Assessing Risks in General Surgery

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1. Introduction and Background

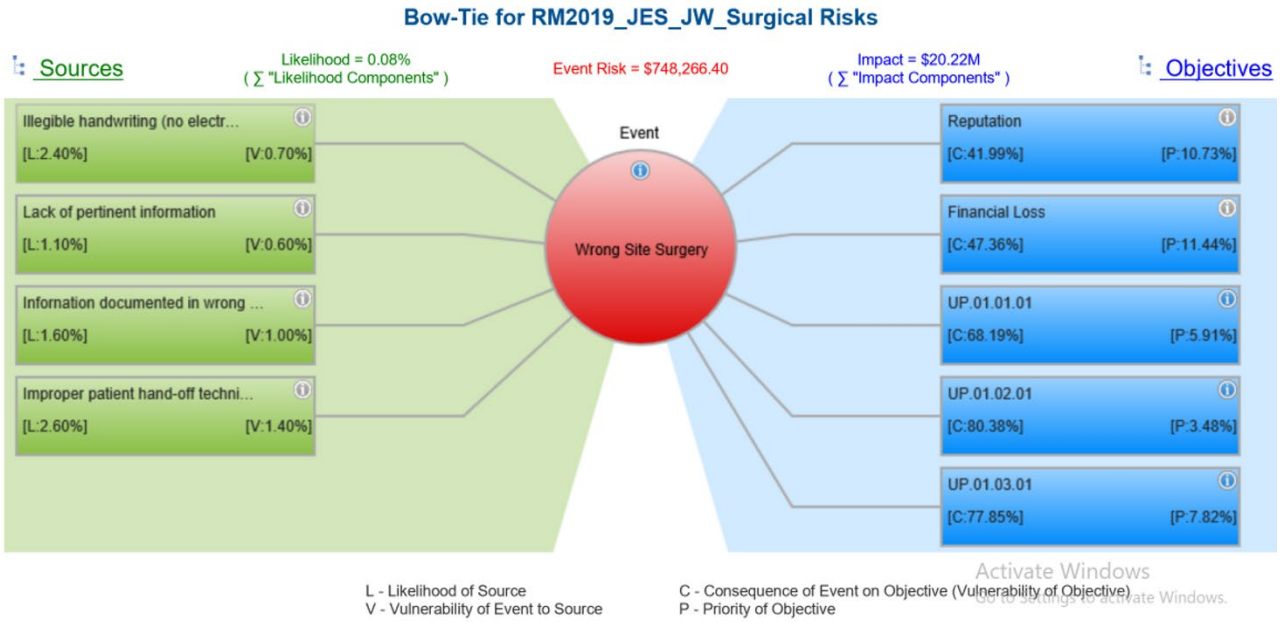
According to Adams (2012), "The overall chance of dying within two months of surgery is one in 28 (3.6 percent)". However, surgery within itself can be a risky and frightening situation for anyone to contemplate. For this reason, this project evaluates the risks one must consider, from the perspective of the hospital, during general surgery.

Therefore, our team chose to perform a practical risk assessment for a hypothetical medical center. Our team based its assessment on their experiences and insights from working as healthcare professionals. The team utilized Riskion® Risk Management software to navigate the various options to measure and synthesis the data. This software allows the team to demonstrate how to make the optimal decision quantitively. The following report provides the team's findings and recommendations.

2. Structuring the Model

As mentioned above, to more clearly visualize, quantify, and assess the components of our model and the possible decisions that can be made, we have used the Expert Choice Riskion® Software. Further, to perform our general surgery risk assessment, we must first define risk and its associated elements. Risk also called a risk-event and used interchangeably hereafter, is something that is uncertain and can lead to a loss. A source, a threat, or a cause is something that can lead to a risk-event, and that does not itself lead to any losses. Objectives are the ones upon which the detrimental consequences of the risk-events take place.

In our model, we will be using many different types of graphics, one of which is called the bow-tie diagram, and an example is presented here. These diagrams help depict the relationship between sources and risk-events and between risk-events and objectives.



It is also essential to present a broad overview of how Riskion® works. The Riskion® software allows us to identify the risk-events, or what can go wrong, and the causes of these risk-events. It also facilitates measuring expected losses and provides an output of calculations in ratio scale measures. Lastly, it models both controls, which are used to reduce risk-events and their consequences, and allocation and optimization of resources.

The diagram below depicts the steps that are used to create a risk model in Riskion®.

1. Identify risk-events, sources and objectives
2. Evaluate or make judgements on the likelihood of sources and risk-events given the sources
3. Identify and judge the consequences of the event on the objectives
4. View Risks – overall risk with likelihood, impact and risk (can be seen in % or $)
5. Identify options (Controls) to decrease threats
6. View impacts before and after added controls (also work on optimization of control use with the use of a budget and/or other constraints)

These steps to create the risk assessment were used as a quasi-model for the structure of this report.

2.1. Identifying the Risks

A risk assessment model can be started by first identifying risk-events, sources, or objectives. There are multiple ways to look at risk, and no one single pattern needs to be followed in identifying risk-events, sources, or threats as long as they are appropriately classified. For our project, we chose to start by identifying several risk-events associated with surgery. The risk-events

we identified are listed in the screen capture below.

2019-10-09 10:30:16

Events

Wrong Site Surgery
Infections
Transfusion reactions
Excessive Bleeding
Patient Death
Equipment Failure
Fire Within the Operating Room (OR)
Reaction to Anesthesia
Wrong patient
Wrong procedure performed
Forein objects left in patient
Nerve injury
Unnecessary surgery
Medication-Medication Interaction or Contraindication (not including ansethetic medicaions or blood products)
Permanent brain damage

1

We identified fifteen different risk-events and they ranged from medication interactions and equipment failure to wrong site surgery and patient death. For a more detailed description of the risk events see the table at the end of this sub-section. Some of these events are more likely to occur than others and some have much more detrimental consequences than others. We will touch upon these topics in a later section of this report.

Event (What are we afraid of?)	Risk Description
1. Wrong Site Surgery	Surgery is performed on the wrong part of the patient's body.
2. Infections	The patient's surgical site or blood stream becomes invaded by disease-causing agents after surgery
3. Transfusion Reactions	The patient may spike a fever, get hives, or any other seemingly allergic reaction to being given blood products.
4. Excessive Bleeding	This may be due to an accidental nick of an artery.
5. Patient Death	When a patient dies from any portion of the surgery; Pre or Post-Operation.
6. Equipment Failure	Any downtime of the equipment used during the surgery.
7. Fire Within the OR	Anything that results in flames in the operating room; likely electrical.
8. Reaction to Anesthesia	• Allergic • Anaphylactic Shock
9. Wrong Patient	The wrong patient is operated on.
10. Wrong Procedure Performed	The procedure performed on the patient was meant for a different patient.
11. Foreign Object Left in Patient	After surgery, an object such as a medical instrument or gauze was left and closed in the patient.
12. Nerve Injury	This may be due to an accidental nick of a nerve.
13. Unnecessary Surgery	Surgery was performed on a patient who did not need the procedure performed
14. Medication-Medication Interaction/Counter Interaction	Interaction or adverse effect that happens due to the concurrent use of two or more medications, in this particular case when adding or administering medication necessary for the surgery.
15. Permanent Brain Damage	Patient may have suffered strokes to both sides of the brain.

2.2 Identifying the Sources

Next, we proceeded to identify the possible sources of the risk-events. It is important to note that not all risk-events will have a source and that some risk-events, or many, can have multiple causes. One of the ways that sources can be found is by asking, "What can cause this particular risk-event to occur?" Aside you can find a list of the sources that we identified. Our list is not an exhaustive list of the possible causes of the identified risk-events. It is the list of causes that we identified for this particular scenario, but the risk is subjective, and given different circumstances, hospital settings, specific types of surgery, then the list of causes could change. Also, notice that the sources are grouped into categories, this helps not only in organizing the project but also helps visualize and conceptualize it as it breaks a big group into smaller, more manageable ones. The image below portrays the relationships between sources and risk-events. Given that we are only considering fifteen risk-events and more than twenty sources, it is easy to see how this analysis could become a challenge to be tackled were it not for risk assessment software.

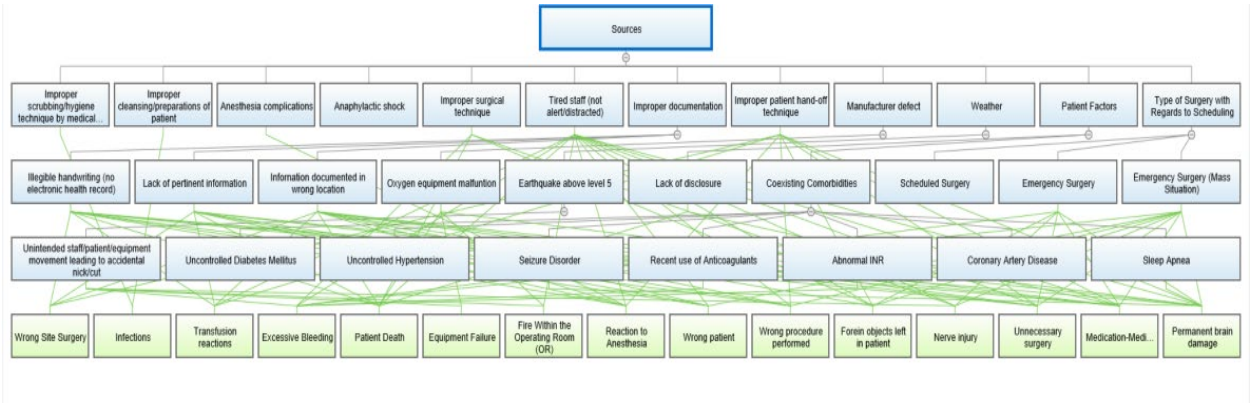
2019-10-09 10:24:42

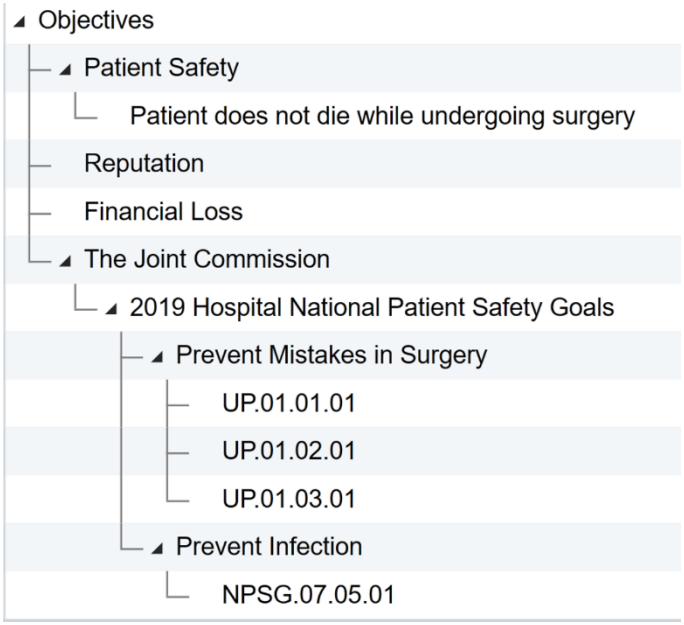
Sources

- Sources
  - Improper scrubbing/hygiene technique by medical personnel
  - Improper cleansing/preparations of patient
  - Anesthesia complications
  - Anaphylactic shock
  - Improper surgical technique
  - Tired staff (not alert/distracted)
  - Improper documentation
    - Illegible handwriting (no electronic health record)
    - Lack of pertinent information
    - Infornation documented in wrong location
  - Improper patient hand-off technique
  - Manufacturer defect
    - Oxygen equipment malfuntion
  - Weather
    - Earthquake above level 5
      - Unintended staff/patient/equipment movement leading to accidental nick/cut
  - Patient Factors
    - Lack of disclosure
    - Coexisting Comorbidities
      - Uncontrolled Diabetes Mellitus
      - Uncontrolled Hypertension
      - Seizure Disorder
      - Recent use of Anticoagulants
      - Abnormal INR
      - Coronary Artery Disease
      - Sleep Apnea
  - Type of Surgery with Regards to Scheduling
    - Scheduled Surgery
    - Emergency Surgery
    - Emergency Surgery (Mass Situation)

