Medical Decision Making Under Uncertainty

Effects of risk preference, tolerance of uncertainty and regret attitude on physician’s surgical decisions

Zijing Yang1, Yaniv Hanoch3, Redzo Mujcic1, Tigran Melkonyan3, Zvi Safra4, Olivera Potparic3, James Palmer

1. Behavioural Science Group, WBS, University of Warwick; 2. Southampton Business School, University of Southampton; 3. Culverhouse College of Business, University of Alabama; 4. Associate Specialist in Anaesthesia, Chelsea and Westminster Hospital NHS Foundation Trust London

INTRODUCTION
Physician’s desire to avoid risk, uncertainty and regret are common judgement heuristics or intuitive decision rules which affect diagnostic strategy. These may have an impact on diagnosis patterns, therapeutic decision, treatment recommendations, and operational decisions which have been shown to work independently and interconnectively in various studies.

Research Question: how individual differences in risk preference, tolerance of uncertainty and regret attitude influence operation decision making?

SURVEY OF MEDICAL EXPERTS
A cross-sectional, vignette-based study is conducted in the UK, December 2019, to elicit participant’s preference including three case-vignettes, three preference measures and other demographics questions. 97 valid responses were obtained out of 152 from the survey participants.

Three scenarios are selected based on the American Associate of Anaesthesiologists (ASA) classification scale.
- Low risk scenario: ASA6_Low
- Medium risk scenario: ASA3_Medium
- High risk scenario: Emergency_High

Measurement Scales:
- Nightingale risk preference measure (Nightingale, 1987): categorical measure including Risk averse, Risk seeking, Prospect theory concordant (loss averse) and Prospect theory discordant.
- Stress from Uncertainty subscale (SUS) (Gerrity et al., 1990): 12-items, 100 points Likert scale.
- Regret sensitivity measure (Schwartz et al., 2002): 5-items, 100 points Likert scale.

We propose two models in analysing the three effects.
- Single-stage model: estimated in Non-parametric Kernel model
- Dual-stage model: estimated in Two-part model

BACKGROUND
Prior to the operation, anesthetists need to assess patient factors, surgical factors and anaesthetic factors with different degree of uncertainties under pressure. Years of training and learning are to ensure that unbiased decisions to be made. However, studies show that psychological factors such as pressure, data uncertainty and stress leads to greater incidence errors and causes delays in operation. ASA reported that more than 50% of diagnosis-related adverse events in practice were related to a delay in diagnosis or treatment. Three cognitive factors have significant impacts on the decision to operate:
- Risk Preference: Risk-averse physicians are more likely to utilise additional medical resources to rule out.
- Tolerance of Uncertainty: lower uncertainty intolerance is associated with higher diagnostic sensitivity and lower risk tolerance.
- Regret Sensitivity: Surgeons were more likely to regret a decision of non-operative intervention versus operative intervention

DESCRIPTIVE OVERVIEW
Participants were asked to provide a rating from ‘Extremely Unlikely’ to ‘Extremely Likely’ on a scale from 0 to 100 for the scenario questions.

How likely you would agree to be their anaesthetist?

![Graph showing the distribution of responses.]

How likely do you perceive each case?

![Graph showing the distribution of responses.]

SINGLE-STAGE MODEL
This captures the classic unitary cognitive style analysis. Non-parametric Kernel regression is used and the graph below shows the estimated conditional effects of SUS and Regret in the ASA risky scenarios.

DUAL-STAGE MODEL
We assume there are two stages while making the decision to operate:
- Absolute certainty (Probit) choose to operate on the patient for sure without a doubt.
- Relative uncertainty (GLM): reported some degree of surgical suspicion in given scenarios.

Assumption is based on the decision curve analysis (Vickers and Elin, 2006), a widely used method for evaluating diagnostic tests and predictive models in medicine. Two-part model is selected for the analysis in this section. Reversed Likert scale for stated Agree to Operate (Q1_R) is generated by subtracting the responses by 100. Lower the number on the scale, the more likely to operate.

CONCLUSION
- As the scenario risk increase, participants are less likely agree to operate, but dual-stage model shows that different decision mechanisms may be applied.
- Absolute certainty: less likely to operate in the medium risk scenario than the low, no differences between the low and the high.
- Relative Uncertainty: less likely to operate in the high risk scenario than the low, no differences between the low and the medium.
- No significant differences in the decision to operate between participants with different risk preferences in the single-stage.
- For individuals having high stress from uncertainty score, they are less likely to choose to operate but the effects are not as strong when we consider the decision making as two processes.
- Regret has a very similar average effect in size as stress from uncertainty in the single-stage model, and the effect is consistent in the dual-stage model.
- Females are on average 10 percentage points less likely to operate compared to male.

CONTRIBUTION
- The first attempt in exploring the effect of risk preference, stress from uncertainty and regret attitude on surgical decisions in single-system and dual system model settings.
- This survey uses a wide array of quality instruments to measure subject preferences.
- Our study deviates from the literatures using student subjects. It is designed for anesthetists with the vignette scenarios chosen to represent situations they face in daily practices and preference measures for medical professionals, ensuring all our participants have similar background knowledge and training, hence lowered the noise in the sample.

ROBUSTNESS CHECKS
Our result is robust when taking into account
- whether participants have correctly identified the risky level of the scenarios,
- the correlation of responses that the same person made in each of the scenarios by using random effect model and Generalized Estimating Equation model,
- different measurement methods to measure stress under uncertainty and regret: principal component analysis and structure equation model with latent measures.

References
Gerrity, Martha S, Robert F DeVellis, and Jo Anne Earp, “Decision making under uncertainty: a new measure and new insights,” Medical Care, 2006, 44(7), 1179-1189.

Contact: Zijing.Yang@warwick.ac.uk