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The implications of using different time horizons when evaluating investment to prevent infectious disease

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Background: A lifetime time horizon is conventional for cost-effectiveness analysis, but not routine for transmission-dynamic modeling, given uncertainty in future epidemiological dynamics and high computation costs. We demonstrate implications of alternative analytic time horizons with a case study of novel tuberculosis (TB) vaccine introduction.

Methods: We developed a system of epidemiological and economic models calibrated to data for India, and assessed a novel TB vaccine (50% efficacy and 10y duration, introduced in 2030), compared to status-quo. We examined time horizons of 20, 50, and 200 years to quantify how this affected discounted disability-adjusted life years (DALYs) averted, incremental costs, and incremental cost-effectiveness ratios. We fit statistical extrapolation models to 20- and 50-year transmission model results, and used the fitted model to project outcomes over 200 years, to determine whether this could approximate the 200-year transmission model results.

Results: For intervention vs. status-quo, cumulative DALYs averted increased by >3x when extending the time horizon from 20 to 50 years, and by >6x when extending to 200 years (Table 1). TB vaccination was cost-effective compared to 15% of per-capita Indian gross domestic product (GDP) ($2,411) at a 20-year time horizon, compared to 10% of per-capita GDP at 50 years, and compared to 7% of per-capita GDP at 200 years. Statistical extrapolation from 20- and 50-year simulations yielded outcomes up to 12% and 3% different on average, respectively, than full transmission model results.

Conclusions: The choice of model time horizon can be influential for economic evaluation of infectious disease prevention. Despite epidemiological uncertainty and computation costs, including long-term consequences in evaluations can be important. Using statistical extrapolation to provide results over longer horizons could reduce computational burden of long simulation periods.

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Conflicts of Interest

None

Table 1. Discounted costs, disability-adjusted life-years (DALYs) averted, and cost-effectiveness of novel tuberculosis vaccines, comparing alternative analytic time horizons.

Analytic horizon	Health system perspective* incremental cost (USD billions)	DALYs averted (millions)	Health system cost (USD) per DALY averted
2030–2050	12.6 (9.78, 18.0)	39.8 (29.4, 51.7)	326 (201, 505)
2030–2080	26.4 (20.0, 38.2)	121 (86.1, 158)	225 (132, 366)
2030–2230	39.5 (29.2, 58.7)	242 (171, 319)	168 (101, 281)
2030–2050–extrapolated to 2230	43.0 (30.6, 66,2)	270 (184, 369)	159 (113, 245)
2030–2080–extrapolated to 2230	39.1 (28.9, 59.3)	238 (168, 336)	172 (121, 249)

*Costs from the health system perspective include vaccination costs and tuberculosis testing and treatment costs.
Note: Values in parentheses represent equal-tailed 95% credible intervals.