Cost-effectiveness of MALDI-TOF and rapid antimicrobial susceptibility testing for high-risk patients

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Introduction/hypotheses

- Early covering antimicrobial therapy reduces mortality†.
- In patients receiving non-covering empirical antimicrobial therapy the availability of AST results provides an opportunity to initiate covering therapy.
- At the Greater Romagna Area Hub Laboratory (GRHL) several “rapid” technologies are available which, relative to conventional methods, can speed up identification and/or Antimicrobial Susceptibility Testing (AST), including:
  - A Biofire Filmarray
  - B MALDI-TOF and Rapid AST (Alifax)
  - C MRSA/Carbapenemase cartridge tests (Cepheid)
- The added cost may only allow rapid analysis of positive blood cultures from high risk patients.
- **The Questions:**
  a) **Are MALDI-TOF and Rapid AST(MRAST) cost-effective**
  b) **Can Risk Stratification of patients selected for MRAST increase the cost-effectiveness**

† Paul et al. (2010) *Antimicrobial Agents and Chemotherapy* 54 (11) 4851-4863
Kumar et al. (2006) *Critical Care Medicine* 34 1589-1596
Wisdom et al. (2015) *Emergency Medicine Australasia* 27 196-201

Setting

- The Greater Romagna Area Hub Laboratory (GRHL) receives blood cultures from 7 hospitals in a region with 1.3 million inhabitants

- GRHL processes approximately 30000 positive blood cultures per year (approximately 80 per day).

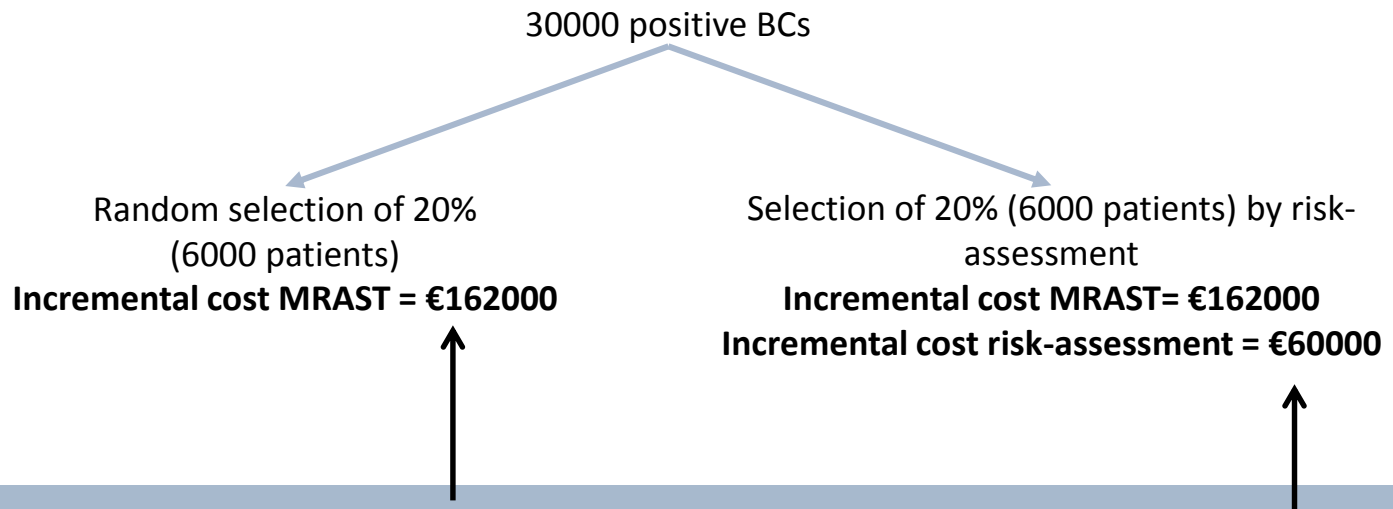
- A MRAST production line would provide capacity to about 20% of all positive blood cultures.

