A Medical Device Regulatory Vigilance Example

Background

Medical Device Company (MDC) has developed and is seeking approval for a first-of-its-kind, implantable defibrillator. The company has submitted data from clinical trials and the device appears to reduce the risk of death in a certain class of patients. But the procedure to implant the device is invasive and involves some risk of adverse events leading to death. Further, the device is designed to last at least 10 years but some can fail earlier which requires an additional replacement procedure. Our objective is to minimize the number of deaths in the relevant class of patients as we consider whether or not to approve the device.

Model Assumptions

- The surgery death rate is a function of how many have the device, adverse events and post-surgery failure rate
- The ongoing death rate is a function of the mortality with the device, how many have the device and the mortality without the device
- Total deaths is a function of the surgery death rate and ongoing death rate

Variable	Base Case Assumption
Patient Population	50,000
Compliance Rate	80%
Failure Rate	5% over 10 years
Mortality Rate w/Device	18% over 10 years
Mortality Rate w/o Device	30% over 10 years

#1 Build a Deterministic Model

Building a deterministic model helps to focus your efforts. We'll add the variable to be minimized or maximized (objective function) to the deterministic influence diagram which in this case is *Deaths in 10*. Values that serve as inputs to our objective function are placed to the left (**Figure 1**). Lastly, an "Approve?" Decision is added to the model for initial analysis.

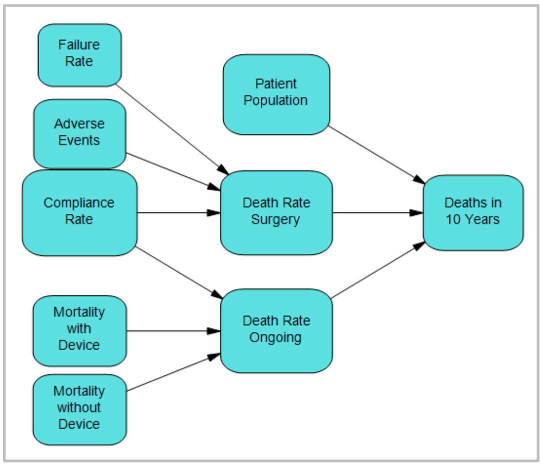

Figure 1. DPL™ Deterministic Model

#2 Conduct Sensitivity Analyses

A deterministic sensitivity analyses is generated to better understand which uncertain variables have the biggest impact on the objective function. In **Figure 2** you see that the Mortality with Device creates the widest swing in expected value in the number of deaths in 10 years. Also, the pink shading at the end of the bar indicates that the variable is decision sensitive – when Mortality with Device is set to its high state, the optimal decision policy changes.

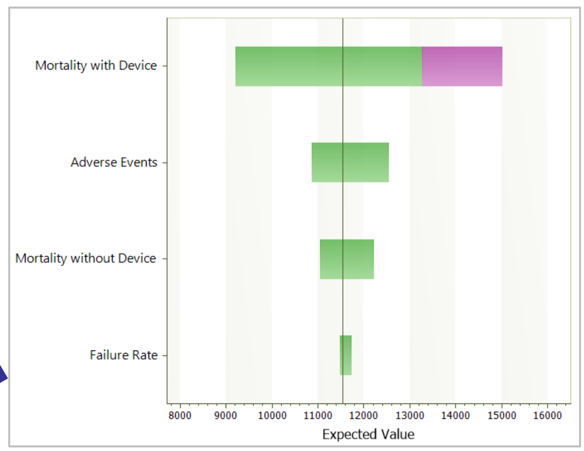

Figure 2. DPL™ Value Tornado Diagram

#3 Introduce Uncertainty

The inputs shown to have an impact on the objective function are modelled probabilistically, i.e., they are changed into a discrete chance nodes as show in **Figures 3 & 4**.. A discrete range of outcomes, in this case Low/Nominal/High, are specified and assigned a value and probability of occurring. Now a Decision Analysis is run and outputs are generated to see which is the optimal decision alternative.

The results of the analysis indicate that the implantable defibrillator device should be approved.

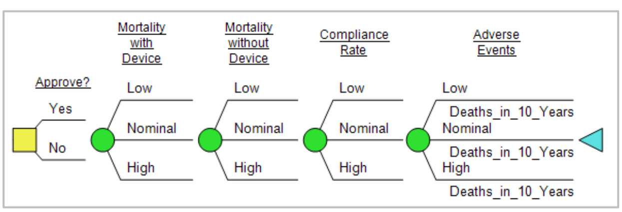

Figure 3. DPL™ Probabilistic Decision Tree

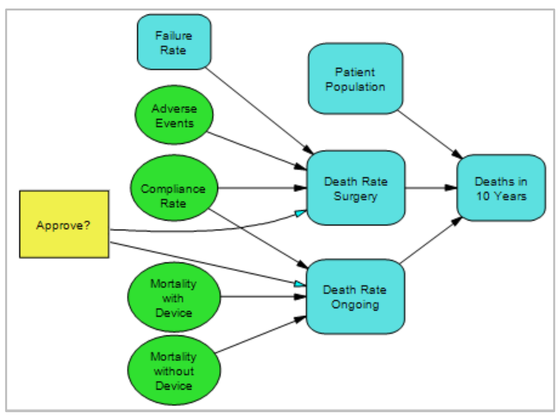

Figure 4. DPL™ Influence Diagram

DPL Case Study