1

2.3 Identifying Objectives





The objectives can be taken from the organization's directly from the organization's objectives, goals, values, and mission as well as from other sources. Other sources could include departmental/section goals as well as accreditation or certification criteria. For this project, some objectives were taken from the National Patient Safety Goals of The Joint Commission. The Joint Commission is "an independent, not-for-profit organization … [that] accredits and certifies over 22,000 health care organizations and programs in the United States" (About The Joint Commission, 2019). The other objectives, which include financial loss, patient safety, and reputation, were taken from the organization's objectives. A full list of the objectives used for this risk assessment is presented here. When performing a risk assessment, it is crucial to note that the strategic and managerial teams assign the priority given to the objectives. That is one element that cannot be managed by adding controls. We will expand upon controls in section six.

2.4 Participants and Roles

There were several participants identified as potential candidates for this risk assessment and we are glad to report that they all participated fully. When it comes to assessing risk, it is said to be better to have multiple people entering judgements. The more people that contribute, especially if they are experts in their field, the more likely that the data will predict the likelihoods of sources, risk-events given sources and losses to objectives close to actuality. The participants in this project are identified below:

	Email Address	Participant Name	Permission	Has Data?
☑	ahd@dodhospital.gov	Assistant Hospital Directc	Evaluator	Yes
☑	con@dodhospital.gov	Chief of Nursing	Evaluator	Yes
☑	cos@dodhospital.gov	Chief of Staff	Evaluator	Yes
☑	cosx@dodhospital.gov	Chief of Surgery	Evaluator	Yes
☑	hd@dodhospital.gov	Hospital Director	Evaluator	Yes
☑	iddc@dodhospital.gov	Infectious Diseases Depa	Evaluator	Yes
☑	suarezje01@gwu.edu	Joan Edge-Suárez	Project Manager	Yes
☑	judit_warren@gwu.edu	Judit Warren	Project Manager	Yes

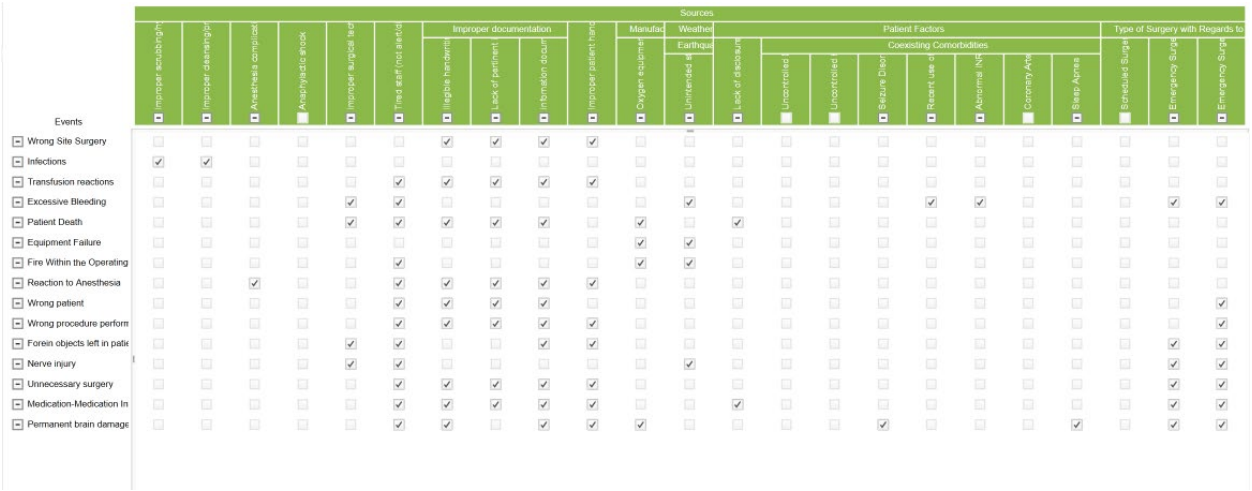
Within these participants, the Hospital Director, Assistant Hospital Director, Chief of Staff and Infectious Disease Department Head are classified as belonging to the Administration Groups. While the Chief Group is composed of the Chief of Surgery and the Chief of Nursing. The remaining participants are the project managers.

3. Events and Source Mapping

Means of relaying data are critical, especially when it is complex data with numerous many-to-many relationships. One way to portray this is by using a grid. Below are two grids to show 1) the relationship between sources and risk-events, and 2) the relationship between risk-events and objectives.

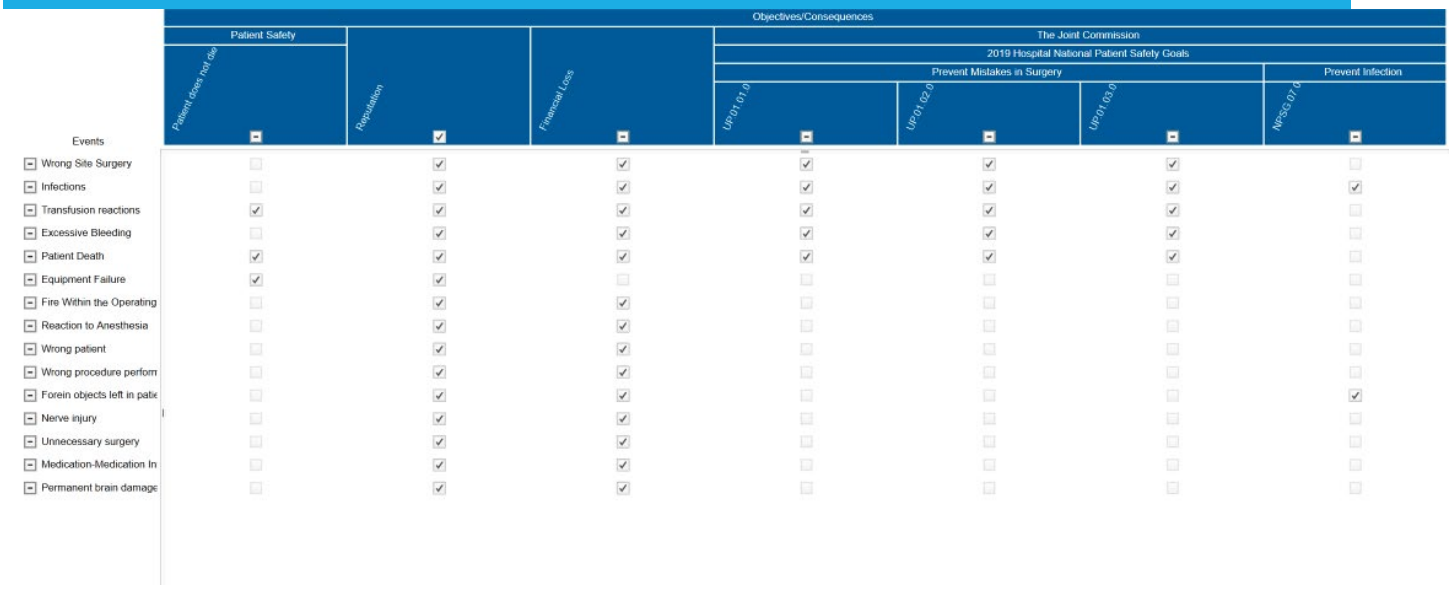
3.1 Likelihood of Events

The grid below shows lists the events and shows which source(s) lead to each risk-event. It is important to remember that not all risk-events will have a source and also that some risk-events might have more than one threat associated with it.



3.2 Impact of Events

Below is the grid that shows the relationship between risk-events and objectives. The risk-events are listed on the left and objectives are listed on top. From here, the chart shows which event(s) might lead to negative consequences on each respective objective. Just as one risk-event can have multiple sources, so too each objective can be affected by one or more risk-events.



Events	Objectives/Consequences						
	Patient Safety			The Joint Commission			
				2019 Hospital National Patient Safety Goals			
				Prevent Mistakes in Surgery			Prevent Infection
	Patient does not die	Reputation	Financial Loss	UP.01.01.0	UP.01.02.0	UP.01.03.0	NPSG.07.0
Wrong Site Surgery	☐	☑	☑	☑	☑	☑	☐
Infections	☐	☑	☑	☑	☑	☑	☑
Transfusion reactions	☑	☑	☑	☑	☑	☑	☐
Excessive Bleeding	☐	☑	☑	☑	☑	☑	☐
Patient Death	☑	☑	☑	☑	☑	☑	☐
Equipment Failure	☑	☑	☐	☐	☐	☐	☐
Fire Within the Operating	☐	☑	☑	☐	☐	☐	☐
Reaction to Anesthesia	☐	☑	☑	☐	☐	☐	☐
Wrong patient	☐	☑	☑	☐	☐	☐	☐
Wrong procedure perform	☐	☑	☑	☐	☐	☐	☐
Forein objects left in patie	☐	☑	☑	☐	☐	☐	☑
Nerve injury	☐	☑	☑	☐	☐	☐	☐
Unnecessary surgery	☐	☑	☑	☐	☐	☐	☐
Medication-Medication In	☐	☑	☑	☐	☐	☐	☐
Permanent brain damage	☐	☑	☑	☐	☐	☐	☐

4. Risk Measurements and Scales

Most organizations rely on a subjective approach when assessing any operational risk. However, by utilizing the Riskion® software, the surgery team can confidently conclude that its assessment is mathematically significant. Through Riskion®, the individuals who are crucial in the decision-making process may incorporate aggregated judgments to reduce surgical risks. For these reasons, our team chose to use various methods to collect judgments from all participants.