Risk-assessment: Finding the high-risk patients

- Risk-assessment was carried out by SepsisFinder, a stochastic (partial) model of the inflammatory response to infection, trained to predict the patient's risk of death† from vital signs and a selection of about 7 biochemical sepsismarkers.
- The training database contained 4707 patients with community acquired infections collected between 2002 and 2016 in Beilinson Hospital, Petah Tiqva, Israel.
- In these patients, the area under the ROC curve for prediction of 30 day mortality was 0.77.
- 35% of the patients with positive BC received non-covering (*in vitro*) empirical antibiotic treatment.
- Patients with positive BC had 15% mortality and the 20% of these with the highest predicted mortality had 33% mortality.

† Ward et al. (2017) *Mathematical Biosciences* 284 12-20

Results

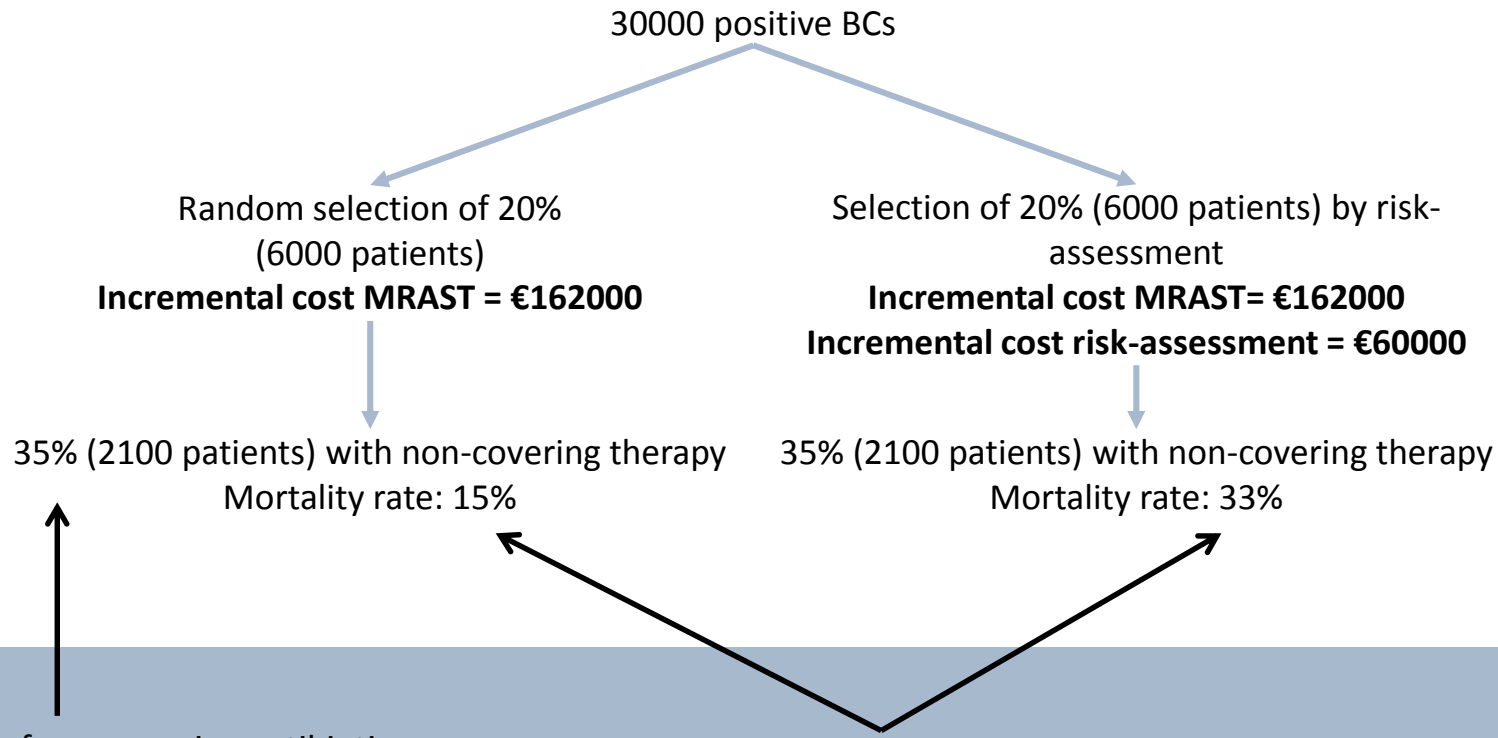


Assumptions

The cost of MRAST, including labour, materials and capital expense is 35€. MRAST is performed as an adjunct test, but allows some processes to be streamlined (e.g. broth enrichment). The estimated incremental cost of testing is 27€.

