A Novel Health Insurance Scheme for Cancer Care in Bangladesh

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ABSTRACT

Health insurance is still a relatively new concept in Bangladesh. There is no universal health insurance coverage. Only a few insurance companies offer general health insurance policies. However, the Bangladesh government has a constitutional mandate to provide healthcare to every citizen. The public hospitals offer "free" medical care, but out-of-pocket expenses are still incurred and the quality of care is often poor. In the absence of health insurance, treatment of critical illnesses like cancer poses a formidable financial challenge to affected individuals, their immediate and extended family, and the society at large. Patients often fail to complete the course of treatment due to unaffordable costs and yet face the prospect of bankruptcy. Moreover, unfortunately, in the last few years, there has been a sharp increase in cancer incidence in Bangladesh. Cancer is now the leading cause of death in the country. Against this backdrop, in this paper we propose a two-tiered novel insurance scheme for cancer care, involving all the major stakeholders: affected individuals and their families, healthcare providers, insurance companies, pharmaceutical industry, and the government. It represents a paradigm shift in cancer care in Bangladesh and has the potential to decrease cancer incidence, save lives, and reduce healthcare expenditure.

Keywords: health insurance, cancer, pharmaceutical industry, Bangladesh.

1. **INTRODUCTION**

As living standards rise, chronic diseases tend to replace infectious diseases as the primary causes of morbidity and mortality in a population (Frieden, 2010). Bangladesh has experienced the same trend in chronic diseases like arthritis, cancer, diabetes, heart diseases and hypertension (BBS, 2012). In Bangladesh, for example, proportional cancer morbidity increased from 0.2% in 2000 to 0.4% in 2012 (BBS, 2012). The U.S. Centers for Disease Control and Prevention (CDC) estimates that cancer is now the number one cause of death in Bangladesh (CDC, 2010). Chronic diseases do not have any easy remedy. They can only be managed, not cured entirely. Long-term

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management of chronic diseases is expensive. This is especially true of cancer. On average newly approved cancer drugs cost $10,000 per month (U.S. News and World Report, 2015). Typical cancer treatment requires surgery, chemotherapy, and radiation therapy individually or in combination. In a country with a GDP per capita of less than 1100 dollars (World Bank, 2016), most people simply cannot afford cancer treatment. Cancer-related expenses impose a formidable financial burden on patients, their immediate and extended family, and the society at large. Patients often cannot complete the course of treatment because of exorbitant costs and yet end up having to file for bankruptcy.

Health insurance could help defray the costs of cancer care and save lives, but the health insurance industry is still in its infancy in Bangladesh. There is no universal health insurance coverage. Employers are not obligated to provide health insurance to their employees. Only a few insurance companies sell health insurance policies. Examples include MetLife, Delta Life, Progressive Life, Green Delta, Agrani, Eastern, Pragati, Prime, Reliance, Takaful Islami, United, Dhaka, and Bangladesh General Insurance Company. Some of them are life insurance companies, so they require their customers to bundle health insurance with life insurance. Since the customer base is small, in spite of limited coverage, the premiums are often high. This creates a vicious cycle for the industry. Due to high premium, poor coverage, and relatively few choices, health insurance products are not popular with customers. This, in turn, prevents the industry from lowering premiums. However, the government could step in to break this vicious cycle.

The Constitution of Bangladesh requires the government to provide healthcare to every citizen. The public hospitals are mandated to provide “free” medical care, but patients visiting them often receive poor quality care and still have to bear out-of-pocket expenses. In this context of unaffordable care, financial hardship, and constitutional commitment, a novel insurance scheme has been proposed for cancer care in Bangladesh that will benefit all the major stakeholders involved: patients and their families, healthcare providers, insurance companies, pharmaceutical industry, and the government.

2. OUTLINE OF THE HEALTH INSURANCE SCHEME

Currently available health insurance policies exclude people with pre-existing conditions. Our scheme will not exclude anyone, but will require a cancer risk screening test for enrollment. We do not believe that this will be a problem because perfectly healthy, young individuals are unlikely to be interested in a health insurance policy specifically designed for cancer care. The typical customer is likely to have health problems, but not necessarily cancer. The proposed scheme will have a two-tiered system in which genetically or otherwise pre-disposed (testing positive in screening) individuals will be charged a higher premium rate than the rest, but preventative care and regular screening will be covered. For example, if someone is at risk for developing colorectal cancer, they will have colonoscopy and endoscopy at regular intervals, and their pre-malignant polyps will be removed. This scheme will require the government to provide need-based subsidies for enrollment. However, it will still be beneficial to the government. It will help the government meet its

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constitutional obligation to provide healthcare at a lower cost because the government will no longer have to provide “free” medical care to enrollees in public hospitals or provide individual medical care grants for treatment overseas. Under the scheme, health insurance companies will subsidize pre-enrollment screening costs because they will be able to charge a higher premium to those testing positive. The participating pharmaceutical companies will provide drugs to enrollees at a discount once they are diagnosed with cancer. However, the pharmaceutical companies will still benefit from the program because it will enable more people to seek and complete the course of treatment, expanding their customer base. Finally, the scheme will help healthcare providers by ensuring timely payment and expanding their patient pool.

3. SIMULATIONS

To test the feasibility of our proposal, we performed Monte Carlo simulation on Crystal Ball. We did simulation runs with 1000 trials for each of several scenarios. In each scenario, we made the following assumptions on the basis of consultation with oncologists and health insurance experts.

1. The base case insuree was female and started the insurance policy when she was 40 years old. Her annual premium was 47940 takas (based on currently available health insurance policies).
2. The insuree would be on the program for 10 years.
3. The insuree would screen either positive or negative for breast cancer risk.
4. The insuree would either have breast cancer or be cancer-free.
5. 70% of all those who were screened would test negative for high risk and 5% of this "low risk" population would get cancer. However, only 30% of “low risk” population would retain insurance.
6. 30% of all those who were screened would test positive for high risk. 70% of this "high risk" population would eventually get cancer. 80% of those who screened positive (“high risk” population) would retain insurance.
7. To test the model under more stringent conditions than our actual proposal, we assumed that both “high risk” and “low risk” groups were charged the same premium. We also did not factor in the discounts from the pharmaceutical companies.
8. We did not incorporate government subsidies into the analysis because those subsidies are meant to be provided directly to consumers for enrollment and would not affect per capita operating profit of the venture.

Table 1 summarizes the base case for each of the scenarios that were examined.

Screening result	Cancer incidence	Premium per insuree (BDT)	Payout per insuree (BDT)	Operating profit per insuree (BDT)
-	-	143,820	13,965	129,855
-	+	143,820	139,363	4,457
+	-	383,520	80,496	303,024

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+	+	383,520	265,818	117,702

Table 2 reports the results of the simulations.

Screening result	Cancer incidence	Premium per insuree (BDT)	Payout per insuree (BDT)	Operating profit per insuree (BDT)
-	-	143,820	36,421.05±301.41	107,398.95±301.41
-	+	143,820	83,140.74±612.48	60,679.26±612.48
+	-	383,520	88,654.73±657.73	294,865.27±657.73
+	+	383,520	302,707.69±1610.36	80,812.31±1610.36

As the preceding table (Table 2) makes it clear, even under the more stringent conditions of no premium differentiation and no discounts from pharmaceutical companies, the policy churns out an operating profit per insuree. This shows that our proposal is likely to be economically viable. However, pilot empirical studies are warranted to confirm feasibility.