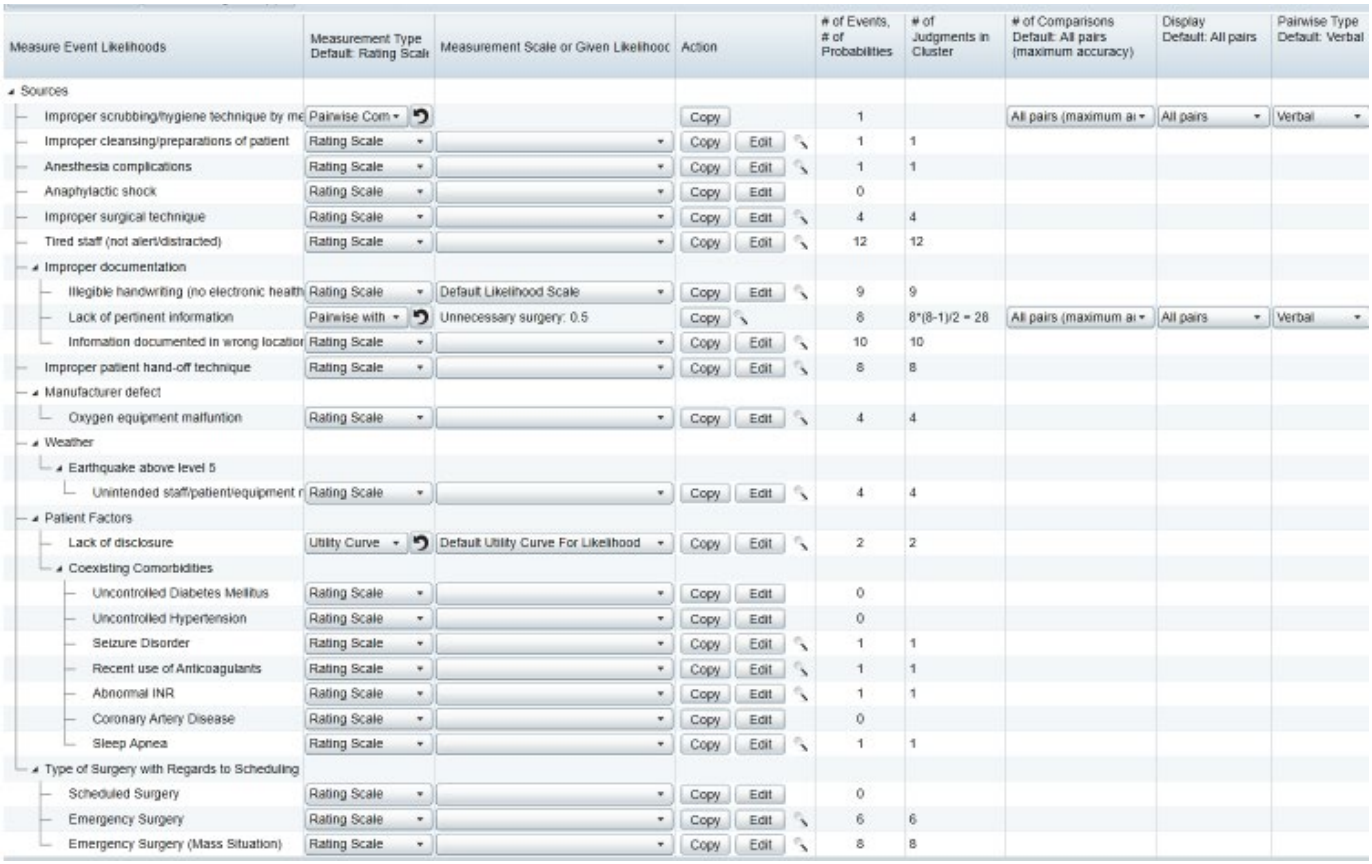
4.1 Methods for Events

Each participant on the team submitted judgments for measurements utilizing ratio scale. The use of the Riskion® software, which is built upon the Analytical Hierarchy Process, assists in the reduction of personal biases from the participants. Riskion® then uses eigenvectors to translate these unbiased judgments into ratio scale priorities.

4.1.1 Likelihood of Events

The following represent the measurement methods used for assessing the likelihood of events:

1. Pairwise with Comparisons—derive ratio scale priorities for the relative importance of each event in its category.
2. Rating Scale—likelihoods entered between given intensities for each event that applied this measurement.
3. Pairwise with Given Likelihood—derived from known or assumed likelihood of occurrences specified by the participants.
4. Utility Curve—provided a linear scale measurement for the likelihood of patient death given the lack of disclosure.



Measure Event Likelihoods	Measurement Type Default: Rating Scale	Measurement Scale or Given Likelihood	Action	# of Events, # of Probabilities	# of Judgments in Cluster	# of Comparisons Default: All pairs (maximum accuracy)	Display Default: All pairs	Pairwise Type Default: Verbal
Sources								
Improper scrubbing/hygiene technique by me	Pairwise Com		Copy	1		All pairs (maximum ac	All pairs	Verbal
Improper cleansing/preparations of patient	Rating Scale		Copy Edit	1	1			
Anesthesia complications	Rating Scale		Copy Edit	1	1			
Anaphylactic shock	Rating Scale		Copy Edit	0				
Improper surgical technique	Rating Scale		Copy Edit	4	4			
Tired staff (not alert/distracted)	Rating Scale		Copy Edit	12	12			
Improper documentation								
Illegible handwriting (no electronic health	Rating Scale	Default Likelihood Scale	Copy Edit	9	9			
Lack of pertinent information	Pairwise with	Unnecessary surgery: 0.5	Copy	8	8*(8-1)/2 = 28	All pairs (maximum ac	All pairs	Verbal
Infomation documented in wrong location	Rating Scale		Copy Edit	10	10			
Improper patient hand-off technique	Rating Scale		Copy Edit	8	8			
Manufacturer defect								
Oxygen equipment malfuntion	Rating Scale		Copy Edit	4	4			
Weather								
Earthquake above level 5								
Unintended staff/patient/equipment r	Rating Scale		Copy Edit	4	4			
Patient Factors								
Lack of disclosure	Utility Curve	Default Utility Curve For Likelihood	Copy Edit	2	2			
Coexisting Comorbidities								
Uncontrolled Diabetes Mellitus	Rating Scale		Copy Edit	0				
Uncontrolled Hypertension	Rating Scale		Copy Edit	0				
Seizure Disorder	Rating Scale		Copy Edit	1	1			
Recent use of Anticoagulants	Rating Scale		Copy Edit	1	1			
Abnormal INR	Rating Scale		Copy Edit	1	1			
Coronary Artery Disease	Rating Scale		Copy Edit	0				
Sleep Apnea	Rating Scale		Copy Edit	1	1			
Type of Surgery with Regards to Scheduling								
Scheduled Surgery	Rating Scale		Copy Edit	0				
Emergency Surgery	Rating Scale		Copy Edit	6	6			
Emergency Surgery (Mass Situation)	Rating Scale		Copy Edit	8	8			

4.1.2 Impact of Events

The impact of events was measured by rating scale.

Measure Events With Respect To	Measurement Type Default: Rating Scale	Measurement Scale	Action	# of Events, # of Probabilities	# of Judgments in Cluster	# of Comparisons Default: All pairs (maximum accuracy)	Display Default: All pairs	Pairwise Type Default: Verbal
Objectives								
Patient Safety								
Patient does not die while undergoing su	Rating Scale		Copy Edit	3	3			
Reputation	Rating Scale		Copy Edit	15	15			
Financial Loss	Rating Scale		Copy Edit	14	14			
The Joint Commission								
2019 Hospital National Patient Safety Go								
Prevent Mistakes in Surgery								
UP.01.01.01	Rating Scale		Copy Edit	5	5			
UP.01.02.01	Rating Scale		Copy Edit	5	5			
UP.01.03.01	Rating Scale		Copy Edit	5	5			
Prevent Infection								
NPSG.07.05.01	Rating Scale		Copy Edit	2	2			

4.2 Methods for Sources and Objectives

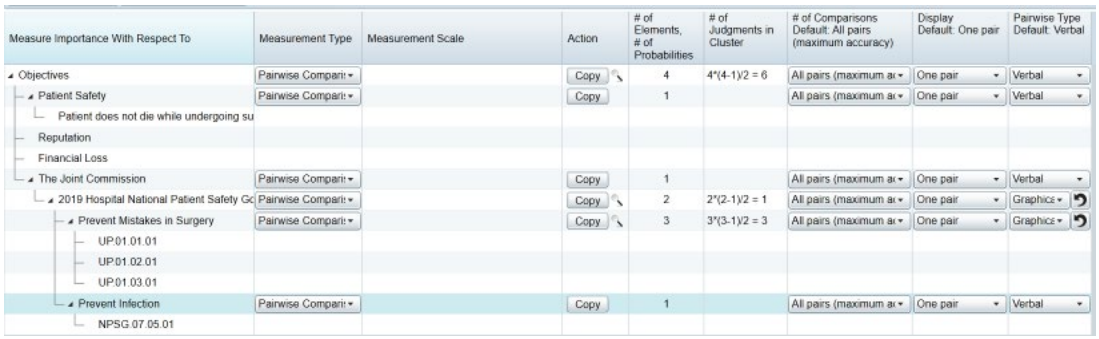
Measurements were all the same as the measurements for the events

4.2.1 Likelihood of Events for Sources

Pairwise comparisons with given likelihood and without as well as rating scales were used.