The cost of risk-assessment was 2€ per patient.

Results

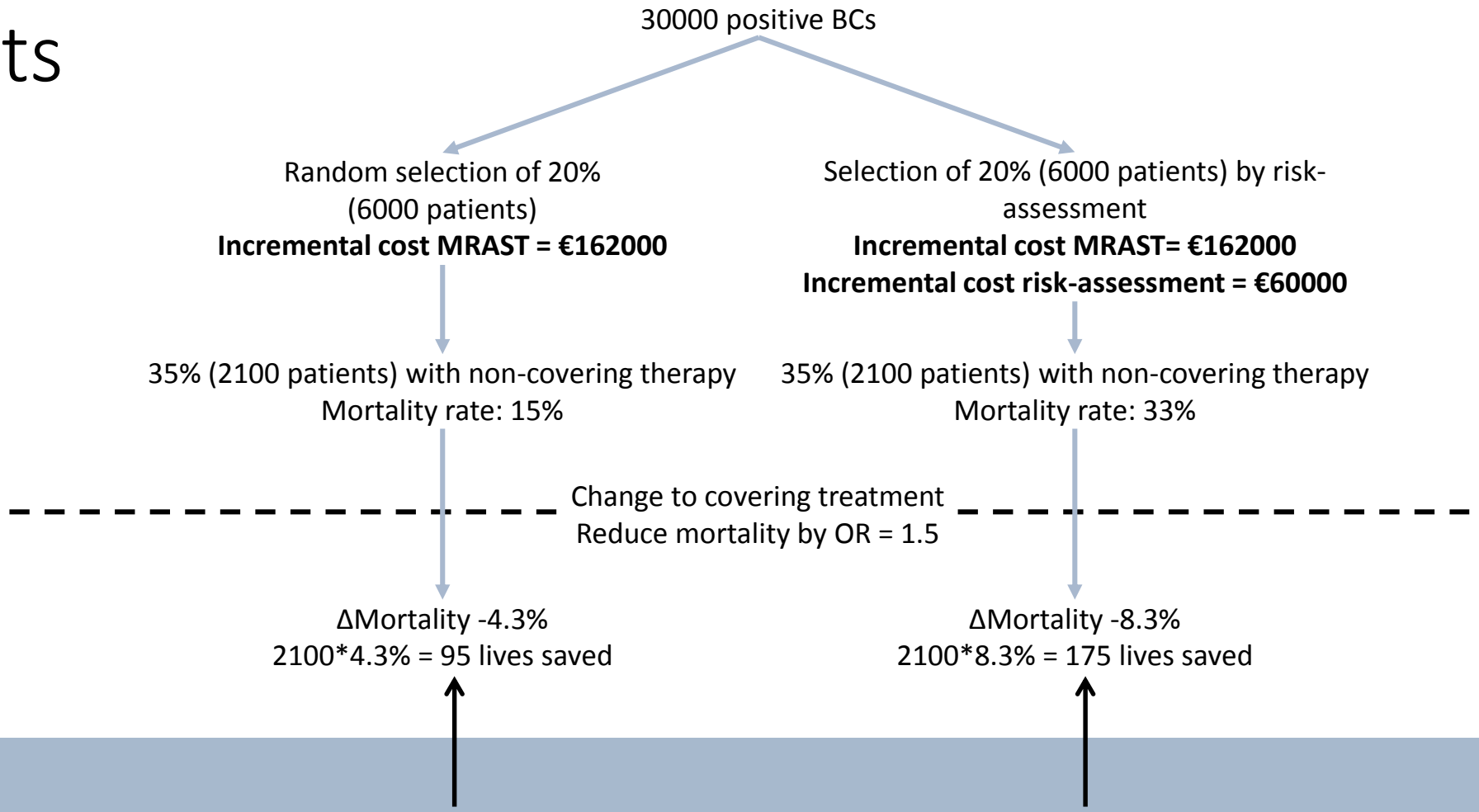


Assumptions

The percentage of non-covering antibiotic treatments for patients with positive BC is the same for Beilinson and GRHL

