Decision Making with Prostate Cancer

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9/19/2007
Background Info

- The prostate is a gland in the male reproductive system
- It is a source of problems for many men as they get older
- Prostate cancer is slow-growing, but can only be cured by early treatment
Two aspects of prostate cancer make it challenging from a decision analyst’s perspective:

- Uncertainties are difficult to quantify
  - Slow cancer growth
  - Depend on many individual traits
- Preferences are difficult to quantify
  - Possible outcomes are complex
  - Length/quality of life tradeoffs
Introduction

- Treatment decisions are currently made using a variety of simple heuristics (doctor’s suggestion, availability, cost, reputation, etc.)
- New method: optimize the rest of your life!
- Use a multiple-objective decision model with uncertainty to choose the optimal treatment
- Implemented by PCaDA (www.PCaDA.com)
Related Literature

- Length/Quality of life preferences:
  - Pliskin et al. (1980), Hazen (2004)

- Multi-attribute decision theory:
  - Keeney and Raiffa (1976), Dyer and Sarin (1979)

- Medical results:
The Decision Frame

- A person has just been diagnosed with prostate cancer
- This person will be the decision-maker
- Which treatment alternative should be chosen?
  - Surgery
  - External radiation
  - Seed radiation
  - Dual radiation
  - No treatment
Uncertainties

- What uncertainties are relevant to the decision?
- Length of life (death from cancer, treatment)
- Side effects
  - Impotence
  - Incontinence
  - Toxicity
- Affected by: age, life expectancy, co-morbidities, choice of surgeon, pre-treatment potency level, and cancer severity (includes several variables)
Uncertainties

- Individualized probability functions over time for each uncertainty
- Example: \( P(\text{death from cancer} \mid \text{surgery}) \) for an early stage case and an advanced case

![Graphs showing probability of cancer death over age for early and advanced stages](image)
Uncertainties

![Graph showing the probability of impotence over age for different treatment options.](image)
Uncertainties
Preferences

- **Multiple-objective model:**
  - Maximize length of life (life span)
  - Minimize $P$(impotence)
  - Minimize $P$(incontinence)
  - Minimize $P$(toxicity)

- Other factors may be taken into account, such as cost and convenience

- Factors besides the four given above tend not to be material to the decision, and are thus omitted
Preferences

- How does the decision-maker compare treatments which differ across these objectives?
- Need to establish relative weights on the attributes
- Solution: use a concept similar to quality-adjusted life years
- Express the weight on each side effect in terms of length of life
- The PCaDA term is “Emotional Weights”
Preferences: Emotional Weights

For each side effect, consider the following choice:

- Option 1: Live the rest of your life with this side effect.
- Option 2: Give up X% of your remaining life, but avoid the side effect entirely.

Determine the value of X that would make you indifferent. This represents the Emotional Weight of the side effect.
Preferences: Emotional Weights

- This yields a tradeoff between (dis)utility of loss of life span and (dis)utility of each side effect
- Can now express the possibility of a side effect as being equivalent to a specific reduction in life span
- Optimize a single variable
Preferences: Life Score

- Using the Emotional Weights, combine the objectives and determine a single utility value for any outcome.
- The PCaDA term for the weighted average utility of a particular treatment decision is a “Life Score”.
- Life Scores take into account both length and quality of life.
Raw Life Score

- This is the value of a particular treatment as a proportion of an “ideal” case
Life Score

- Instead of this “ideal” Life Score, use a scenario without cancer to compute the reference Life Score.
- Express Life Scores as percentages of this reference “no cancer” Life Score.
- Life Score = \[ \frac{\text{Raw Life Score}}{\text{No Cancer Life Score}} \]
An Example

Consider a man with the following profile*:

Age: 50
Life Expectancy: 85
Impotence EW: 4%
Incontinence EW: 4%
Toxicity EW: 2%

*This is only a small section of the profile. As alluded to earlier, the full profile also include pre-treatment potency level, surgeon skill in preserving potency and continence, co-morbidities, and several variables which determine the severity of the cancer.
An Example: Life Score

Life Scores for each possible treatment strategy
Impotence impact of each possible treatment strategy
Summary

- This multiple-objective method deals with preferences and uncertainties specific to the individual patient.
- It can provide not only the final result, but the effects of individual pieces of the analysis.
- Much better than the status quo!

Website: www.PCaDA.com
Possible Extensions

- Delaying treatment
- Monetary Life Score value
- Screening implications
- Other stakeholders
Questions?