Measure Likelihood	Measurement Type	Measurement Scale or Given Likelihood	Action	# of Elements, # of Probabilities	# of Judgments in Cluster	# of Comparisons Default: All pairs (maximum accuracy)	Display Default: One pair	Pairwise Type Default: Verbal
Sources	Pairwise with Give	Anesthesia complications: 0.015	Copy	12	12*(12-1)/2 = 66	All pairs (maximum a	One pair	Verbal
Improper scrubbing/hygiene technique by me								
Improper cleansing/preparations of patient								
Anesthesia complications								
Anaphylactic shock								
Improper surgical technique								
Tired staff (not alert/distracted)								
Improper documentation	Pairwise Compari		Copy	3	3*(3-1)/2 = 3	All pairs (maximum a	One pair	Graphics
Illegible handwriting (no electronic health								
Lack of pertinent information								
Information documented in wrong locatior								
Improper patient hand-off technique								
Manufacturer defect	Pairwise Compari		Copy	1		All pairs (maximum a	One pair	Verbal
Oxygen equipment malfuntion								
Weather	Rating Scale		Copy Edit	1	1			
Earthquake above level 5	Rating Scale		Copy Edit	1	1			
Unintended staff/patient/equipment r								
Patient Factors	Pairwise Compari		Copy	2	2*(2-1)/2 = 1	All pairs (maximum a	One pair	Graphics
Lack of disclosure								
Coexisting Comorbidities	Pairwise Compari		Copy	7	7*(7-1)/2 = 21	All pairs (maximum a	One pair	Verbal
Uncontrolled Diabetes Mellitus								
Uncontrolled Hypertension								
Seizure Disorder								
Recent use of Anticoagulants								
Abnormal INR								
Coronary Artery Disease								
Sleep Apnea								
Type of Surgery with Regards to Scheduling	Pairwise Compari		Copy	3	3*(3-1)/2 = 3	All pairs (maximum a	One pair	Graphics
Scheduled Surgery								
Emergency Surgery								
Emergency Surgery (Mass Situation)								

4.2.2 Impact of Events for Sources



Measure Importance With Respect To	Measurement Type	Measurement Scale	Action	# of Elements, # of Probabilities	# of Judgments in Cluster	# of Comparisons Default: All pairs (maximum accuracy)	Display Default: One pair	Pairwise Type Default: Verbal
Objectives	Pairwise Comparis		Copy	4	4*(4-1)/2 = 6	All pairs (maximum ac	One pair	Verbal
Patient Safety	Pairwise Comparis		Copy	1		All pairs (maximum ac	One pair	Verbal
Patient does not die while undergoing su								
Reputation								
Financial Loss								
The Joint Commission	Pairwise Comparis		Copy	1		All pairs (maximum ac	One pair	Verbal
2019 Hospital National Patient Safety Go	Pairwise Comparis		Copy	2	2*(2-1)/2 = 1	All pairs (maximum ac	One pair	Graphics
Prevent Mistakes in Surgery	Pairwise Comparis		Copy	3	3*(3-1)/2 = 3	All pairs (maximum ac	One pair	Graphics
UP.01.01.01								
UP.01.02.01								
UP.01.03.01								
Prevent Infection	Pairwise Comparis		Copy	1		All pairs (maximum ac	One pair	Verbal
NPSG.07.05.01								

5. Synthesis and Sensitivity Analysis

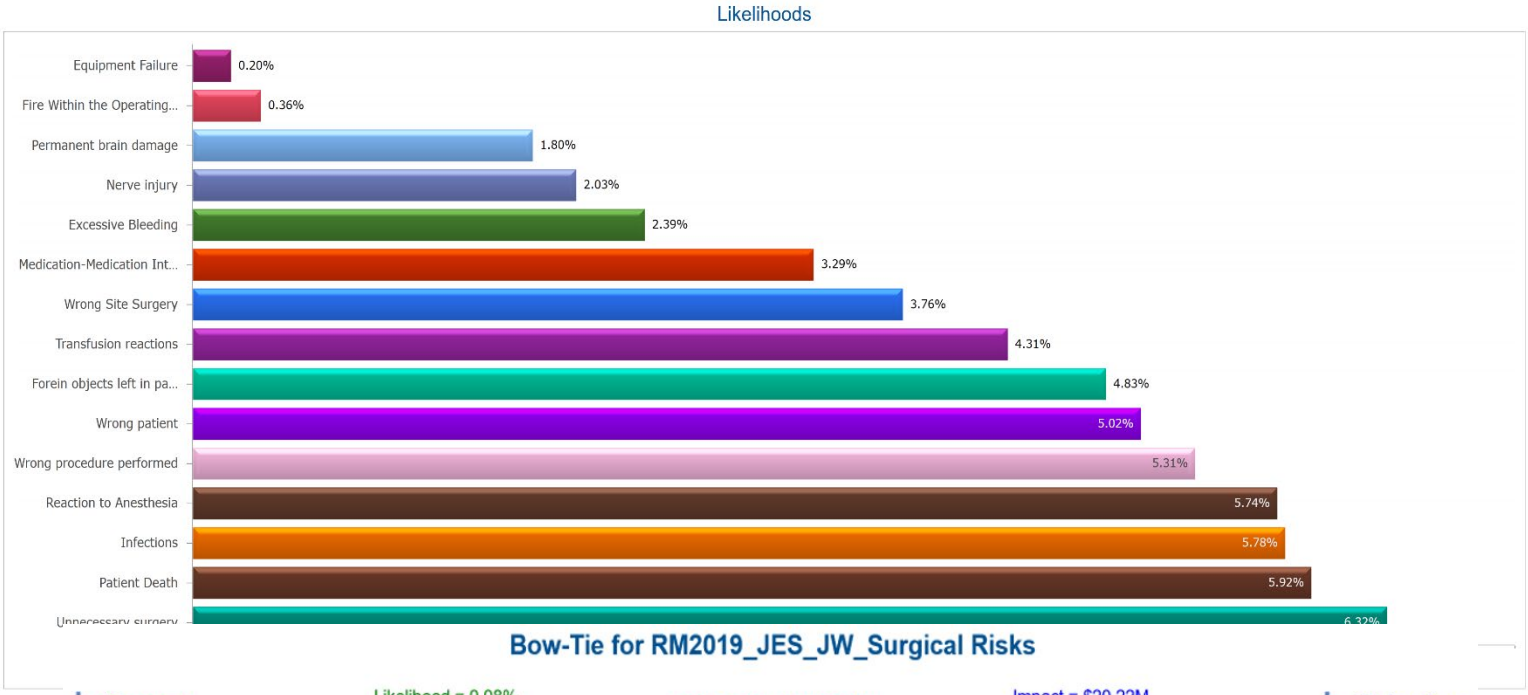
Setting up the risk assessment project in the Riskion® program means:

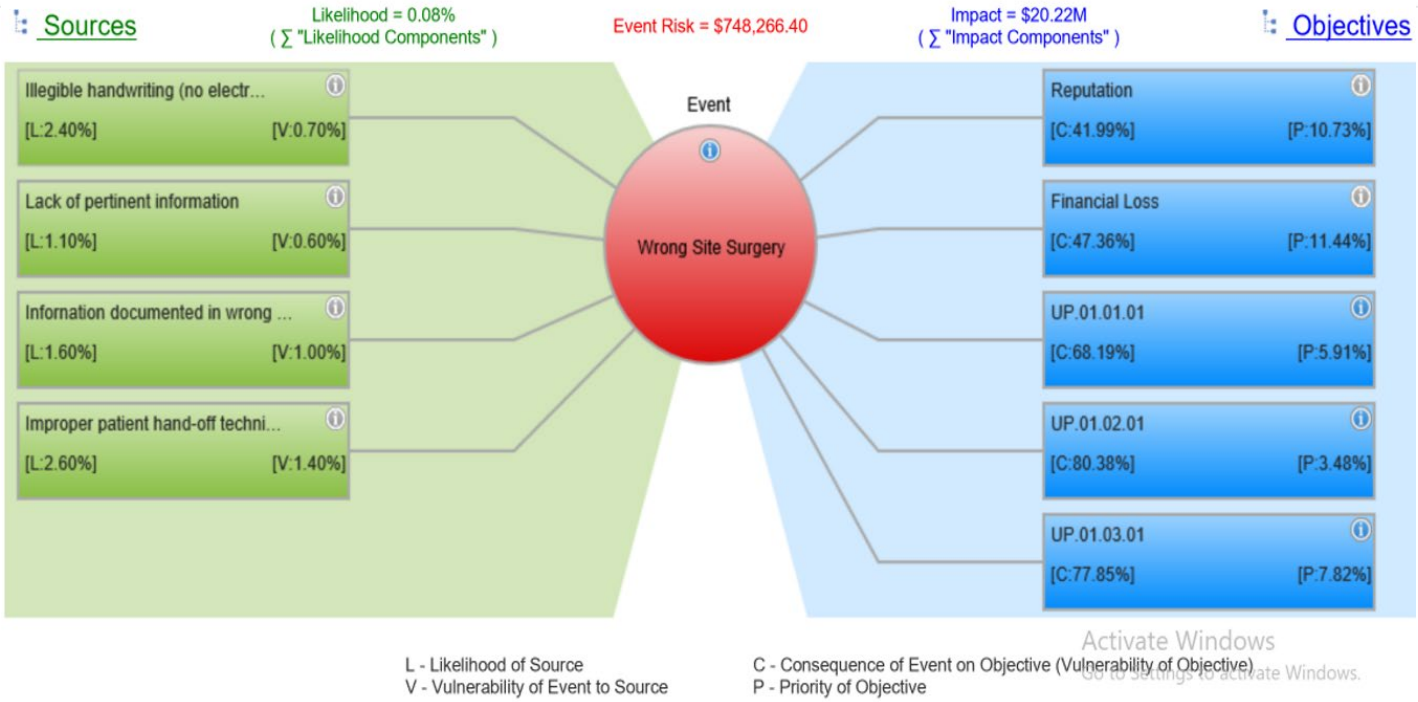
- selecting, entering and categorizing the sources, risk-events, and objectives
- selecting and grouping the participants and then assigning each their own section(s)
- mapping the source to the respective risk-event(s)
- mapping the risk-events to the respective objective(s)
- selecting the methods for measurement for the different judgments

After the risk assessment project has been set up, the participants enter their judgments. The Riskion® software quantitatively synthesizes the data, including qualitative judgments, due to their mode of measurement. The output is ratio scale measures, which means that they are mathematically meaningful and have a persistent and predictable ratio and the relationship between each number. The following sub-sections show the results of the judgments entered.

