</td>
<td>3'091'358</td>
<td>6'390'519</td>
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The highest savings per patient could be generated in Switzerland for all three outcome scenarios. In Switzerland, for CH and UK, the following assumptions lead to 67.1 patients on average per year with definitive IE but without diagnosis for a specific pathogen after cardiosurgery by assuming Respective figures for GER and CH and the UK cases in S2 and S3 are depicted in Table 1.

In conclusion, for these assumptions lead to 67.1 patients on average per year with definitive IE but without diagnosis for a specific pathogen after cardiosurgery by assuming Respective figures for GER and CH, and the UK cases in S2 and S3 are depicted in Table 1.

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The outcome spectra and their economic performance were transferred into potential savings due to Endocarditis-Gen® Tissue.

Conclusions
Due to current clinical reality and according to Dukas criteria it is assumed that Endocarditis-Gen® Tissue would not replace microbiological culturing completely, but could complement the standard diagnostic procedure by improving the clinical outcome in speed.

In CH main contributing cost factors relevant for potential savings are in the same order as follows: the mitigation of productivity losses YLL, shortage of hospitalisation and avoidance of reoperation.

In CH and Switzerland the mortality of patients after cardiosurgery is already about 10%. Furthermore, productivity losses and adapted antibiotic treatment have a financial impact yet in GER with a shared amount of about 400'000 €/year.

In the UK reduction in productivity losses YLL also accounts for the most potential savings. But following avoidance of reoperation contributes the second most before shorter lengths of stay in hospital due to lower relative costs per hospital day and patient in an average UK hospital compared to GER and CH.

Additional economic benefits from earlier and more targeted treatment for different indications of IE (e.g. is microbial for systemic embolism) can be expected and are not taken into account in this study. Furthermore, operation and maintenance costs in more diverse outcome scenarios as well as the impact on long-term mortality could contribute to a higher level of detail and exactness.

Therefore, it is recommended to verify the assumptions and estimated potentials supplementing this study with additional data and information from pilot studies and clinical trials with Endocarditis-Gen® Tissue.

Bibliography