A Medical Device Regulatory Vigilance Example

DPL Case Study

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 various clinical trials, and the device appears to reduce the risk of death due to cardiac arrest 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 are expected to fail earlier and would require an additional procedure for replacement. As the Regulatory Body, 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.

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

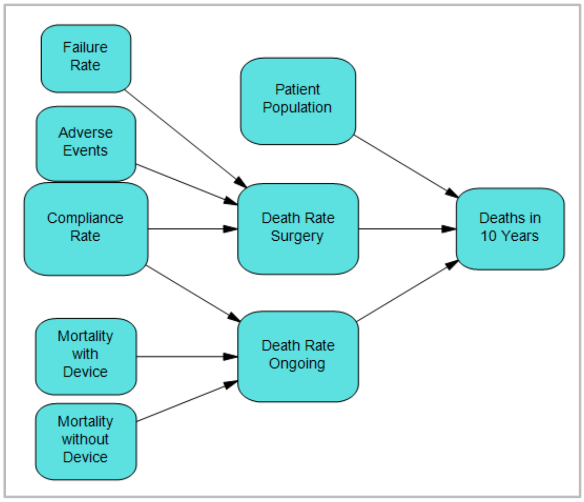

Figure 1. DPL™ Deterministic Model

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

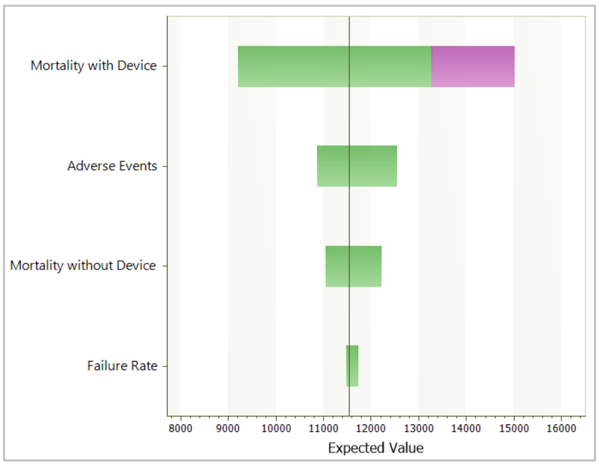

Figure 2. DPL™ Value Tornado Diagram

#1 Build a Deterministic Model

Starting to build a deterministic model can help to focus your efforts. For some models it is most efficient to start your deterministic influence diagram with the variable to be minimized or maximized , in this case *Deaths in 10 Years* by placing it to the right. Values that serve as inputs to the objective function are placed to it's left. Lastly an explicit Approve? Decision is added to the model for initial analysis.

#2 Conduct Sensitivity Analyses

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

#3 Introduce Uncertainty

Those inputs shown to have an impact on the objective function are modelled probabilistically, i.e., they are changed into a discrete chance nodes. 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.

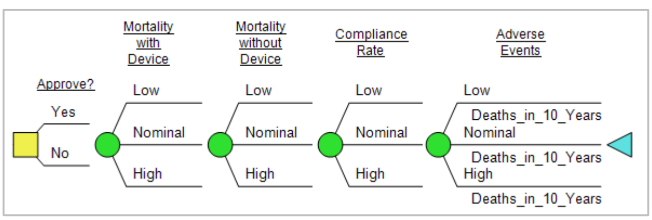

Figure 3. DPL™ Probabilistic Decision Tree

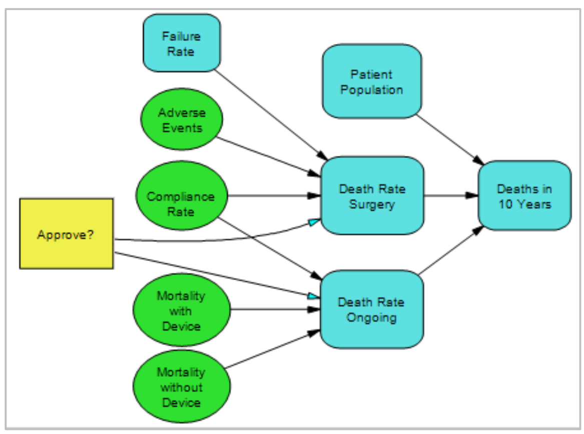

Figure 4. DPL™ Influence Diagram