Using whole disease models to inform resource allocation decisions

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Overview of fellowship

• Funded through NIHR PAS Fellowship
• What is the role and value of Whole Disease Modelling in informing resource allocation decisions?
• Focus on cancer (specifically bowel) but wider transferability
• Mixed methods approach
  – Phase 1 Problem definition via methods review, economic analysis review & case study work → framework development
  – Phase 2 Application of framework within a large case study problem & qualitative examination of value from decision-makers’ perspective
• Outstanding issues – feasibility, impact on results and value
Piecewise cost-effectiveness analysis

Theoretical approach to maximising health gains.
Threshold determined by CE of last technology purchased.
HTA models involve forward projection from single decision node.
Comparison against threshold/range.

Decision problem
Should the NHS fund new drug B or existing drug A?

Drug A
(Standard treatment)
Costs (C₁)
Health outcomes (Q₁)

Drug B
(novel treatment)
Costs (C₂)
Health outcomes (Q₂)

Incremental comparison

Incremental cost-effectiveness ratio
\( \text{ICER} = \frac{(C₂ - C₁)}{(Q₂ - Q₁)} \)
Limitations of “conventional” economic analysis

1. Interdependence of decisions, the healthcare budget and the cost-effectiveness threshold
   - Vague resemblance to optimisation framework
   - Assumes repeated use of threshold will move towards a QALY maximising solution
   - Separation of budget constraint and decision rule ignores disinvestment

2. The interdependence of health technologies
   - Difficult not to treat decisions as independent
   - Upstream and downstream impacts e.g. screening ↔ follow-up

3. The model development process
   - Absence of shared agreement about how to develop models both conceptually and mathematically
Economic evidence to inform resource allocation in bowel cancer

Hereditary CRC (FAP/HNPCC)
- Strong economic evidence
- Weak economic evidence
- No economic evidence

Colon cancer
- Surveillance → Treatment
- Diagnosis/referral
- Surgery
- Chemotherapy
- RT/CRT
- Follow-up
- Curative treatment for metastases
- Palliative treatment for metastases
- End-of-life care

Rectal cancer
- Surveillance
- Surgery
- Surgery

Prevention
- Genetic testing/family history
- Symptomatic presentation
- Secondary care
- Population screening
- Surveillance

Key:
- Strong economic evidence
- Weak economic evidence
- No economic evidence
An alternative approach – Whole Disease Modelling

- Usefulness of models is in part determined by the scope of the decision it is intended to inform.
- Single isolated point versus whole pathway model.
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- Single isolated point versus whole pathway model.
A lot of effort – so why bother?

- Framework to allow evaluation of any intervention at any point in a disease/treatment pathway.
- Consistent underlying worldview of disease and treatment systems across all evaluations
- Capture knock-on impacts both upstream and downstream
- Flexibility in terms of resource allocation decision rules
  - Piece-wise cost-effectiveness analysis
  - Combined investment/disinvestment approach - PBMA, BSG
  - Disease-level constrained optimisation - using evolutionary programming (e.g. GAs) to search for best service configurations in defined set
Methods framework

- 3 basic framework principles

1. Ensure model boundary breadth captures all relevant aspects
   From preclinical disease through to presentation, referral, diagnosis, staging, early treatments, follow up, treatment of potential metastases, end-of-life care and eventual death

2. Ensure transferability of decision node to any point in model
   Enable comparison of alternative service configurations

3. Model events, costs and outcomes in a dependent fashion
   Disaggregate the consequences of specific interventions
Guideline scope

- Diagnostic modalities/sequences
- Management of suspected obstruction
- Pre-operative staging
- Stenting (bridge to surgery)
- (Neo-)adjuvant radiotherapy/chemotherapy
- Imaging for detection of hepatic/extrahepatic metastases
- Follow-up schedules
- Palliative chemotherapy
- Patient support

- Screening & increased-risk outside of remit
A Whole Disease Model for bowel cancer

1. Preclinical disease
   - Normal
   - LR adenoma
   - HR adenoma
   - Preclinical Duke's CRC
   - Preclinical Stages CRC

2. Presentation, screening and diagnosis
   - Symptomatic presentation
   - GP visit
   - Clinic visit
   - Screening test
   - FSIG
   - Confirmation CCL
   - Diagnosed cancer

3. Non-malignant pathology surveillance and screening
   - Adenoma surveillance
   - Surveillance router

4. Colon cancer treatment (neo/adjuvant)
   - Follow-up router
   - Surig (c)
   - Surg and adjuvano (c)
   - Metastatic US router (c)
   - Metastatic FU router (c)

5. Rectal cancer treatment (neo/adjuvant)
   - Follow-up router (r)
   - Prep RT plus surg (r)
   - R0 surg plus CRT (r)
   - R1+2 Priog RT (r)
   - Metastatic US router (r)
   - Metastatic FU router (r)

6. Metastatic disease
   - Palliative chemo (cr)
   - BSC only

7. End-of-life care
   - Unmet need (cr)
   - Death
Conclusions so far...

- Feasible...subject to certain simplifications.
- Hard...but not impossibly so.
- Valuable...but not perfect.
- Non-trivial investment of time and resource at outset. But the longer-term payoff may be considerable.
- Value of approach particularly apparent in supporting guidelines and PCT commissioning.