4. CONCLUSION

Cancer is currently one of the world's most pressing health challenges. The U.S. National Cancer Institute projects that 1 in 2 men and 1 in 3 women will develop cancer in their lifetime (American Cancer Society, 2016). By the year 2030, cancer deaths could increase globally by as much as 80% according to WHO estimates (Thomas et al., 2015). There were approximately 13.3 million new cases of cancer worldwide in 2010, with the number projected to rise to 21.5 million in 2030, according to an analysis by the Harvard School of Public Health and the World Economic Forum (Bloom et al., 2011). This challenge is not just one facing high-income countries; if not addressed it will be expected to hit the low-income countries as well. As the number of cases rise, so does the pressure on finances which will be compounded because, for a variety of reasons, cancer is becoming more expensive to treat with each passing year (Thomas, Callahan, Bartlett & Geissler, 2015). Taking these trends into account, if we do not act now, we might find ourselves blindsided by a cancer endemic in Bangladesh.

The proposed healthcare scheme is tailored to people who are already somewhat sick or have health concerns. They are most likely to see the benefits of this scheme and be interested. They would possibly like to take the subsidized cancer screening test anyway, so having it as a requirement for enrollment is unlikely to be an impediment. The fact of the matter is that even in countries with long-established culture of health insurance, enrolling healthy, young people into a health insurance scheme is always a

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very big challenge. That is why the U.S. Affordable Care Act imposes a fine on individuals who do not enroll in any health insurance plan. It will be a much harder sale in Bangladesh if we were to target young, healthy individuals. However, as a culture of health insurance begins to take root in the country, we might be able to design attractive health insurance policies for young, healthy individuals and gradually move towards universal health insurance coverage.

Although considerable progress has been made in the screening, diagnosis, treatment as well as follow-up care for cancer patients, improving quality of life for patients throughout the cancer continuum is yet another critical component of overall cancer care that deserves our attention. Progress has been substantially hampered because of the high costs involved in this area. Most people simply cannot afford access to the fruits of the latest breakthroughs in biomedical research. Globally cancer care costs have risen dramatically, particularly during the period of initial treatment immediately after diagnosis and during the last few months before death.

By emphasizing screening, monitoring, preventative procedures, and early detection, the proposed health insurance scheme attempts to implement a least costly approach with the greatest effectiveness. It represents a paradigm shift in cancer care in Bangladesh and has the potential to reduce cancer incidence, save lives, and decrease healthcare costs. Since this scheme will help patients and their families, healthcare providers, insurance companies, pharmaceutical industry, and the government alike, they could all be encouraged to collaborate in figuring out the details of this program.

APPENDIX

Monte Carlo Simulation Reports.

Appendix 1. Monte Carlo Simulation on Cancer Expenses: Negative Screening with No Cancer Case

Crystal Ball Report - Full

Simulation started on 5/9/2016 at 9:58 AM

Simulation stopped on 5/9/2016 at 9:58 AM

Run preferences:	
Number of trials run	1,000
Monte Carlo	
Random seed	
Precision control on	
Confidence level	95.00%
Run statistics:	

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Total running time (sec)	0.59
Trials/second (average)	1,682
Random numbers per sec	26,911
Crystal Ball data:	
Assumptions	16
Correlations	0
Correlation matrices	0
Decision variables	0
Forecasts	3

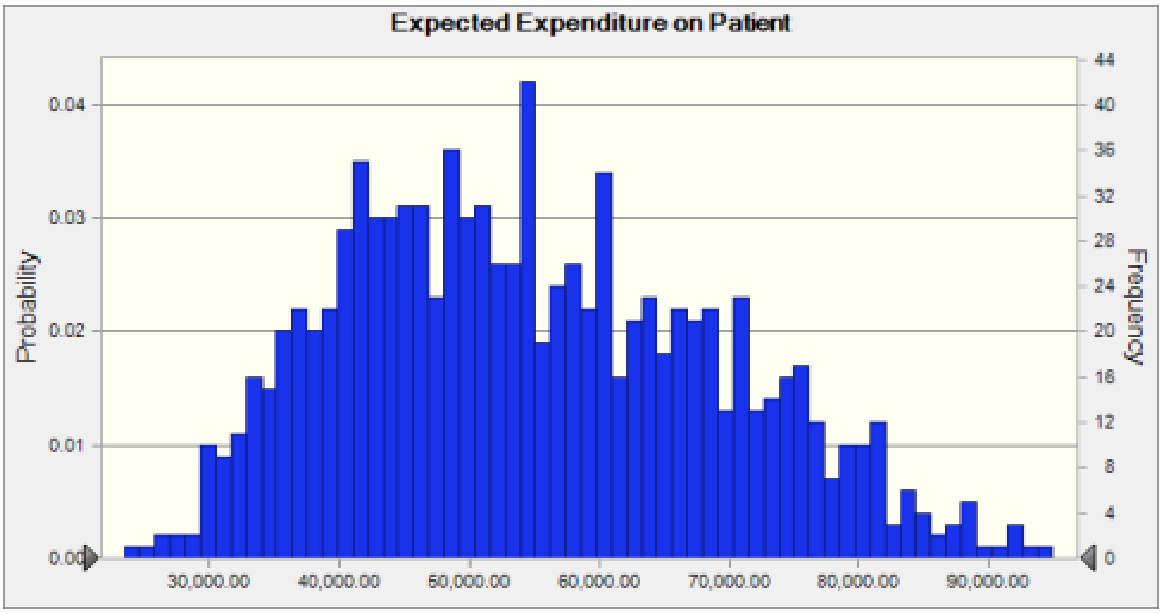
Forecast: Expected Expenditure on Patient Cell: D23

Summary:

Entire range is from 23,451.45 to 98,223.08

Base case is 21,000.00

After 1,000 trials, the std. error of the mean is 453.25



Statistics:	Forecast values
Trials	1,000
Base Case	21,000.00
Mean	54,768.49
Median	53,428.71

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Mode	---
Standard Deviation	14,332.88
Variance	205,431,469.85
Skewness	0.3654
Kurtosis	2.47
Coeff. of Variation	0.2617
Minimum	23,451.45
Maximum	98,223.08
Range Width	74,771.64
Mean Std. Error	453.25

Percentiles:	Forecast values
0%	23,451.45
10%	36,764.72
20%	41,664.57
30%	45,260.10
40%	49,261.99
50%	53,382.84
60%	57,671.06
70%	62,330.49
80%	67,984.20
90%	74,904.07
100%	98,223.08

Forecast: Expected Payout per Insuree at 66.5% Occurrence Rate Cell: B28

Summary:

Entire range is from 15,595.21 to 65,318.35

Base case is 13,965.00

After 1,000 trials, the std. error of the mean is 301.41

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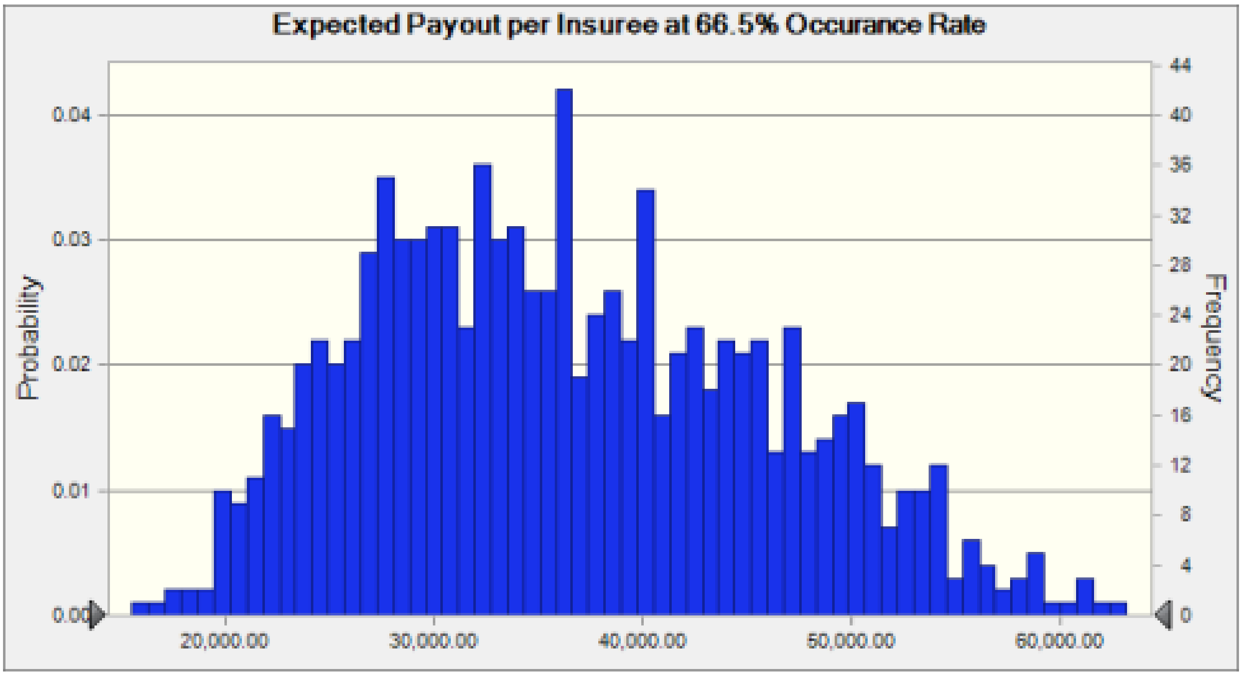

Statistics:	Forecast values
Trials	1,000
Base Case	13,965.00
Mean	36,421.05
Median	35,530.09
Mode	---
Standard Deviation	9,531.37
Variance	90,846,931.76
Skewness	0.3654
Kurtosis	2.47
Coeff. of Variation	0.2617
Minimum	15,595.21
Maximum	65,318.35
Range Width	49,723.14
Mean Std. Error	301.41

Percentiles:	Forecast values
0%	15,595.21
10%	24,448.54

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20%	27,706.94
30%	30,097.97
40%	32,759.22
50%	35,499.59
60%	38,351.25
70%	41,449.78
80%	45,209.50
90%	49,811.21
100%	65,318.35

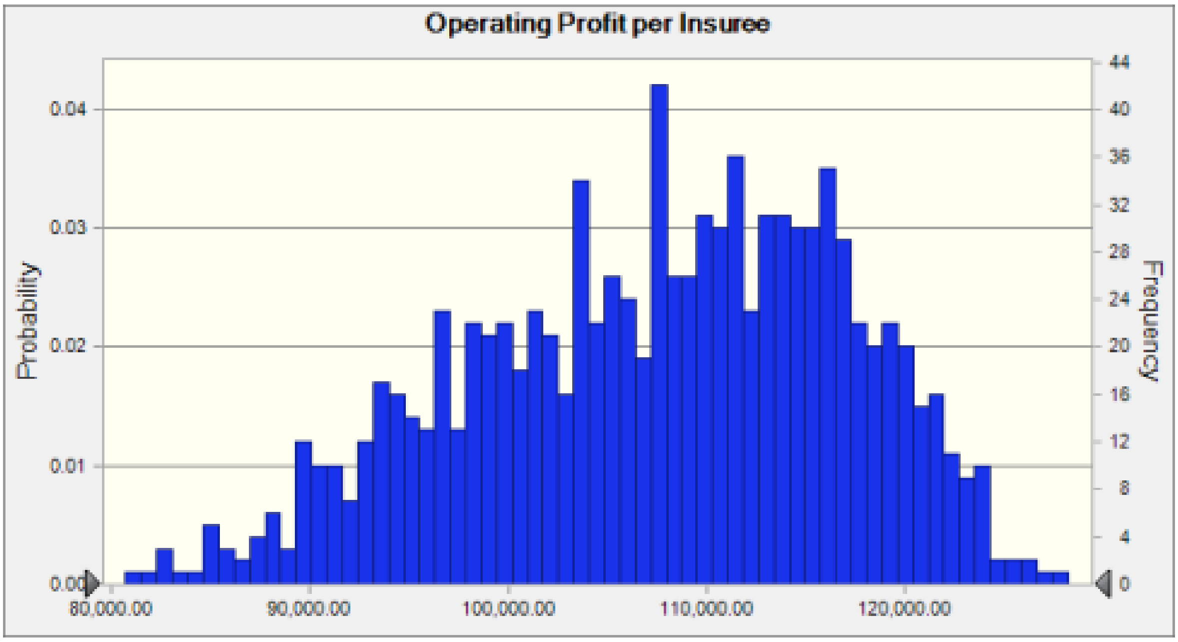
Forecast: Operating Profit per Insuree Cell: B30

Summary:

Entire range is from 78,501.65 to 128,224.79

Base case is 129,855.00

After 1,000 trials, the std. error of the mean is 301.41



Statistics:	Forecast values
Trials	1,000
Base Case	129,855.00
Mean	107,398.95
Median	108,289.91
Mode	---

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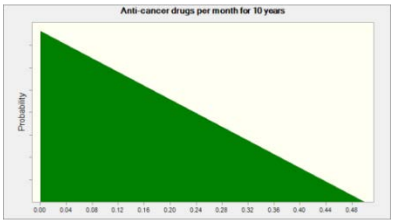
Standard Deviation	9,531.37
Variance	90,846,931.76
Skewness	-0.3654
Kurtosis	2.47
Coeff. of Variation	0.0887
Minimum	78,501.65
Maximum	128,224.79
Range Width	49,723.14
Mean Std. Error	301.41

Percentiles:	Forecast values
0%	78,501.65
10%	93,937.88
20%	98,578.69
30%	102,338.04
40%	105,459.08
50%	108,259.40
60%	111,051.00
70%	113,721.88
80%	116,095.11
90%	119,363.64
100%	128,224.79

Assumption: Anti-cancer drugs per month for 10 years Cell: B17

Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00
Maximum	0.50



Assumption: Bi-monthly follows-up Cell: B18

Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00

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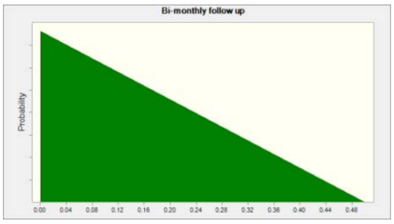
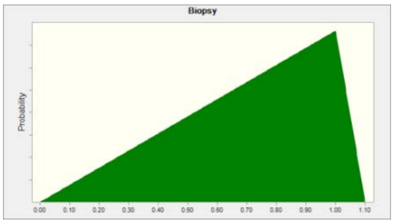
Maximum 0.50



Assumption: Biopsy Cell: B6

Triangular distribution with parameters:

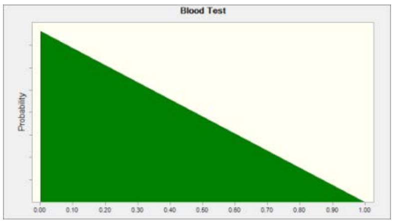
Minimum	0.00
Likeliest	1.00
Maximum	1.10



Assumption: Blood Test Cell: B13

Triangular distribution with parameters:

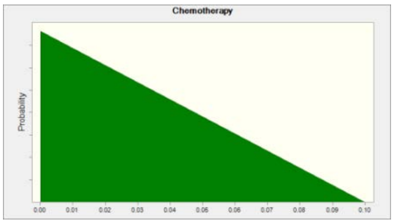
Minimum	0.00
Likeliest	0.00
Maximum	1.00



Assumption: Chemotherapy Cell: B9

Triangular distribution with parameters:

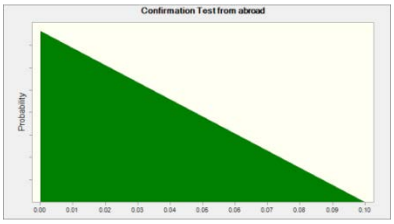
Minimum	0.00
Likeliest	0.00
Maximum	0.10



Assumption: Confirmation Test from abroad Cell: B14

Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00
Maximum	0.10



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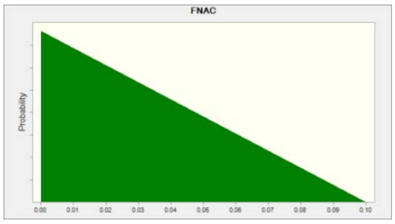
Assumption: FNAC Cell: B5

Triangular distribution with parameters:

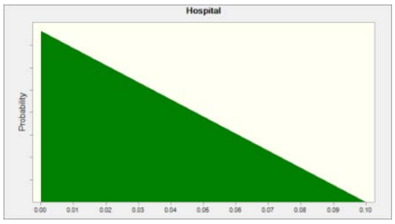
Minimum	0.00
Likeliest	0.00
Maximum	0.10



Assumption: Hospital Cell: B10

Triangular distribution with parameters:

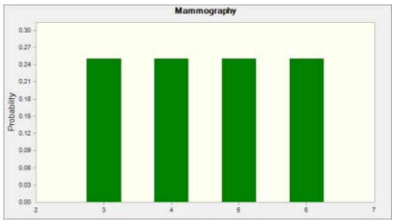
Minimum	0.00
Likeliest	0.00
Maximum	0.10



Assumption: Mammography Cell: B8

Discrete Uniform distribution with parameters:

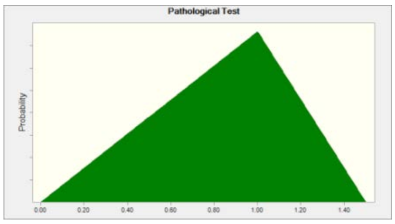
Minimum	3.00
Maximum	6.00



Assumption: Pathological Test Cell: B7

Triangular distribution with parameters:

Minimum	0.00
Likeliest	1.00
Maximum	1.50



Assumption: Post Surgery Pathological Tests Cell: B12

Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00
Maximum	0.50

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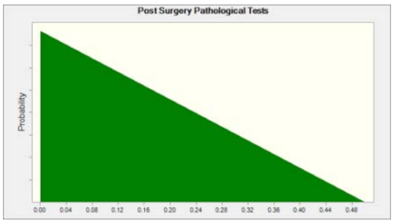
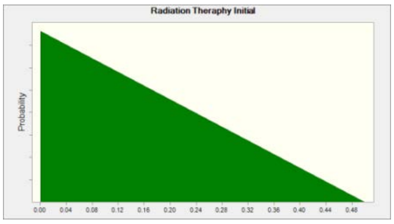


Assumption: Radiation Therapy Initial Cell: B16

Triangular distribution with parameters:

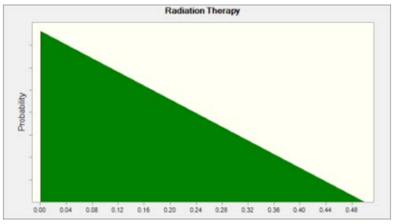
Minimum	0.00
Likeliest	0.00
Maximum	0.50



Assumption: Radiation Therapy Cell: B15

Triangular distribution with parameters:

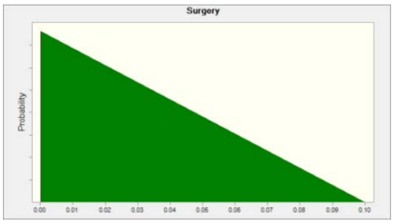
Minimum	0.00
Likeliest	0.00
Maximum	0.50



Assumption: Surgery Cell: B11

Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00
Maximum	0.10



Assumption: Treatment associated travel expenses abroad Cell: B19

Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00
Maximum	0.10

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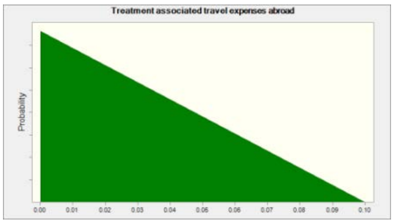
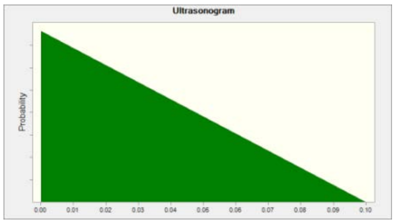


Assumption: Ultra sonogram Cell: B20

Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00
Maximum	0.10



End of Assumptions

Appendix 2. Monte Carlo Simulation on Cancer Expenses: Negative Screening but with Cancer Case

Crystal Ball Report - Full

Simulation started on 5/9/2016 at 10:01 AM

Simulation stopped on 5/9/2016 at 10:01 AM

Run preferences:	
Number of trials run	1,000
Monte Carlo	
Random seed	
Precision control on	
Confidence level	95.00%
Run statistics:	
Total running time (sec)	0.60
Trials/second (average)	1,669
Random numbers per sec	26,707
Crystal Ball data:	
Assumptions	16
Correlations	0
Correlation matrices	0

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Decision variables	0
Forecasts	3

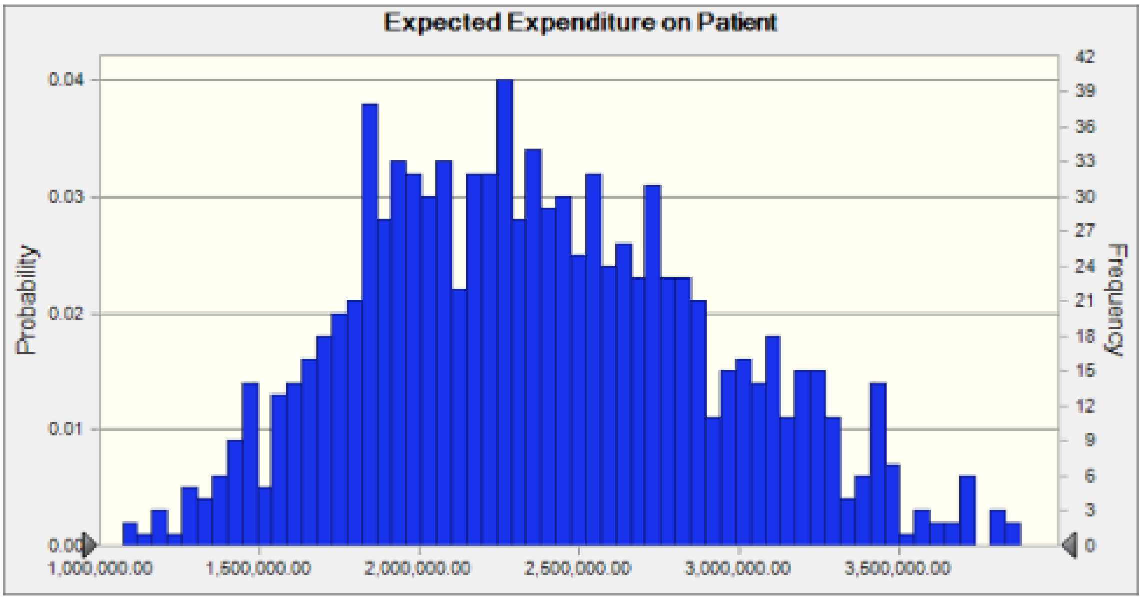
Forecast: Expected Expenditure on Patient Cell: D23

Summary:

Entire range is from 1,068,023.98 to 4,043,008.25

Base case is 3,981,800.00

After 1,000 trials, the std. error of the mean is 17,499.57



Statistics:	Forecast values
Trials	1,000
Base Case	3,981,800.00
Mean	2,375,449.84
Median	2,332,133.76
Mode	---
Standard Deviation	553,384.90
Variance	306,234,843,952.73
Skewness	0.3033
Kurtosis	2.64
Coeff. of Variation	0.2330
Minimum	1,068,023.98

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Maximum	4,043,008.25
Range Width	2,974,984.28
Mean Std. Error	17,499.57

Percentiles:	Forecast values
0%	1,068,023.98
10%	1,689,585.36
20%	1,881,027.02
30%	2,027,448.62
40%	2,186,189.69
50%	2,330,692.58
60%	2,485,432.25
70%	2,657,419.87
80%	2,844,025.68
90%	3,153,925.54
100%	4,043,008.25

Forecast: Expected Payout per Insuree at 3.5% (5% of 70%) Occurrence Rate

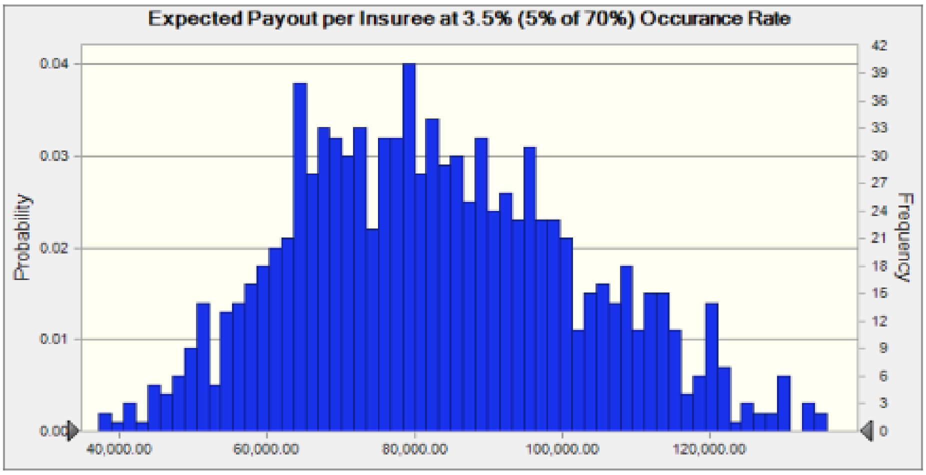
Cell: B28

Summary:

Entire range is from 37,380.84 to 141,505.29

Base case is 139,363.00

After 1,000 trials, the std. error of the mean is 612.48



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Statistics:	Forecast values
Trials	1,000
Base Case	139,363.00
Mean	83,140.74
Median	81,624.68
Mode	---
Standard Deviation	19,368.47
Variance	375,137,683.84
Skewness	0.3033
Kurtosis	2.64
Coeff. of Variation	0.2330
Minimum	37,380.84
Maximum	141,505.29
Range Width	104,124.45
Mean Std. Error	612.48

Percentiles:	Forecast values
0%	37,380.84
10%	59,135.49
20%	65,835.95
30%	70,960.70
40%	76,516.64
50%	81,574.24
60%	86,990.13
70%	93,009.70
80%	99,540.90
90%	110,387.39
100%	141,505.29

Forecast: Operating Profit per Insuree Cell: B30

Summary:

Entire range is from 2,314.71 to 106,439.16

Base case is 4,457.00

After 1,000 trials, the std. error of the mean is 612.48

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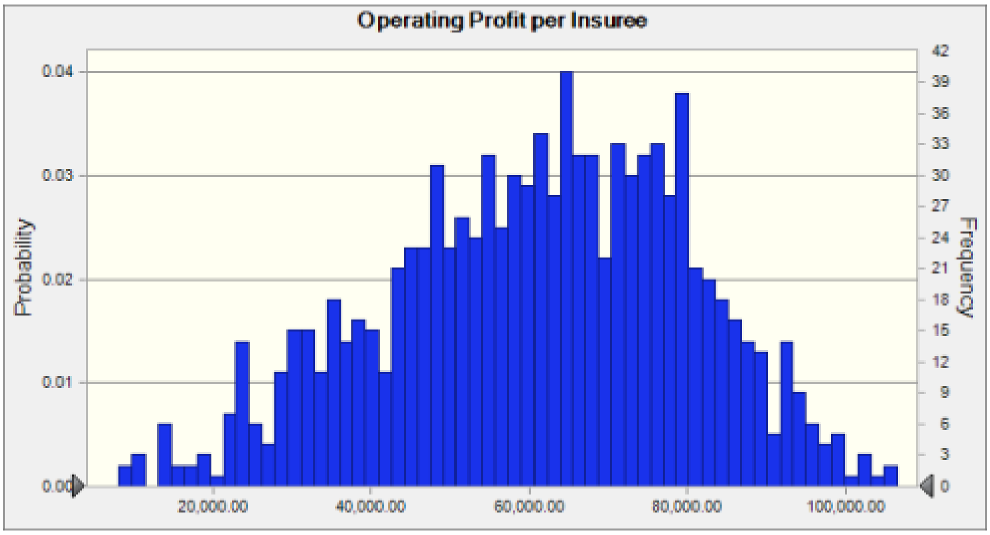

Statistics:	Forecast values
Trials	1,000
Base Case	4,457.00
Mean	60,679.26
Median	62,195.32
Mode	---
Standard Deviation	19,368.47
Variance	375,137,683.84
Skewness	-0.3033
Kurtosis	2.64
Coeff. of Variation	0.3192
Minimum	2,314.71
Maximum	106,439.16
Range Width	104,124.45
Mean Std. Error	612.48

Percentiles:	Forecast values
0%	2,314.71
10%	33,377.40
20%	44,097.40
30%	50,704.65
40%	56,577.98
50%	62,144.88

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60%	67,036.02
70%	72,796.01
80%	77,975.80
90%	84,657.25
100%	106,439.16

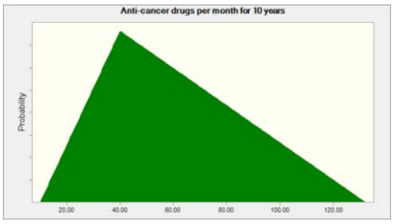
End of Forecasts

Assumptions

Assumption: Anti-cancer drugs per month for 10 years Cell: B17

Triangular distribution with parameters:

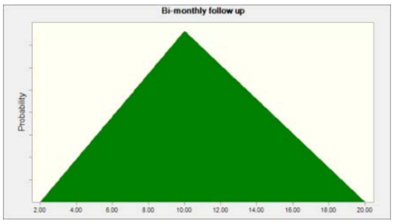
Minimum	10.00
Likeliest	40.00
Maximum	132.00



Assumption: Bi-monthly follow-up Cell: B18

Triangular distribution with parameters:

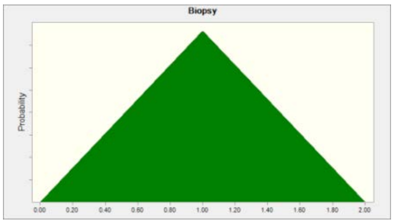
Minimum	2.00
Likeliest	10.00
Maximum	20.00



Assumption: Biopsy Cell: B6

Triangular distribution with parameters:

Minimum	0.00
Likeliest	1.00
Maximum	2.00



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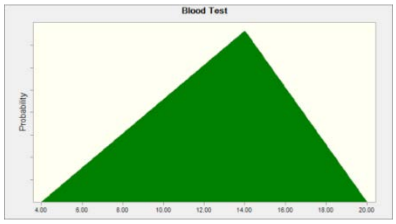
Assumption: Blood Test Cell: B13

Triangular distribution with parameters:

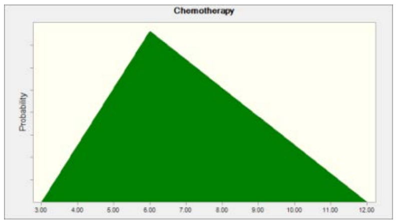
Minimum	4.00
Likeliest	14.00
Maximum	20.00



Assumption: Chemotherapy Cell: B9

Triangular distribution with parameters:

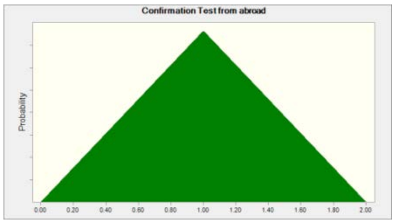
Minimum	3.00
Likeliest	6.00
Maximum	12.00



Assumption: Confirmation Test from abroad Cell: B14

Triangular distribution with parameters:

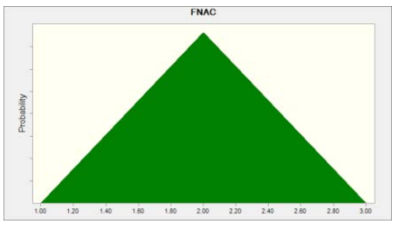
Minimum	0.00
Likeliest	1.00
Maximum	2.00



Assumption: FNAC Cell: B5

Triangular distribution with parameters:

Minimum	1.00
Likeliest	2.00
Maximum	3.00



Assumption: Hospital Cell: B10

Triangular distribution with parameters:

Minimum	0.00

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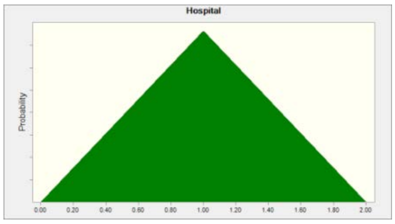
Likeliest 1.00

Maximum 2.00

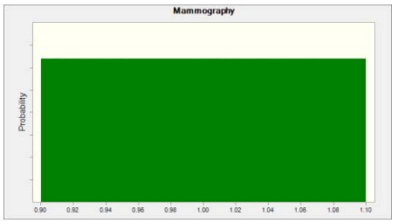


Assumption: Mammography Cell: B8

Uniform distribution with parameters:

Minimum 0.90

Maximum 1.10



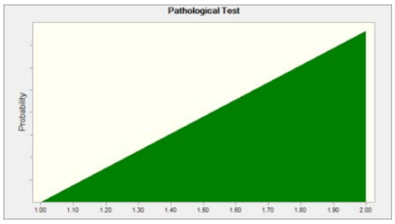
Assumption: Pathological Test Cell: B7

Triangular distribution with parameters:

Minimum 1.00

Likeliest 2.00

Maximum 2.00



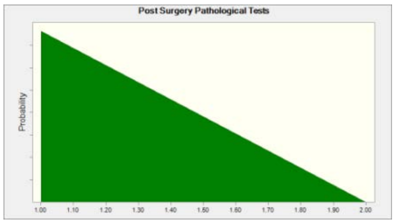
Assumption: Post Surgery Pathological Tests Cell: B12

Triangular distribution with parameters:

Minimum 1.00

Likeliest 1.00

Maximum 2.00



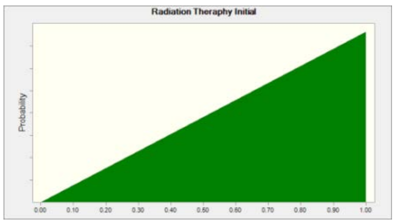
Assumption: Radiation Therapy Initial Cell: B16

Triangular distribution with parameters:

Minimum 0.00

Likeliest 1.00

Maximum 1.00



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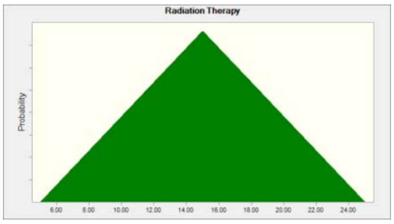
Assumption: Radiation Therapy Cell: B15

Triangular distribution with parameters:

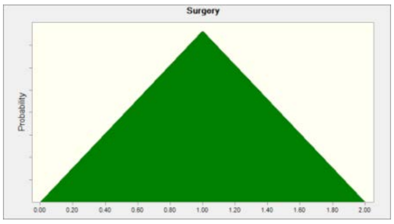
Minimum	5.00
Likeliest	15.00
Maximum	25.00



Assumption: Surgery Cell: B11

Triangular distribution with parameters:

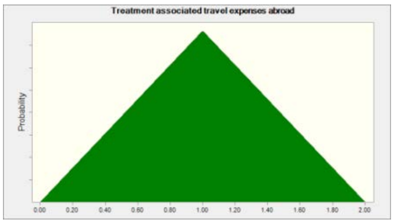
Minimum	0.00
Likeliest	1.00
Maximum	2.00



Assumption: Treatment associated travel expenses abroad Cell: B19

Triangular distribution with parameters:

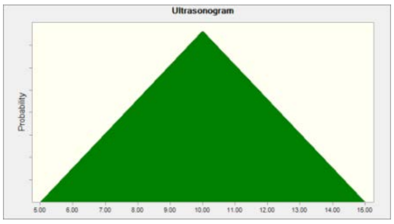
Minimum	0.00
Likeliest	1.00
Maximum	2.00



Assumption: Ultra sonogram Cell: B20

Triangular distribution with parameters:

Minimum	5.00
Likeliest	10.00
Maximum	15.00



End of Assumptions

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Appendix 3. Monte Carlo Simulation on Cancer Expenses: Positive Screening but with No Cancer Case

Crystal Ball Report - Full

Simulation started on 5/9/2016 at 10:05 AM

Simulation stopped on 5/9/2016 at 10:05 AM

Run preferences:	
Number of trials run	1,000
Monte Carlo	
Random seed	
Precision control on	
Confidence level	95.00%
Run statistics:	
Total running time (sec)	0.98
Trials/second (average)	1,016
Random numbers per sec	16,264
Crystal Ball data:	
Assumptions	16
Correlations	0
Correlation matrices	0
Decision variables	0
Forecasts	3

Forecast: Expected Expenditure on Patient Cell: D23

Summary:

Entire range is from 399,169.42 to 1,608,660.92

Base case is

894,400.00

After 1,000 trials, the std. error of the mean is 7,308.06

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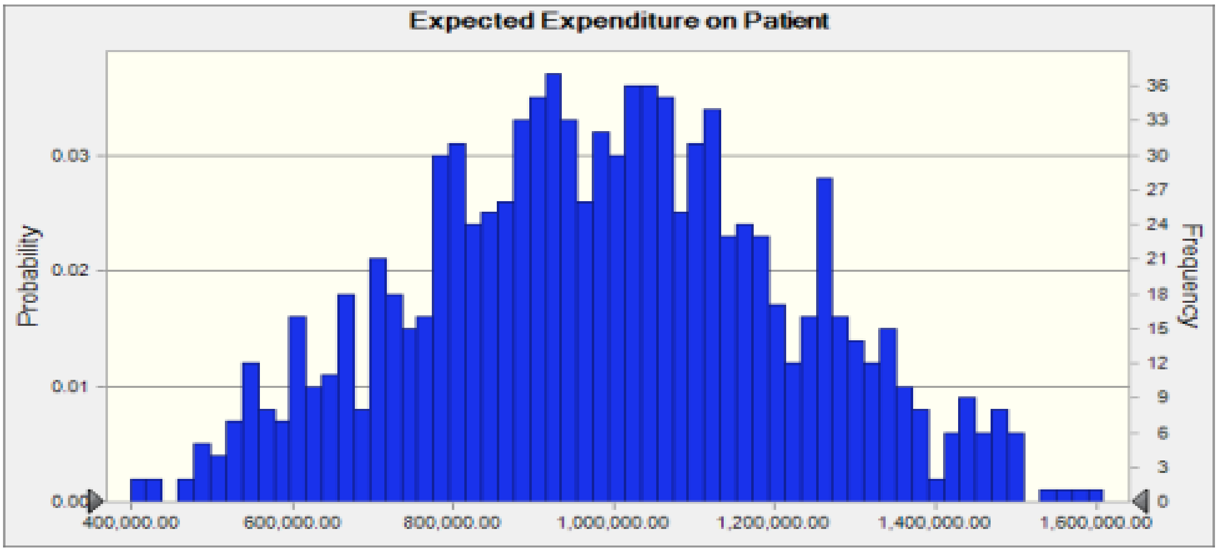