The mortality for patients with positive BC is the same for Beilinson and GRHL

Results

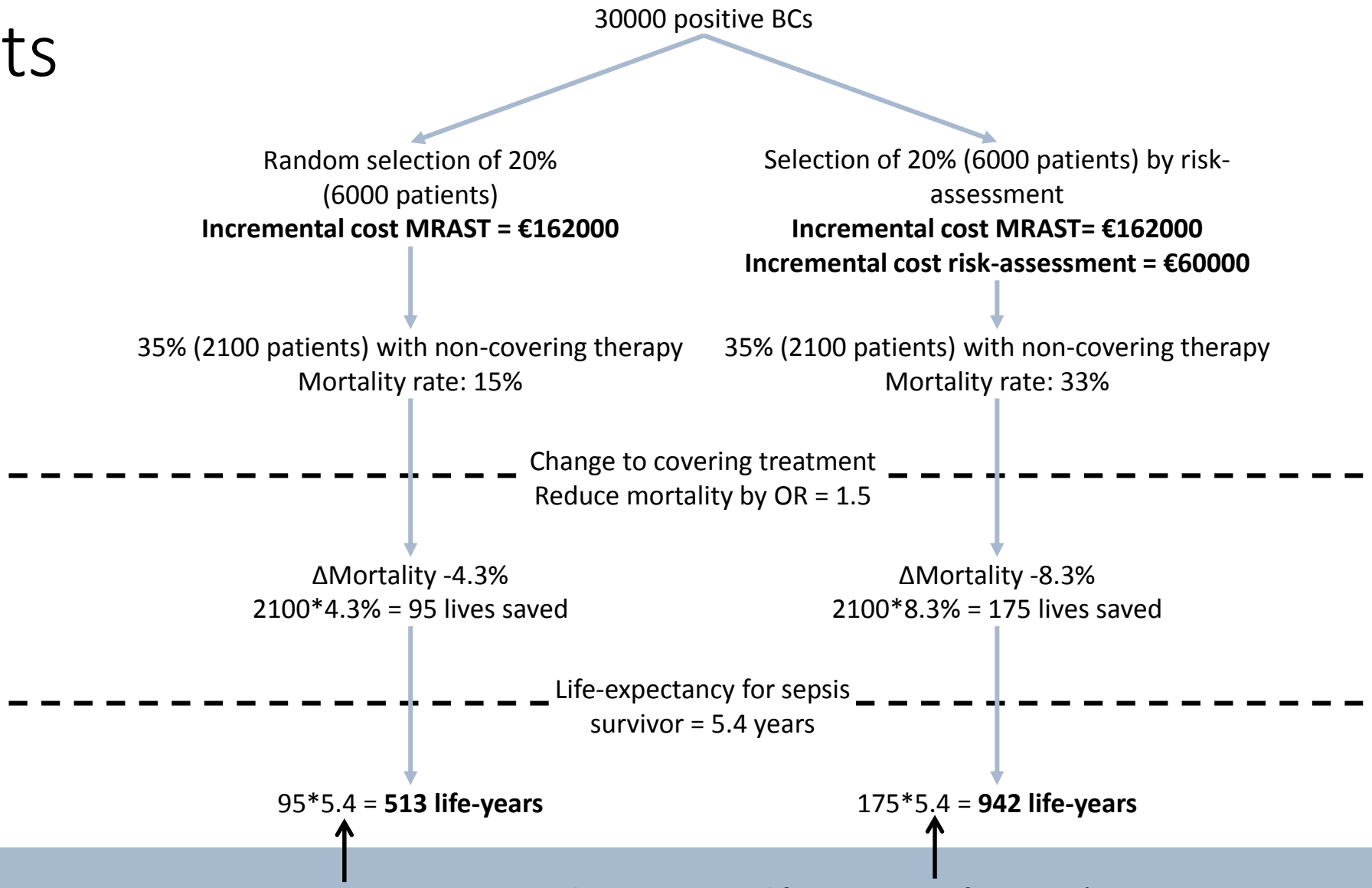


Assumptions

Initiation of covering antibiotic therapy at 30 hours relative to at 48 hours reduces the mortality by an odds ratio of 1.5†

† The OR of 1.5 was calculated from data given by Huang et al. (2013) *Clinical Infectious Diseases* 57 (9) 1237-1245

