Problem 1: Building Transition Matrix (Weight 6):

Follow the steps below to calculate the transition matrix when anticoagulation is not used.

Part 1: Find the rate of stroke-associated and background (non-stroke associated) mortality events based on these data:

‐ The annual mortality due to all causes is 18 per 1,000 population (of age 65 and older)

‐ The annual death rates for stroke is 36.2 per 100,000 population (of age 65 and older)

Hint: The non-stroke associated mortality rate is therefore 18\*100 - 36.2 per 100,000 population (of age 65 and older).

Non-stroke mortality = 1736.8 per 100,000 individuals 65+

Stroke mortality = 36.2 per 100,000 individuals 65+

**λnon-stroke death = -ln(1 – 1736.8/100,000) = 0.0175**

**λstroke death= -ln(1-36.2/100,000) = 0.0003621**

Part 2: Assume that the annual rate of first-ever stroke is 15 per 1,000 population (of age 65 and older). Calculate the rate of stroke events for our population. While data suggest that this rate changes with age, to simply our model, we assume that this rate remains constant as the patient ages.

**λfirst stroke = -ln (1-15/1000) = 0.015114**

Part 3: For our population, among patients who experience stoke, 90% survives (and move to “Stoke” state) and 10% dies (and move to “Stroke Death”). Remember that in our model “Stroke” is a temporary state to keep track of costs and health outcome of patients who survive a stroke. Use these probabilities and the rate you calculated in Part 2, to find the rate of transition from state “Well” to “Stroke” and to “Stroke Death”. Hint: Assume that the transition from state “Well” to “Stroke” occurs at rate 𝜆1 and from state “Well” to “Stroke Death” at rate 𝜆2. What you estimated in Part 2 is 𝜆1 + 𝜆2 (the rate at which strokes occur). Therefore, if someone moves out of “Well” due to stroke, he or she will move to “Stroke” with the probability 𝜆1/(𝜆1 + 𝜆2) and move to “Stroke Death” with probability 𝜆2/(𝜆1 + 𝜆2).

**Well 🡪Stroke🡪Post-Stroke:**

**0.9 = 𝜆1/(𝜆1 + 𝜆2) = 𝜆1 / 0.015114 / year**

**𝜆1 = 0.0136**

**Stroke 🡪 Stroke Death:**

**0.1 = 𝜆2/(𝜆1 + 𝜆2) = 𝜆2 / 0.015114**

**𝜆2 = 0.0015114**

Part 4: In our population the proportion of patients with recurrent stroke in 5 years after first stroke is 17%. Use this number to calculate the annual rate of recurrent stroke events.

**𝜆3 = annual rate of recurrent stroke events**

**𝜆3 = 0.17 \* 0.0136 = 0.002312 / 5 years = 0.0004624**

Part 5: Assume that the probability of surviving a recurrent stroke is 80%. Follow the procedure in Part 3, to calculate the transition rates from state “Post-Stroke” to “Stroke” and “Stroke Death”.

**𝜆4 = transition rate from post-stroke to stroke**

**𝜆5 = transition rate from post-stroke to stoke death**

**𝜆4 / 𝜆3 = 0.8 🡺 .8\*0.0004624 = 0.0003699**

**𝜆5 / 𝜆3 = 0.2 🡺 0.2 \* 0.0004624 = 0.00009248**

Part 6: A patient who survives a stroke stays in state “Stroke” on average 1 week. Calculate the rate of transition from “Stroke” to “Post-Stroke”. Remember we have been using year as the unit of time. Hint: If the transition rate out of a state is 𝜆, the expected stay time in the state is 1/𝜆.

**0.0136+0.0003699 /52 = 0.0002687**

**𝜆4 = 0.0002687**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Well** | **Stroke** | **Post-Stroke** | **Stroke Death** | **Background Death** |
| Well | **0** | **0.015114** | **0** | **0** | **0.0175** |
| Stroke | **0** | **0** | **0.0002687** | **0.0015114+0.00009248 =**  **0.0016** | **0** |
| Post-Stroke | **0** | **0.0004624** | **0** | **0** | **0.0175** |
| Stroke Death | **0** | **0** | **0** | **0** | **0** |
| Background Death | **0** | **0** | **0** | **0** | **0** |

Problem 2: Transition Matrix Under Anticoagulation Use (Weight 2): Find the transition matrix when anticoagulation is used. Assume that the anticoagulation reduces the rate of stroke events while in “Post-Stroke” by 25% but increases the rate of non-stroke related mortality by 5%.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Well** | **Stroke** | **Post-Stroke** | **Stroke Death** | **Background Death** |
| Well | **0** | **0.015114** | **0** | **0** | 0.018375 |
| Stroke | **0** | **0** | **0.0002687** | **0.0015114+0.00009248 =**  **0.0016** | **0** |
| Post-Stroke | **0** | 0.0003468 | **0** | **0** | 0.018375 |
| Stroke Death | **0** | **0** | **0** | **0** | **0** |
| Background Death | **0** | **0** | **0** | **0** | **0** |

Post-Stroke 🡪 Stroke =

0.0004624 – (0.25)(0.0004624) = 0.0003468

Well🡪 death = 0.0175 + 0.0175\*0.05 = 0.018375