Background:

• While colon cancer is one of the major cancers in the US, there exists no quantitative and systematic framework that enables evaluation of the impacts on the overall health and economic outcomes of a specific intervention for colon cancer in real world settings.

• We developed a comprehensive and quantitative framework that (i) evaluates the impacts of colon cancer therapies on clinical and economic outcomes in real world settings and (ii) enables integration with PKPD and tumor growth models for projection of cost-effectiveness of new drugs based on early phase clinical trial data.

Figure 1. Schematic of colon cancer treatment model in the Archimedes Model.

Methods:

• The Archimedes Model is a large-scale simulation model of human physiology, diseases and health care systems.

• The Model tracks disease progression in individuals and their interactions with the health care systems.

• Currently, the Archimedes Model includes diabetes, congestive heart failure, coronary artery disease, stroke, hypertension, obesity, and cancers of the breast, lung, and colon.

• The model of colon cancer treatment (Figure 1) was developed by synthesizing data from the Surveillance, Epidemiology and End Results (SEER) database, the Adjuvant Colon Cancer Endpoints Group (ACCENT) database, and meta-analyses of clinical trials, observational and retrospective studies in literature.

• The colon cancer treatment model was validated against several chemotherapy trials for stage II/III and metastatic colon cancer (Figure 2).

• Costs are based on Medicare reimbursement rates.

• Treatments of recurrent and metastatic colon cancer are based on National Comprehensive Cancer Network (NCCN) Clinical Practice Guidelines in Oncology for Colon Cancer.

Case study: Cost-effectiveness of adjuvant therapy for colon cancer in patients with pre-existing diabetes

• The decision to treat stage II colon cancer patients with adjuvant chemotherapy involves assessment of multiple factors including life expectancy, risk for recurrent disease, and the potential benefit and likelihood of adverse effects from treatment.

• We use the Archimedes Model to analyze the cost effectiveness of adjuvant therapy in stage II colon cancer patients with pre-existing diabetes.

• Set up of virtual trial:
  
  Trial arms:
  - Control arm: no adjuvant chemotherapy
  - Treatment arm: patients are treated with FOLOFOX regimen after surgery

  Population: stage II A, and II B colon cancer patients with pre-existing diabetes

  Outcomes: disease-free survival, overall survival, treatment complications, cost of treatments, life years gained, quality-adjusted life years (QALYs) and cost per QALY gained.

Table 1. Cost-effectiveness of adjuvant chemotherapy for stage II colon cancer in patients with diabetes: life years gained (LYG) as compared with no treatment and cost per life year gained. Costs and life years are discounted 3% annually. Red font indicates that the cost-effectiveness ratio is higher than the oft-quoted threshold of $50,000 per LYG for cost-effectiveness.

Simulation results:

• Life years gained and cost per LYG depend strongly on tumor stage, age at diagnosis and duration of diabetes (Table 1).

• Cost-effectiveness results are sensitive to assumptions on cost of adjuvant chemotherapy and effectiveness of adjuvant chemotherapy.

Study conclusion:

• The current study suggests that diabetes may be a predictor of outcome in stage II colon cancer patients and that prospective studies of this patient population should be conducted to determine whether this group in fact benefits from therapy.

Conclusion:

• In summary, we have constructed a comprehensive mathematical model of colon cancer treatment that can be integrated with other models to predict health and economic outcomes of new therapies for colon cancer.

References:


A Mathematical Model of Health and Economic Outcomes of Colon Cancer Treatment

Tuan Dinh, PhD and Peter Alperin, MD

Archimedes Inc., San Francisco, CA