Lin-Somnia

This year, a peculiar epidemic has been sweeping the nation among men in their mid-20s, resulting in high mortality due to complete inability to sleep while endlessly searching the internet for stories on celebrity athletes. Scientists, stumped by this unusual phenomenon, refer to it as "Lin-Somnia," hypothesizing that these men have become completely obsessed with the stardom of Jeremy Lin, the point-guard for the Brooklyn Nets basketball team. In order to address the urgent situation, the U.S. Centers for Disease Control and Prevention (CDC) commissions a research group at the National Beauty-sleep Association (NBA) to immediately begin a study to evaluate strategies in the prevention of deaths attributable to Lin-Somnia.

It turns out that epidemiologists at HSPH have already studied two strategies to improve survival with Lin-Somnia after a smaller epidemic occurred in Cambridge while Jeremy Lin was an undergraduate Harvard student. The following table gives survival probabilities (i.e., survival from all causes of mortality) from a 5-year randomized trial of 25-year-old men diagnosed with Lin-Somnia who were assigned to (1) take sleeping pills or (2) cancel their internet subscription throughout the trial. In this question, use the 2018 US life tables (posted along with this practice exam) to inform age-specific background mortality rates.

Time (years)	Sleeping Pill	Cancel Internet
0	1.0	1.0
1	0.92	0.74
2	0.77	0.64
3	0.61	0.56
4	0.47	0.49
5	0.36	0.42

(a) For each of the 2 study arms, calculate the disease-specific annual mortality rates for each year of the trial. What disease-specific mortality rates might you use for Year 6 and beyond for each group (note: use your judgment; there is no single correct answer here)? (5 points)

(b) Estimate the discounted life expectancies for two otherwise identical cohorts of 25-year-old men newly diagnosed with Lin-Somnia who: (1) take sleeping pills, and (2) cancel their internet subscriptions. (5 points)

Use the following assumptions and data:

- Use the disease-specific mortality rates calculated for each of the 5 years of the trial for the two arms (from part a); for simplicity, hold the rates constant after year 5 (equal to the rates at year 5 in each of the arms).
- Assume that there is no cure for Lin-Somnia.
- Assume an annual discount rate of 3% and no half-cycle correction.

(c) What is the lifetime risk of dying from Lin-Somnia in the two arms? (3 points)

After several years of studying Lin-Somnia, the researchers at HSPH discover that men with Lin-Somnia are at risk for experiencing symptoms of hallucinations, believing they see celebrity athletes in public places. Once these symptoms occur, they persist for the remainder of one's life. Although men experiencing these symptoms do not experience any excess mortality (above and beyond the excess mortality associated with Lin-Somnia), they do experience a diminished quality of life. Based on the trial observations, the researchers from HSPH estimate that the prevalence of symptoms at year 5 is 17.0% in those who take the sleeping pills and 14.3% in those who cancel their internet.

(d) Estimate the annual probability of symptoms in each of the two study arms (assume that the probability is constant over time in both arms). Describe how you came up with these estimates. (5 points)

(e) Estimate the discounted, quality-adjusted life expectancies for two otherwise identical cohorts of 25-year-old men newly diagnosed with Lin-Somnia who: (1) take sleeping pills, and (2) cancel their internet subscriptions. (3 points)

Use the assumptions from part (b) and the following data:

- Assume a constant annual probability of symptoms in each arm (from part d).
- Assume men who take the sleeping pills experience a utility of 0.98.
- Assume men who cancel their internet subscriptions experience a utility of 0.2 for the first year and then a utility equivalent to 1 thereafter (unless they become symptomatic).
- Assume men who experience hallucinations have a constant utility of 0.6 regardless of what study group they are in.

In the first year, the strategy of taking sleeping pills has a cost of $10,000, inclusive of the pills and monthly doctor visits to ensure tolerance to the drug; after the first year, the cost decreases to $500 per year to include only the pills. For those who cancel their internet subscription, there is a cost of $2,000 in the first year associated with weekly therapy visits to deal with withdrawal from the worldwide web; thereafter, there is a cost of $100 every 10 years to check-in with a therapist. Assume 100% compliance to treatment over the lifetime.

(f) Given a willingness-to-pay threshold of $50,000 per quality-adjusted life year (QALY) gained, which would be the optimal strategy? (4 points)