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

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Background: The combination of MALDI-TOF and rapid Antimicrobial Susceptibility Testing (MrAST) has the potential to greatly reduce time to covering therapy. We explore the cost-effectiveness of implementing this technology, with and without risk-based selection of patients.

Material/methods:

Setting: The Greater Romagna Area Hub Laboratory (GRHL) processes approximately 30000 positive blood cultures (BC) per year (approximately 80 per day). Equipment for MrAST would provide capacity to handle up to 20 analyses per day.

Model: SepsisFinder, a stochastic (partial) model of the inflammatory response to infection was trained to predict the patient's risk of death. The training database contained 4707 patients with community acquired infections collected between 2002 and 2016 at Beilinson Hospital, Petah Tiqva, Israel. 35% of the patients with positive BC received non-covering (*in vitro*) empirical antibiotic treatment. Patients with positive BC had 15.0% mortality and the 20% of these with the highest predicted mortality had 33.2% mortality.

Assumptions: The cost of performing 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). Estimated incremental cost of testing is 27€. The cost of risk-assessment was 2€ per patient. The mortality and percentage of non-covering antibiotic treatments for patients with positive BC is the same for Beilinson and GRHL. Initiation of covering antibiotic therapy at 30 hours relative to at 48 hours reduces the mortality by an odds ratio of 1.5: a reduction of 4.3% for patients with positive BCs and 8.3% for the high-risk group. Patients surviving sepsis have an average life expectancy of 5.4 years.

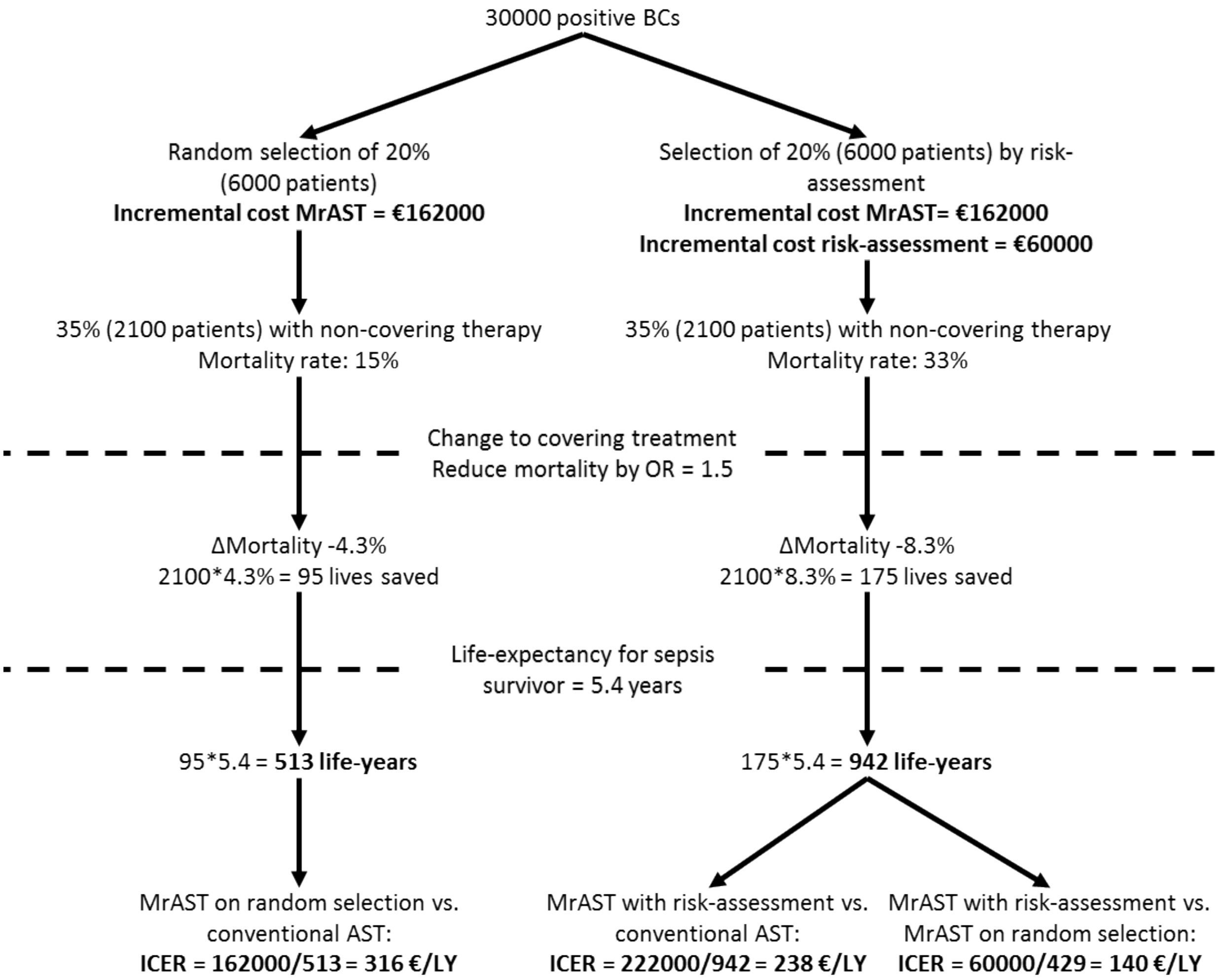
Results: If MrAST is applied to 20% or 6000 of the 30000 positive BCs, the incremental cost will be 6000*27€ =162000€. The incremental benefit is calculated from the 35%*6000 = 2100 patients receiving ineffective antibiotic therapy.

For randomly selected patients (Figure: left side) the expected reduction in mortality is 4.3%. This will save 95 lives or 95*5.4 = 513 life-years, giving an Incremental Cost Effectiveness Ratio (ICER) of 316 €/Life-year, relative to conventional AST.

For risk-assessment there is an additional cost of 30000*2 = 60000€ (Figure: right side). The expected reduction in mortality is 8.3% which will save 175 lives or 942 life-years. This gives an Incremental Cost Effectiveness (ICER) of 238 €/life-year, relative to conventional AST.

The combined intervention of MrAST and risk-assessment compared to MrAST applied to randomly selected patients, saves a further 80 lives or 429 more life years, giving ICER = 140 €/life-year.

Conclusions: Purchasing equipment for MrAST is extremely cost-effective with an ICER of 316 €/Life-year. Adding risk-assessment to this has an ICER of 140 €/Life-year. Both interventions have ICER less than 1% of typical “willingness to pay” thresholds of 35000€ to 50000€.


30000 positive BCs
Random selection of 20% (6000 patients)
Incremental cost MrAST = €162000
Selection of 20% (6000 patients) by risk-assessment
Incremental cost MrAST= €162000
Incremental cost risk-assessment = €60000
35% (2100 patients) with non-covering therapy
Mortality rate: 15%
35% (2100 patients) with non-covering therapy
Mortality rate: 33%
Change to covering treatment
Reduce mortality by OR = 1.5
ΔMortality -4.3%
2100*4.3% = 95 lives saved
ΔMortality -8.3%
2100*8.3% = 175 lives saved
Life-expectancy for sepsis survivor = 5.4 years
95*5.4 = **513 life-years**
175*5.4 = **942 life-years**
MrAST on random selection vs. conventional AST:
ICER = 162000/513 = 316 €/LY
MrAST with risk-assessment vs. conventional AST:
ICER = 222000/942 = 238 €/LY
MrAST with risk-assessment vs. MrAST on random selection:
ICER = 60000/429 = 140 €/LY