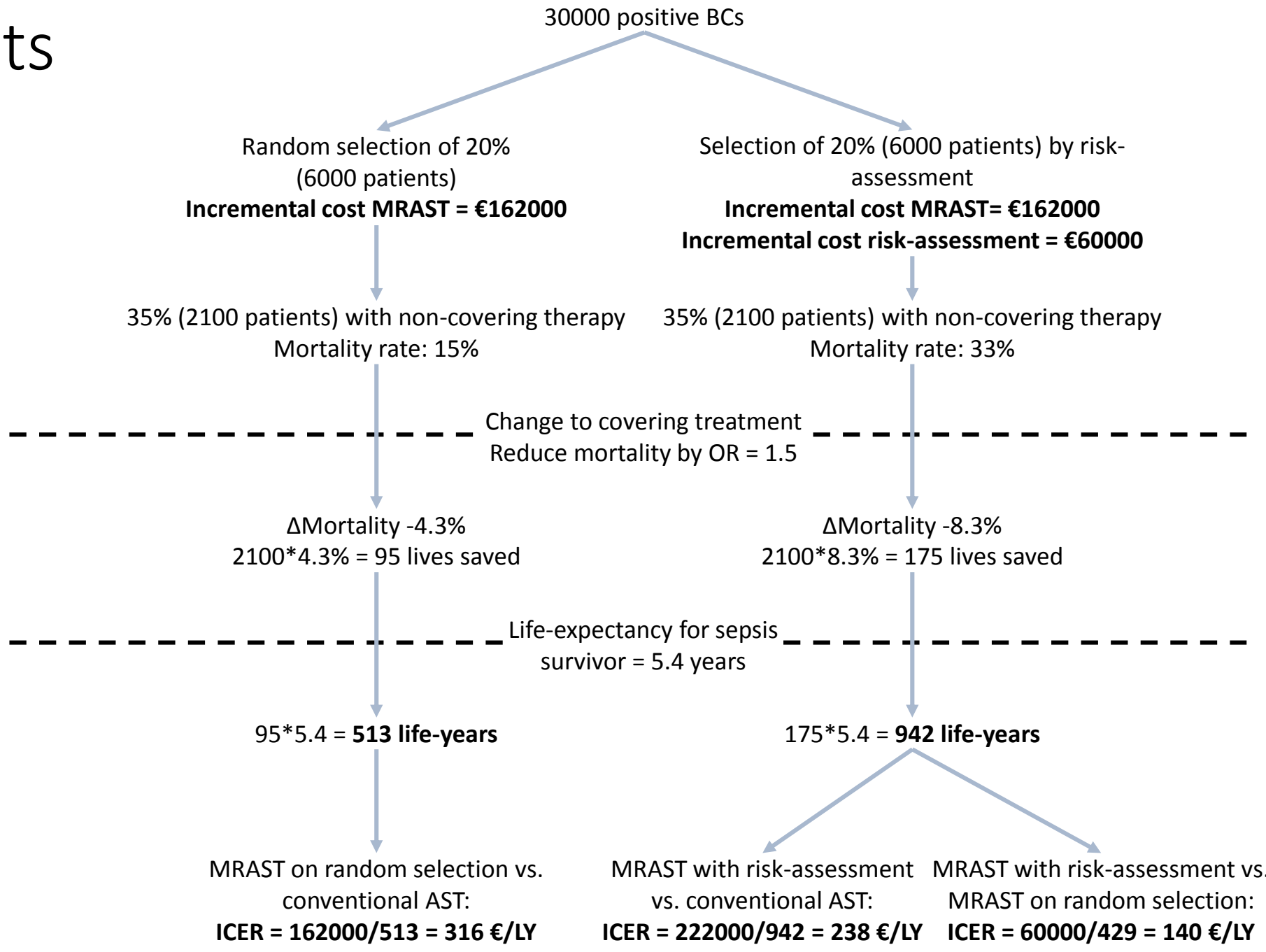
Results



Assumptions

† Lehmann et al. (2010) *Critical Care* 14:R186

Results



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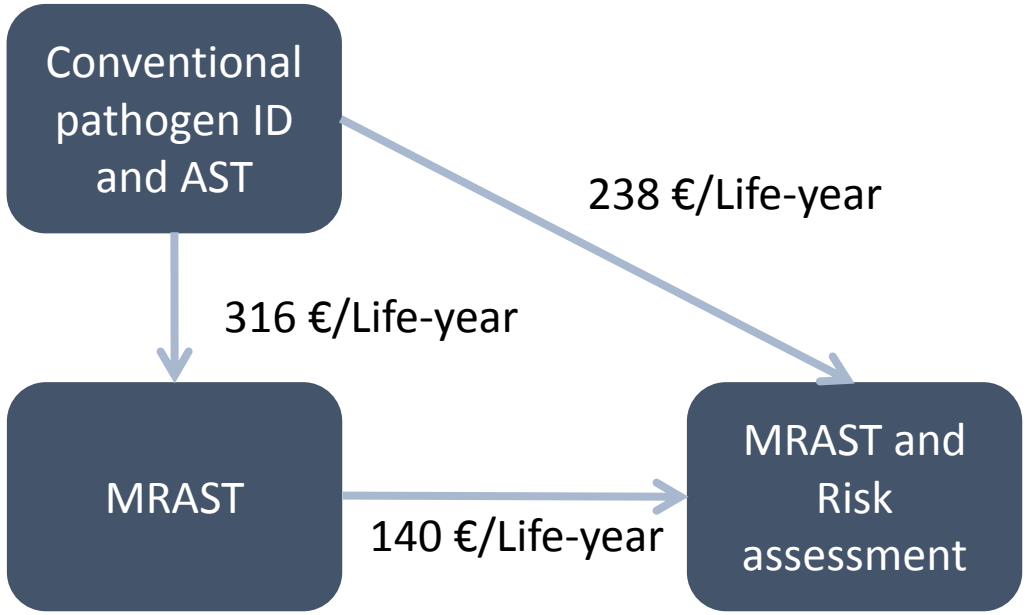
Conclusions on cost-effectiveness of MRAST



ICER in the range of 30000 – 40000 €/Life-year (NICE†) is considered to represent the upper limit of typical "willingness to pay".

Research question 1: **Is MRAST cost-effective?**

Yes, at 316 €/Life-year it is about 100 times more cost effective than the NICE threshold.

Research question 2: **Can Risk Stratification of patients selected for MRAST increase the cost-effectiveness?**

Yes, at 140 €/Life-year it is also very cost effective, resulting in a total cost-effectiveness of 238 €/Life-year for the combination.

† Appleby et al. (2007) *BMJ* 335 (7616) 358-359

Limitations

- Results rely on assumptions derived from the literature, primarily:
  - Shortening the time to covering antimicrobial treatment from 48 to 30 hours reduces mortality by an odds ratio of OR =1.5
  - The mortality for patients with positive BC is the same for Beilinson and GRHL (preliminary data confirms this)
  - The percentage of non-covering antibiotic treatments for patients with positive BC is the same for Beilinson and GRHL

- Future work
- A prospective study is planned to provide local data on the assumptions above.