5.1 Likelihood of Events and Sources

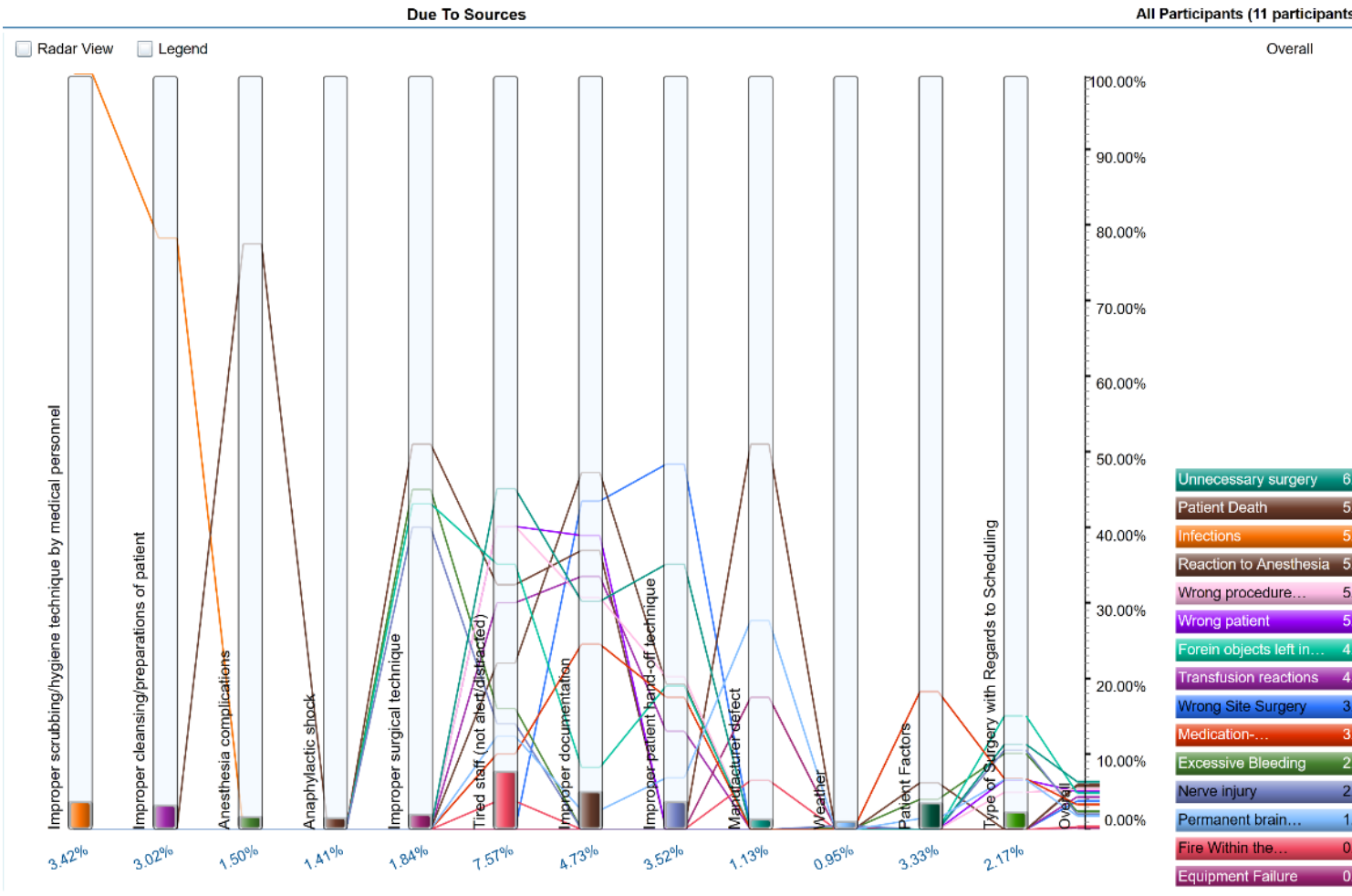
The bar graph below shows the calculated likelihood of the risk-events.





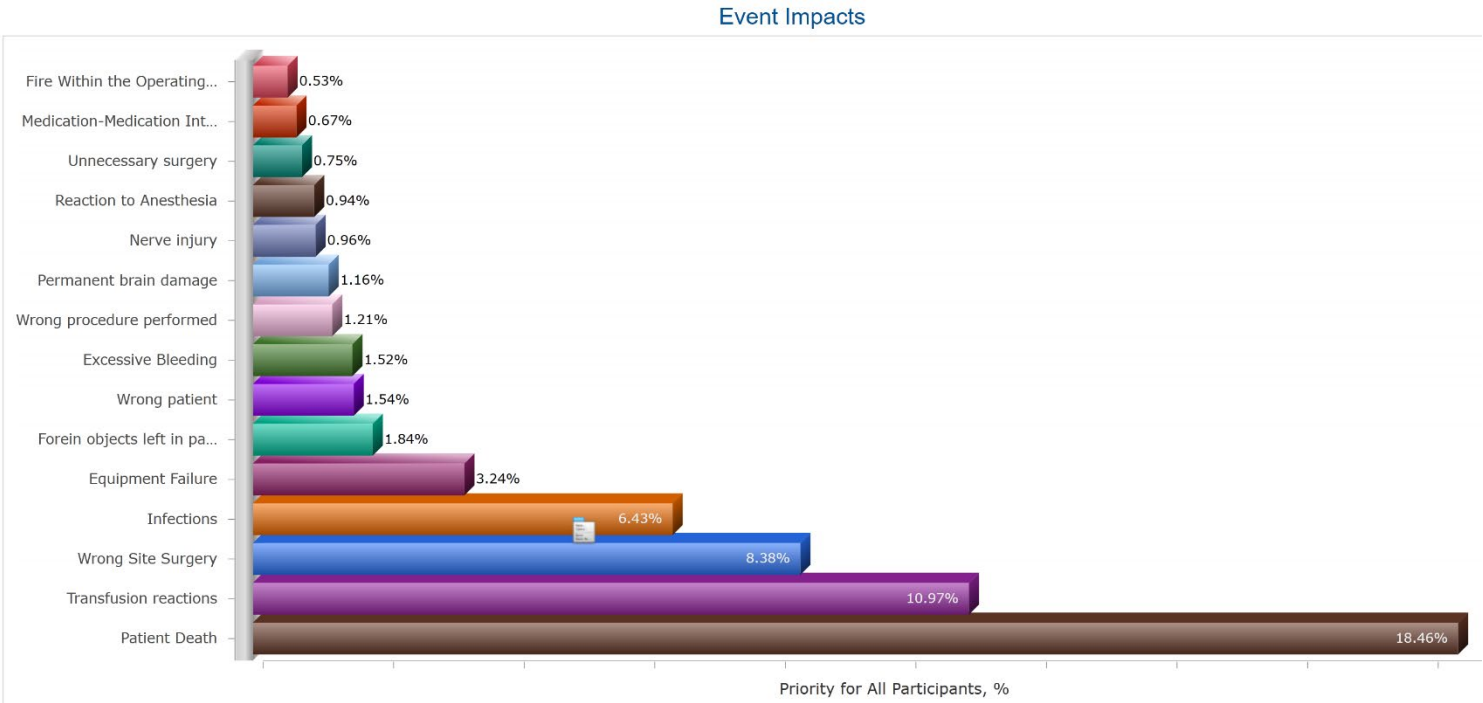
The likelihood value is obtained by the sum product of the likelihood of the source multiplied by the vulnerability of the event to the source (or in other words the likelihood of the event given the source). This computation, as well as the one for impact and risk, are illustrated in the bow-tie diagram presented below.

The likelihood of the risk-events ranges from 0.2% for equipment failure to 6.32% for unnecessary surgery. The top five risk-events in terms of likelihood are unnecessary surgery (6.32%), patient death (5.92%), infections (5.78%), reaction to anesthesia (5.74%), and wrong procedure performed (5.31%). Furthermore, a performance sensitivity analysis showing the sources and risk-event likelihoods is shown on the next page.



5.2 Impact of Events and Sources

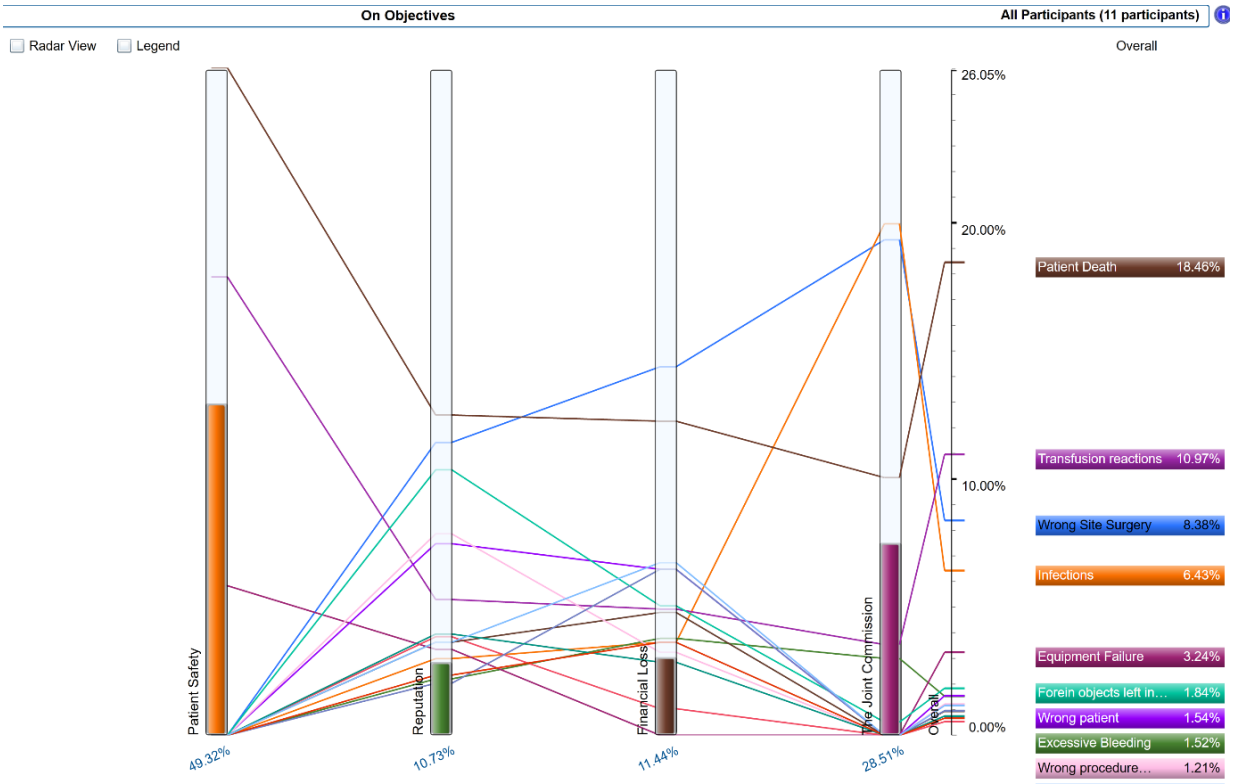
The bar graph below shows the calculated impact of the risk-events on the objectives.



The impact is calculated as the sum product of consequence of the risk-event on the objective (also referred to as the vulnerability of the objective) times the priority of the objective. This calculation, much like the one for likelihood in the previous subsection is also illustrated in the previous bow-tie diagram.

The impact of the risk-events on the objectives ranged from 0.53% for fire within the operating room to 18.46% for patient death. The range of impact is much more widespread than was the range or likelihood for the events. Therefore, we can see that although the events might not have a high likelihood, they do carry the potential for substantial impact upon the organization's objectives. As with the sources and events, a performance sensitivity the risk-events and their consequences on the objectives is shown to below.

6. Risk Evaluation



After the likelihood and the impact are assessed, the risk of each risk-event can be calculated. Riskion® ordinarily provides measures as percentages. However, assigning a monetary value allows the measurements to be displayed in monetary terms. The value assigned to the hospital as an enterprise was $88,538,881, calculated by setting the value for preventing infections at $10,000,000.

6.1 Overall Risks without Controls

The figures below show the overall likelihoods, impacts and risks for each risk-events without any controls. The first one is given in percentages and the second one in monetary terms.

Overall Likelihoods, Impacts, and Risks for RM2019_JES_JW_Surgical Risks

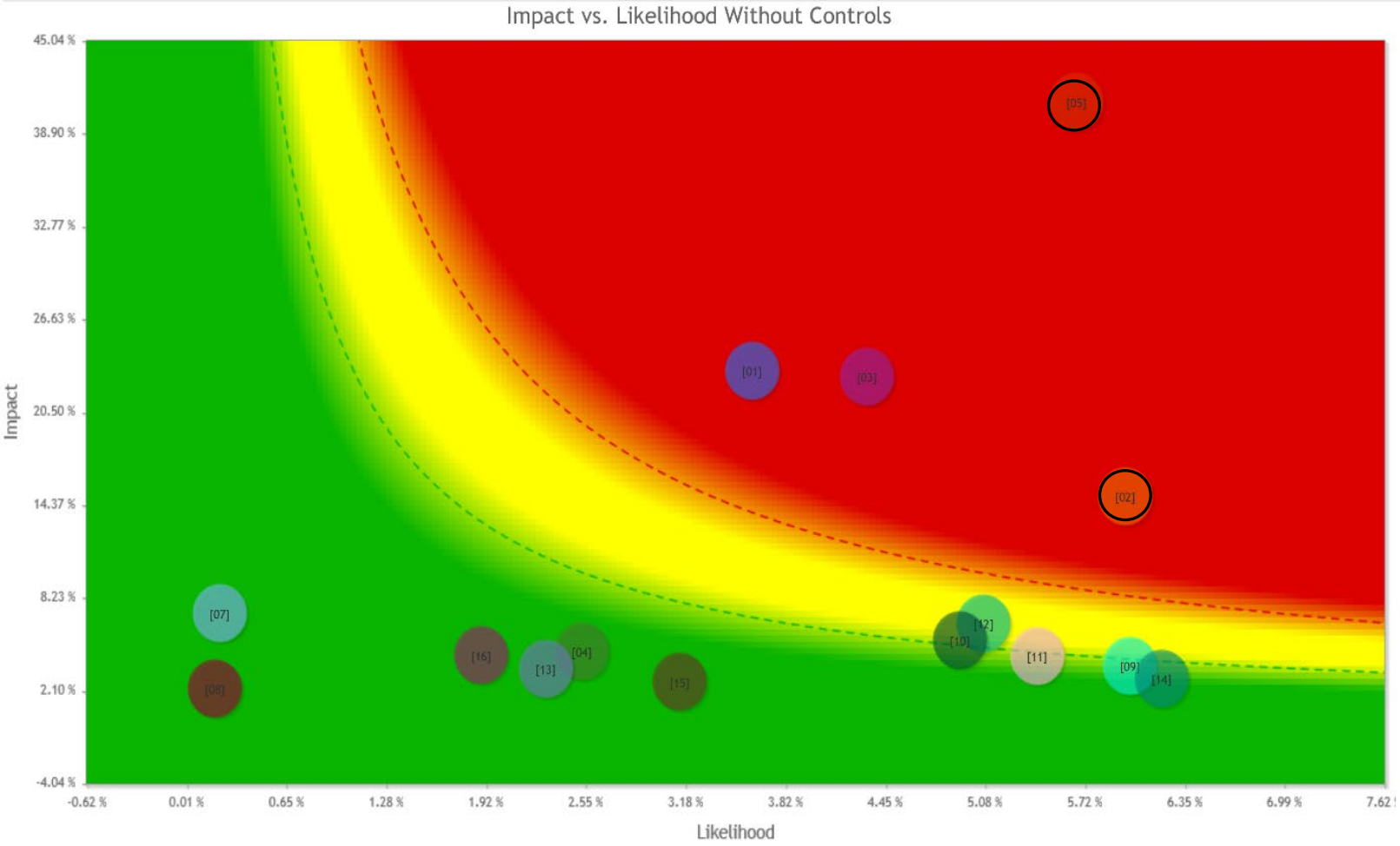
No.	Event	All Participants Likelihood Simulated	Impact, $ Simulated	Risk, $ Simulated ▼
[05]	Patient Death	5.67%	36,256,248	2,055,729
[03]	Transfusion reactions	4.34%	20,195,196	876,471
[02]	Infections	5.98%	13,190,768	788,807
[01]	Wrong Site Surgery	3.61%	20,528,852	741,091
[12]	Forein objects left in patient	5.08%	5,743,054	291,747
[10]	Wrong patient	4.93%	4,761,295	234,731
[11]	Wrong procedure performed	5.42%	3,842,988	208,289
[09]	Reaction to Anesthesia	6.01%	3,267,962	196,404
[14]	Unnecessary surgery	6.21%	2,522,176	156,627
[04]	Excessive Bleeding	2.53%	4,113,722	104,077
[15]	Medication-Medication Interaction or Contraindication (not including ansethetic medicaions or blood products)	3.15%	2,341,834	73,767
[16]	Permanent brain damage	1.89%	3,895,451	73,624
[13]	Nerve injury	2.30%	3,096,812	71,226
[07]	Equipment Failure	0.23%	6,344,189	14,591
[08]	Fire Within the Operating Room (OR)	0.20%	1,928,008	3,856
				Simulated
			Total Risk (Average Loss)	$5,891,044

Overall Likelihoods, Impacts, and Risks for RM2019_JES_JW_Surgical Risks

No.	Event	All Participants Likelihood Simulated	Impact Simulated	Risk Simulated ▼
[05]	Patient Death	5.67%	40.95%	2.32%
[03]	Transfusion reactions	4.34%	22.81%	0.99%
[02]	Infections	5.98%	14.90%	0.89%
[01]	Wrong Site Surgery	3.61%	23.19%	0.84%
[12]	Forein objects left in patient	5.08%	6.49%	0.33%
[10]	Wrong patient	4.93%	5.38%	0.27%
[11]	Wrong procedure performed	5.42%	4.34%	0.24%
[09]	Reaction to Anesthesia	6.01%	3.69%	0.22%
[14]	Unnecessary surgery	6.21%	2.85%	0.18%
[04]	Excessive Bleeding	2.53%	4.65%	0.12%
[15]	Medication-Medication Interaction or Contraindication (not including ansethetic medicaions or blood products)	3.15%	2.64%	0.08%
[16]	Permanent brain damage	1.89%	4.40%	0.08%
[13]	Nerve injury	2.30%	3.50%	0.08%
[07]	Equipment Failure	0.23%	7.17%	0.02%
[08]	Fire Within the Operating Room (OR)	0.20%	2.18%	0.004%
				Simulated
			Total Risk (Average Loss)	6.65%

6.2 Risk Heat Map without Controls

Another major diagram is called a heat map. The heat map for this risk assessment without controls applied is shown below. Due to the way that the measurements are done and the judgments are entered, the program can produce ration scale measures, which allows this heat map to be unique to others you might have seen before. The usual heat map is a grid with boxes, and each box has an assigned number. The beauty of this heat map is that due to the ratio scales, this is not broken up into boxes, but rather it is fluid, and the risk-events can be plotted at any point and be meaningful in relation to where they are and to each other.

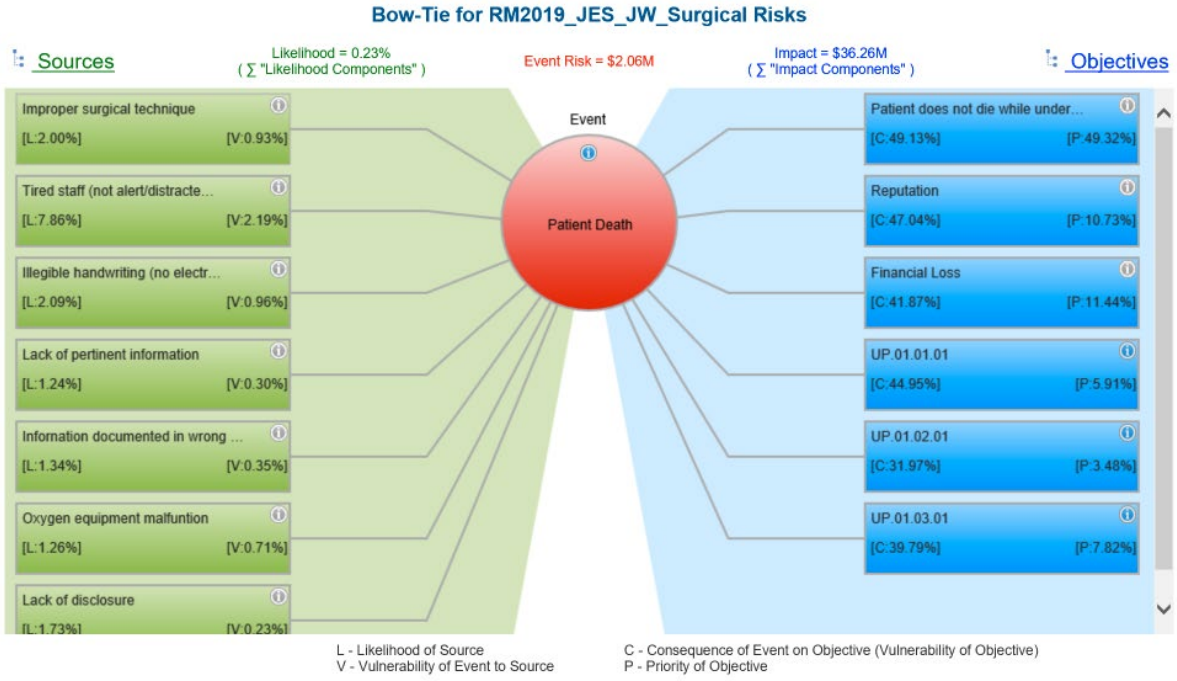


No.	Event
[05]	Patient Death
[03]	Transfusion reactions
[02]	Infections
[01]	Wrong Site Surgery
[12]	Forein objects left in patient
[10]	Wrong patient
[11]	Wrong procedure performed
[09]	Reaction to Anesthesia
[14]	Unnecessary surgery
[04]	Excessive Bleeding
[15]	Medication-Medication Interaction or Contraindication (not including ansethetic medicaions or blood products)
[16]	Permanent brain damage
[13]	Nerve injury
[07]	Equipment Failure
[08]	Fire Within the Operating Room (OR)

Risk Regions	
	Over 0.5 %
	0.25 % - 0.5 %
	Under 0.25 %

The three different color zones depicted on the heat map represent the risk regions, and they represent levels or categories of risk as the organization defines them. As shown previously in the heat map, there is one risk-event--patient death, which is clearly in the red section. Three others are on the boundary between the yellow and red regions. Still, nine risk-events are on the verge between the green and yellow sectors. Also, note that the x-axis represents the likelihood, and the y-axis represents the impact.

The next bow-tie diagrams is that of risk-event five, patient death, the one that carries the highest overall risk. The circle in the middle of the diagram is red, which represents its risk region of the heat map.



6.3 Identifying and Selecting Controls

The next step is to identify the controls that can be put in place to mitigate the overall risk measures. The controls can be applied in three locations on the model. Controls can be used to decrease the likelihood of the threats, they can be used to reduce the likelihood of the risk-events given the source, and they can also be used to minimize the impact of the risk-event upon the objectives.

The controls that we identified are listed below. Some controls, such as annual training and WRS Health, are listed more than once. These controls are not duplicative, but instead, demonstrate that they can be applied at different portions of the risk assessment model. WRS Health is an electronic health record and practice management system.

Controls for "RM2019_JES_JW_Surgical Risks"

Search:

Index		Control Name	Control for	Selected	Cost	Applications	Categories	Must	Must Not
01	☐	Annual Training	Vulnerability	Yes	0	27		☐	☐
02	☐	Annual Training	Source	Yes	22000	11		☐	☐
03	☐	ChloraPrep	Source		568000	1		☐	☐
04	☐	WRS Health	Source	Yes	3588	14		☐	☐
05	☐	WRS Health	Vulnerability	Yes	3588	4		☐	☐
06	☐	Adequate back-up personnel	Vulnerability	Yes	0	6		☐	☐
07	☐	WRS Health	Consequence	Yes	0	38		☐	☐
08	☐	Annual Training	Consequence	Yes	0	48		☐	☐
09	☐	Inclimate Weather Preperation Training	Source	Yes	2000	3		☐	☐
10	☐	Daily, Weekly, and Monthly Maintenance	Vulnerability	Yes	2000	5		☐	☐

The chart also indicates the number of applications for each control and the respective cost. The application number refers to how many times a specific control is able to decrease a likelihood, impact or risk whether that be on a source, event or objective.

The next chart shows the controls that were manually selected for the simulation. The ChloraPrep was the only one not chosen as it was the most expensive and only had one

Select Controls

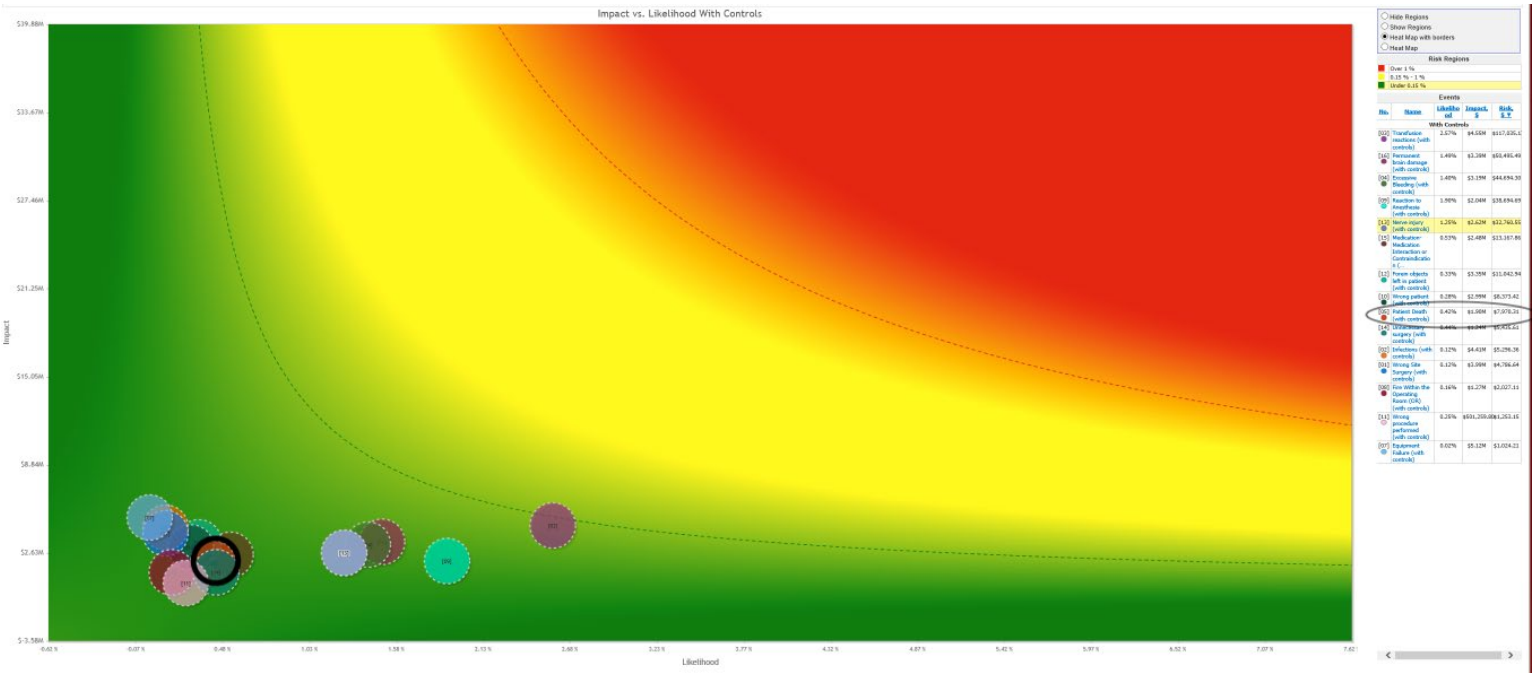
Search:

Index	Selected	Control Name	Control for	Selected	Cost	Applications	Categories	Must	Must Not
01	☑	Annual Training	Vulnerability	Yes	0	27		☐	☐
02	☑	Annual Training	Source	Yes	22000	11		☐	☐
03	☐	ChloraPrep	Source		568000	1		☐	☐
04	☑	WRS Health	Source	Yes	3588	14		☐	☐
05	☑	WRS Health	Vulnerability	Yes	3588	4		☐	☐
06	☑	Adequate back-up personnel	Vulnerability	Yes	0	6		☐	☐
07	☑	WRS Health	Consequence	Yes	0	38		☐	☐
08	☑	Annual Training	Consequence	Yes	0	48		☐	☐
09	☑	Inclimate Weather Preperation Training	Source	Yes	2000	3		☐	☐
10	☑	Daily, Weekly, and Monthly Maintenance	Vulnerability	Yes	2000	5		☐	☐

application.

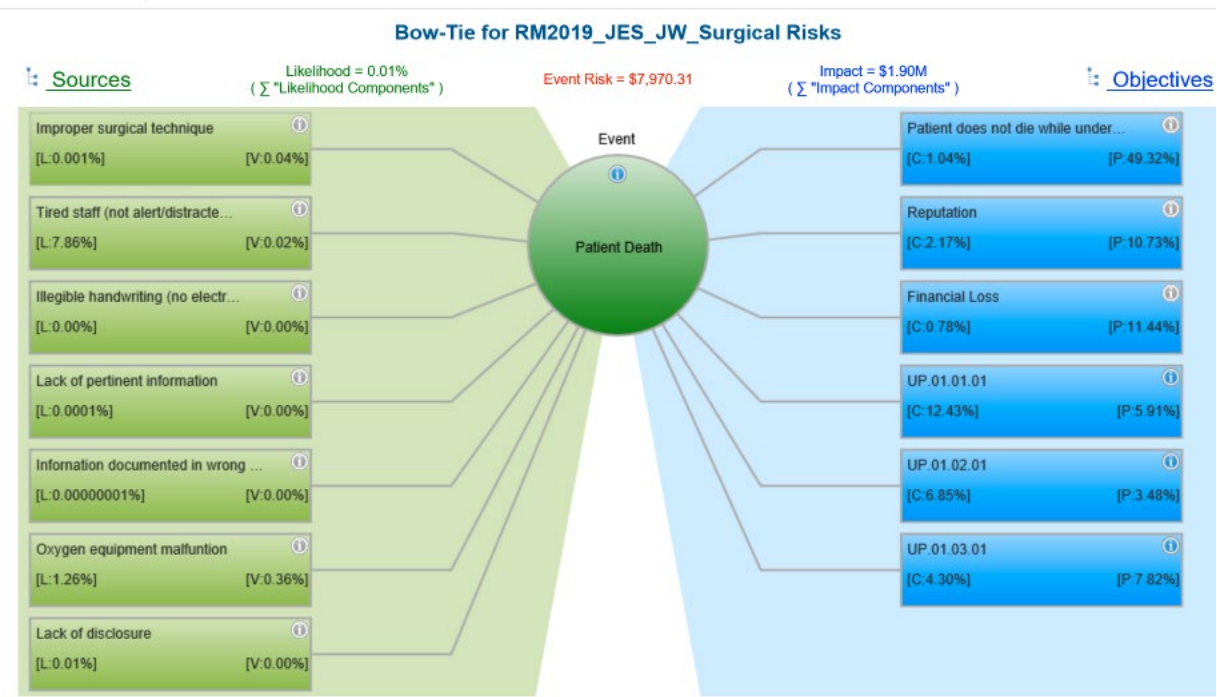
6.4 Overall Risks with Controls

The heat map shown on the previous page shows the results of the simulation with controls applied. There are no longer any risk-events in the red risk or in the yellow risk regions.



Most of the events are aggregated in the lower leftmost corner which indicates low likelihood and low impact.

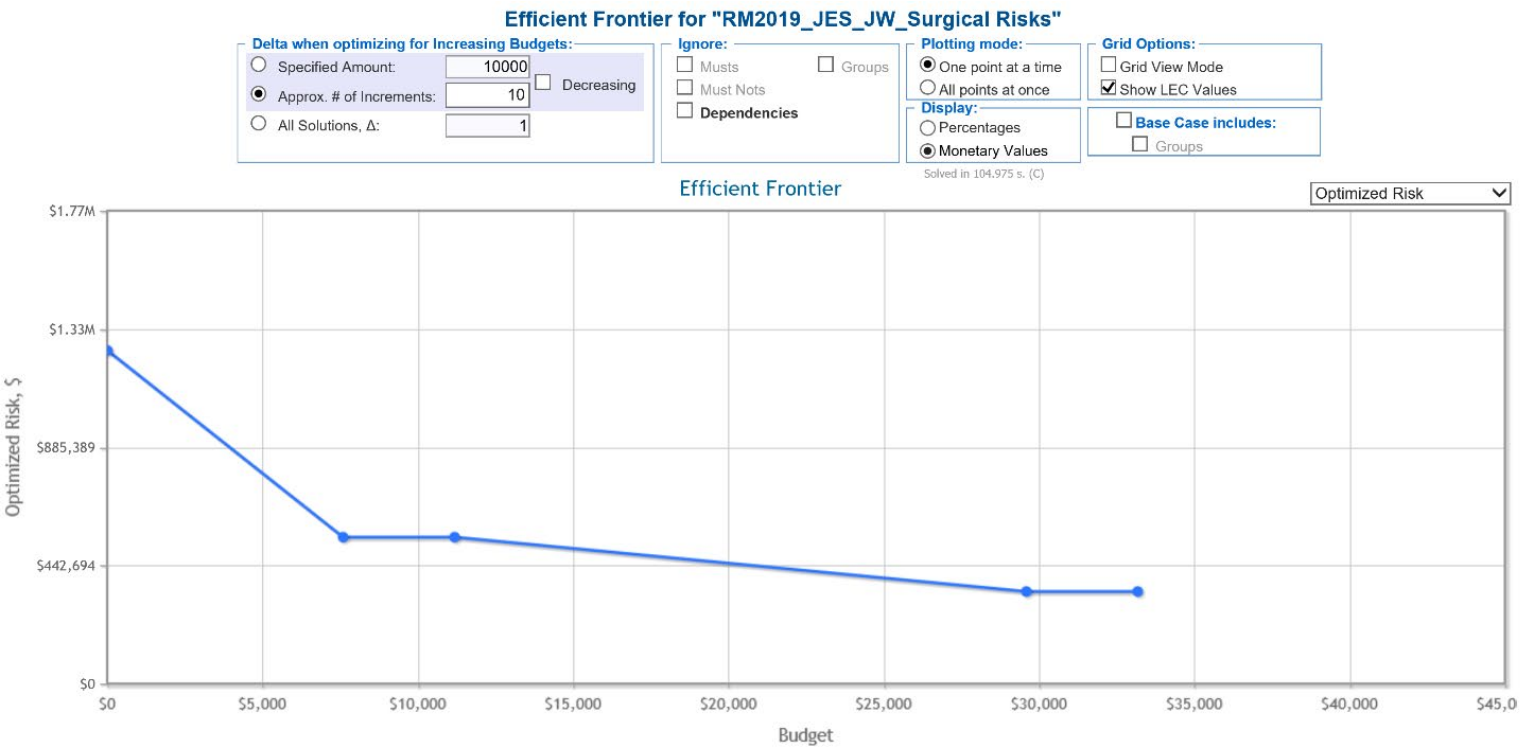
Below is a bow-tie diagram for the risk-event patient death, with the control applied. The center circle is no longer red, but green as this objective has moved from the red risk region to



the green risk region. Also, if you compare this bow-tie diagram to the one presented in page 22, you can see how the likelihood of the events, indicate by the letter L in the left side green rectangles has decreased. The vulnerability of the event given the source, indicated by the letter V in the left side green rectangles has also decreased. A bit counterintuitively, the consequence of the risk-events upon the impacts, indicated by the letter C on the right blue rectangles, has increased. These numbers increase as the number of risk-events that can affect the objectives decreases. The priority of the objective has remained unchanged as mentioned previously that is set by the strategic/management team.

7. Efficient Frontier

The next step in the process is the efficient frontier. The definition of efficient frontier as provided by Investopedia , “The efficient frontier is the set of optimal portfolios that offer the highest expected return for a defined level of risk or the lowest risk for a given level of expected return” (Ganti, 2019). The definition in this site is referring to investment portfolios, but it can apply in a similar sense in this risk assessment scenario. Each point in the efficient frontier can be seen as an investment by the



organization in order to attempt to mitigate risk down to different levels. In this way, each point of investment can also be assessed for potential return on investment. This information is presented in both the form of a graph and a table. It serves to focus and compare the benefits and costs of different options regarding the risk assessment and control implementation for risk management.

Efficient Frontier for "RM2019_JES_JW_Surgical Risks"

Delta when optimizing for Increasing Budgets: Specified Amount: 10000 / Approx. # of Increments: 10 Decreasing / All Solutions, Δ: 1

Ignore: Musts, Groups, Must Nots, Dependencies

Plotting mode: One point at a time / All points at once

Display: Percentages / Monetary Values

Grid Options: Grid View Mode, Show LEC Values

Base Case includes: Groups

Solved in 104.975 s. (C)

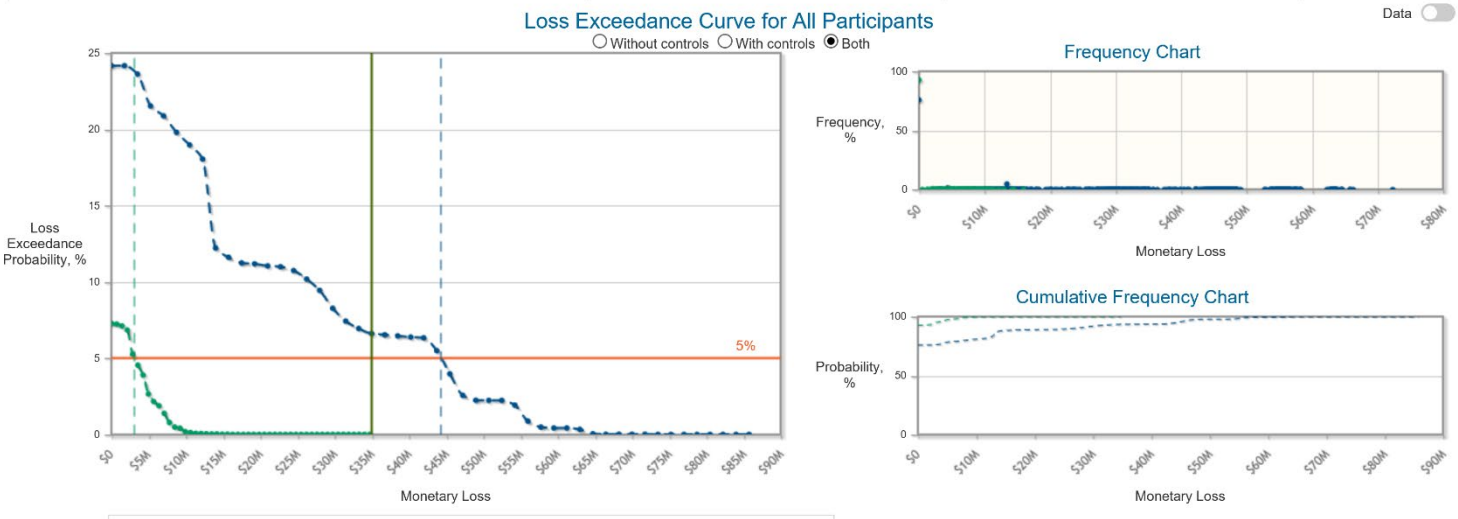
Index	Controls/Budget	$0	$10,000	$20,000	$30,000	$40,000
	Risk Reduction, $	$4.65M	$5.34M	$5.34M	$5.55M	$5.55M
	Funded Cost	$0	$7,588	$11,176	$29,588	$33,176
	Expected Savings, $	$4.65M	$5.34M	$5.33M	$5.52M	$5.51M
	Investment Leverage	0	704.27	478.25	187.45	167.2
	Risk with Selected Controls, $	$1.25M	$547,028	$546,174	$344,763	$344,058
	5% loss exceedance	$10.13M	$4.71M	$4.70M	$3.11M	$3.09M
	Likelihood of losing more than $35M	~0%	~0%	~0%	~0%	~0%
1.	Annual Training				FUNDED	FUNDED
2.	ChloraPrep					
3.	WRS Health		FUNDED	FUNDED	FUNDED	FUNDED
4.	Inclimate Weather Preperation Training		FUNDED	FUNDED	FUNDED	FUNDED
5.	Annual Training	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED
6.	WRS Health			FUNDED		FUNDED
7.	Adequate back-up personnel	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED
8.	Daily, Weekly, and Monthly Maintenance		FUNDED	FUNDED	FUNDED	FUNDED
9.	WRS Health		FUNDED	FUNDED	FUNDED	FUNDED
10.	Annual Training	FUNDED	FUNDED	FUNDED	FUNDED	FUNDED

The graph and table above, of the efficient frontier for this scenario present five possible scenarios, each one in increments of $10,000 for investment. It shows the optimized control selection at each budget level. The first point is one in which no investment is made and yet some risk reduction is still achieved due to the controls that were suggested. The second point or scenario, in which a budget of $10,000 is given, only $7,588 are invested into implementing controls. In this scenario, there is a risk reduction of $5.34 million down to a risk of $547,028 with the selected controls. The selected controls are marked as 'Funded' in the table. The investment leverage which is the amount of risk reduction per dollars spent, similar to return on

investment, is $704.27 in risk reduction per dollar spent. The table also shows the 5% loss exceedance. This measure indicates that on average, five percent of the time the organization could lose this amount of money. For scenario two this value is $4.71 million down from $10.13 million for scenario one when no investment is made.

The efficient frontier graph shows the risk in financial terms on the y-axis and the budget on the x-axis. You can see a decline in the risk as the budget increases, as is expected. There is a point near the $30,000 budget mark where it seems that the efficient frontier plateaus off. This can be seen in more detail in the table, under scenario 4, corresponding to $30,000, and scenario 5 which corresponds to $40,000 budget.

Loss Exceedance	Without controls	With controls	Δ
Average loss	$5.89M	$344,058	$5.55M
VAR, probability: 5% probability that loss will exceed	$44.31M	$3.09M	$41.23M
VAR, loss: % chance of losing more than $35M	7%	~0%	7%
Cost of Controls	$0.00	$33,176.00	$-33,176.00



The above figure shows the loss exceedance curve with and without control. The average loss without controls is $5.89 million, but this decreases to $344,058 with the implementation of controls for a change of $5.5 million. The loss exceedance without controls is portrayed in the graph as the blue dotted line. The green dotted line shows the loss exceedance with controls applied. A distinct and significant decrease can be seen between the two. Two other measures given are the 5% value-at-risk (VAR) and the VAR for the percentage chance of losing more than

$35 million. Both of these terms can be used to assess the short-term or catastrophic loss. The levels that are considered appropriate for the 5% loss, and the value that is set for the percentage VAR of a exceeding a specific financial loss are the best set and judged by the organization. In this assessment, we see that without the use of controls, the 5% VAR is $44.31 million, and with the controls this decreases to $3.09 million. This represents a decrease of more than $40 million for an investment of less than $40,000.00--more than a 1000:1 ratio. The percentage chance of losing more than $35 million also decreases from 7% to zero.

8. Recommendations

Our recommendation given the data made available by the Riskion® software for this general surgery risk assessment is to invest in implementing controls to mitigate the risks faced by the hospital due to general surgery. At the minimum, an investment of $7,588 should be made. Details of the uses of these controls are discussed in the previous section seven. Given that the budget for reducing general surgery risk is set to $50,000, the best option would be to invest $33,176. This investment allows for the most amount of controls to be implemented under the given budget. Even though the risk reduction between $29,588 and $33,176 investments is the same at $5.55 million and the investment leverage decreases from $187.45 to $167.20, the 5% VAR decreases from $3.11million to $3.09 million which we believe is worth the extra $3,588 in investment.

Other recommendations are to continue performing risk assessments for general surgery, at the very least biennially or preferentially annually. Since risk is subjective, a change in circumstances or scenarios might lead to a different recommendation, decision, or a different set of controls to be invested in and implemented. Also, we recommend that the organization, this hospital, begin risk assessment implementation throughout the entire organization. Continuing to use the Riskion® software is recommended because it has proven useful to the organization. Now that the organization has some experience with it. More importantly, Riskion® provides ratio scale measures, making the process of requesting the involvement and expertise of others a less daunting task. Risk analysis and risk management are best performed as a comprehensive analysis of the entire enterprise or organization. Risk analysis can also lead to potential cost

savings, for as the organization continues to implement controls, there may be duplicates. The reduction achieved by the addition of a control for one risk could also act as a control in another risk(s). As Peter L. Bernstein said, “The essence of risk management lies in maximizing the areas where we have some control over the outcome while minimizing the areas where we have absolutely no control over the outcome” (Top 8 Quotes by Peter L. Bernstein, n.d.).

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