Statistics:	Forecast values
Trials	1,000
Base Case	894,400.00
Mean	985,052.55
Median	986,918.49
Mode	---
Standard Deviation	231,101.22
Variance	53,407,773,278.66
Skewness	0.0343
Kurtosis	2.56
Coeff. of Variation	0.2346
Minimum	399,169.42
Maximum	1,608,660.92
Range Width	1,209,491.49
Mean Std. Error	7,308.06

Percentiles:	Forecast values
0%	399,169.42
10%	671,714.37
20%	787,954.55
30%	861,902.92
40%	920,729.59

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50%	986,873.66
60%	1,045,987.19
70%	1,105,864.77
80%	1,182,327.29
90%	1,288,978.81
100%	1,608,660.92

Forecast: Expected Payout per Insuree at 9% (30% of 30%) Occurrence Rate

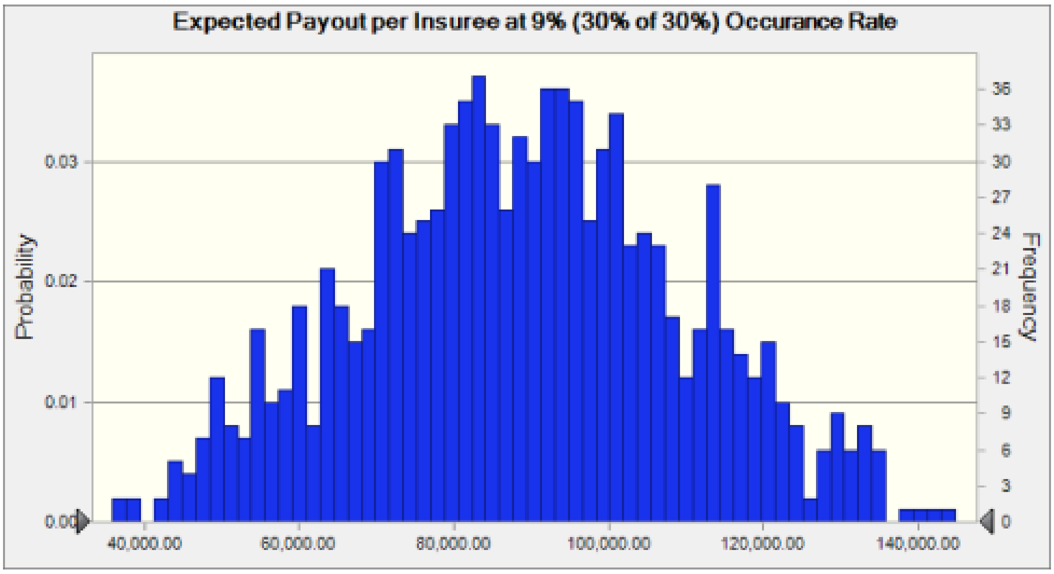
Cell: B28

Summary:

Entire range is from 35,925.25 to 144,779.48

Base case is 80,496.00

After 1,000 trials, the std. error of the mean is 657.73



Statistics:	Forecast values
Trials	1,000
Base Case	80,496.00
Mean	88,654.73
Median	88,822.66
Mode	---
Standard Deviation	20,799.11
Variance	432,602,963.56

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Skewness	0.0343
Kurtosis	2.56
Coeff. of Variation	0.2346
Minimum	35,925.25
Maximum	144,779.48
Range Width	108,854.23
Mean Std. Error	657.73

Percentiles:	Forecast values
0%	35,925.25
10%	60,454.29
20%	70,915.91
30%	77,571.26
40%	82,865.66
50%	88,818.63
60%	94,138.85
70%	99,527.83
80%	106,409.46
90%	116,008.09
100%	144,779.48

Forecast: Operating Profit per Insuree Cell: B30

Summary:

Entire range is from 238,740.52 to 347,594.75

Base case is 303,024.00

After 1,000 trials, the std. error of the mean is 657.73

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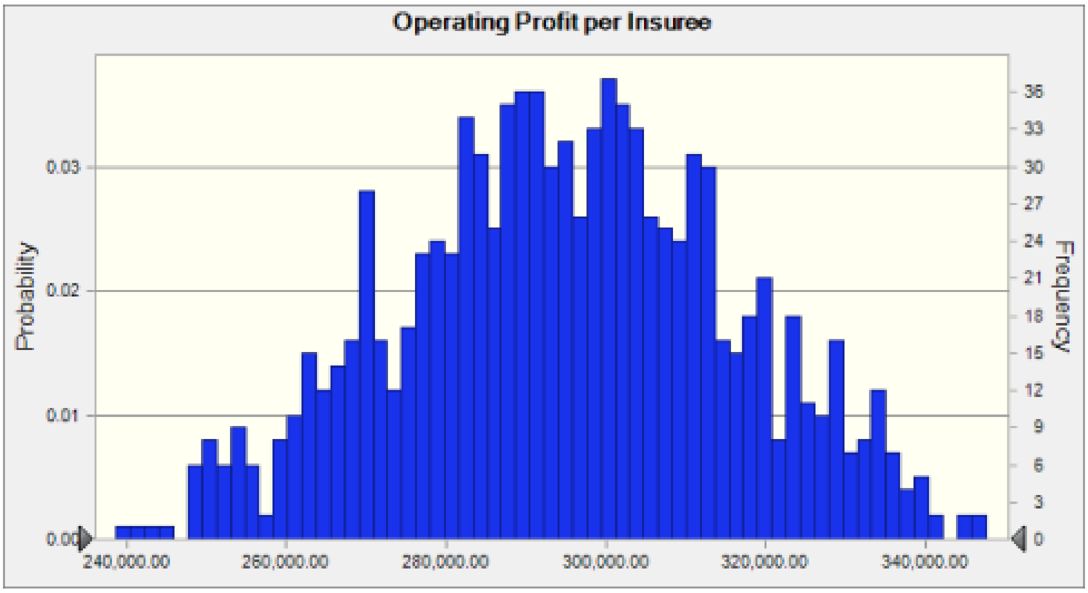

Statistics:	Forecast values
Trials	1,000
Base Case	303,024.00
Mean	294,865.27
Median	294,697.34
Mode	---
Standard Deviation	20,799.11
Variance	432,602,963.56
Skewness	-0.0343
Kurtosis	2.56
Coeff. of Variation	0.0705
Minimum	238,740.52
Maximum	347,594.75
Range Width	108,854.23
Mean Std. Error	657.73

Percentiles:	Forecast values
0%	238,740.52
10%	266,988.25
20%	277,110.51
30%	283,925.12

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40%	289,377.04
50%	294,693.30
60%	300,627.43
70%	305,912.87
80%	312,491.33
90%	323,052.98
100%	347,594.75

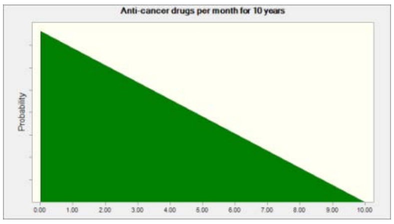
End of Forecasts

Assumptions

Assumption: Anti-cancer drugs per month for 10 years Cell: B17

Triangular distribution with parameters:

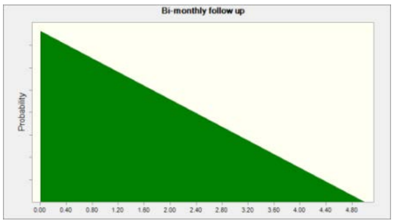
Minimum	0.00
Likeliest	0.00
Maximum	10.00



Assumption: Bi-monthly follow-up Cell: B18

Triangular distribution with parameters:

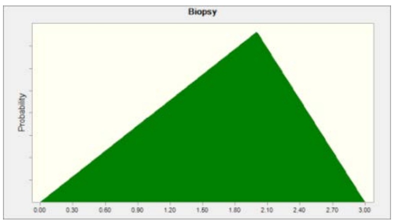
Minimum	0.00
Likeliest	0.00
Maximum	5.00



Assumption: Biopsy Cell: B6

Triangular distribution with parameters:

Minimum	0.00
Likeliest	2.00
Maximum	3.00



Assumption: Blood Test Cell: B13

Triangular distribution with parameters:

Minimum	8.00
Likeliest	10.00

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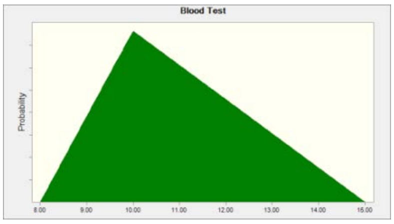
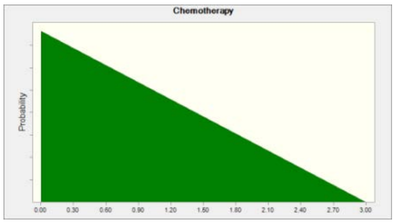
Maximum	15.00



Assumption: Chemotherapy Cell: B9

Triangular distribution with parameters:

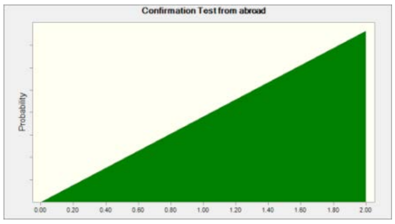
Minimum	0.00
Likeliest	0.00
Maximum	3.00



Assumption: Confirmation Test from abroad Cell: B14

Triangular distribution with parameters:

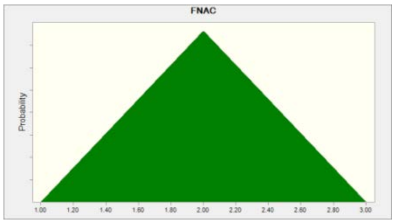
Minimum	0.00
Likeliest	2.00
Maximum	2.00



Assumption: FNAC Cell: B5

Triangular distribution with parameters:

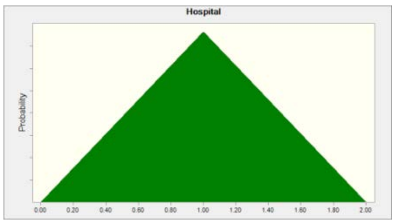
Minimum	1.00
Likeliest	2.00
Maximum	3.00



Assumption: Hospital Cell: B10

Triangular distribution with parameters:

Minimum	0.00
Likeliest	1.00
Maximum	2.00



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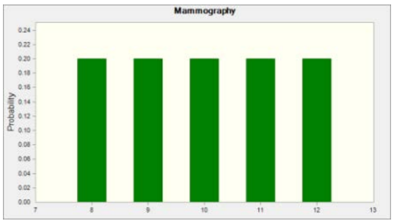
Assumption: Mammography Cell: B8

Discrete Uniform distribution with parameters:

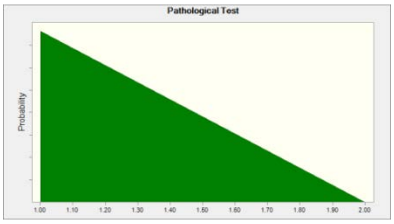
Minimum	8.00
Maximum	12.00



Assumption: Pathological Test Cell: B7

Triangular distribution with parameters:

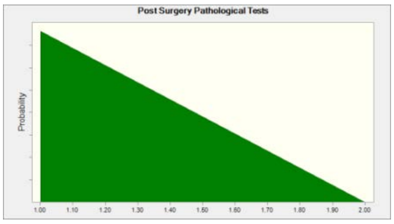
Minimum	1.00
Likeliest	1.00
Maximum	2.00



Assumption: Post Surgery Pathological Tests Cell: B12

Triangular distribution with parameters:

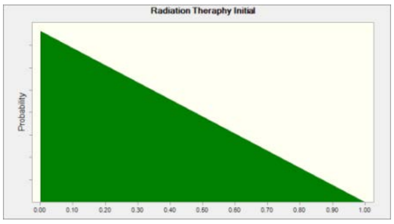
Minimum	1.00
Likeliest	1.00
Maximum	2.00



Assumption: Radiation Therapy Initial Cell: B16

Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00
Maximum	1.00



Assumption: Radiation Therapy Cell: B15

Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00
Maximum	3.00

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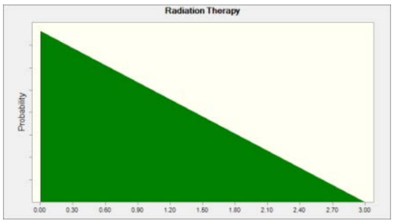
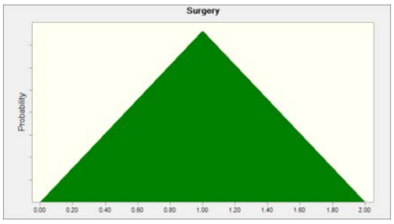


Assumption: Surgery Cell: B11

Triangular distribution with parameters:

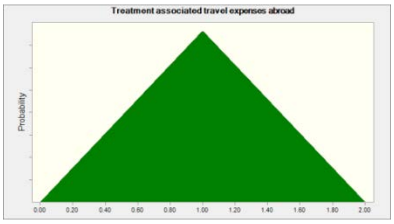
Minimum	0.00
Likeliest	1.00
Maximum	2.00



Assumption: Treatment associated travel expenses abroad Cell: B19

Triangular distribution with parameters:

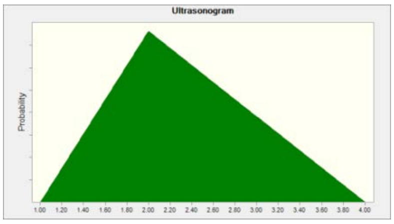
Minimum	0.00
Likeliest	1.00
Maximum	2.00



Assumption: Ultra sonogram Cell: B20

Triangular distribution with parameters:

Minimum	1.00
Likeliest	2.00
Maximum	4.00



End of Assumptions

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Appendix 4. Monte Carlo Simulation on Cancer Expenses: Positive Screening with Cancer Case

Crystal Ball Report - Full

Simulation started on 5/9/2016 at 10:07 AM

Simulation stopped on 5/9/2016 at 10:07 AM

Run preferences:	
Number of trials run	1,000
Monte Carlo	
Random seed	
Precision control on	
Confidence level	95.00%
Run statistics:	
Total running time (sec)	1.07
Trials/second (average)	937
Random numbers per sec	14,992
Crystal Ball data:	
Assumptions	16
Correlations	0
Correlation matrices	0
Decision variables	0
Forecasts	3

Forecast: Expected Expenditure on Patient Cell: D23

Summary:

Entire range is from 760,596.46 to 2,144,125.00

Base case is 1,265,800.00

After 1,000 trials, the std. error of the mean is 7,668.40

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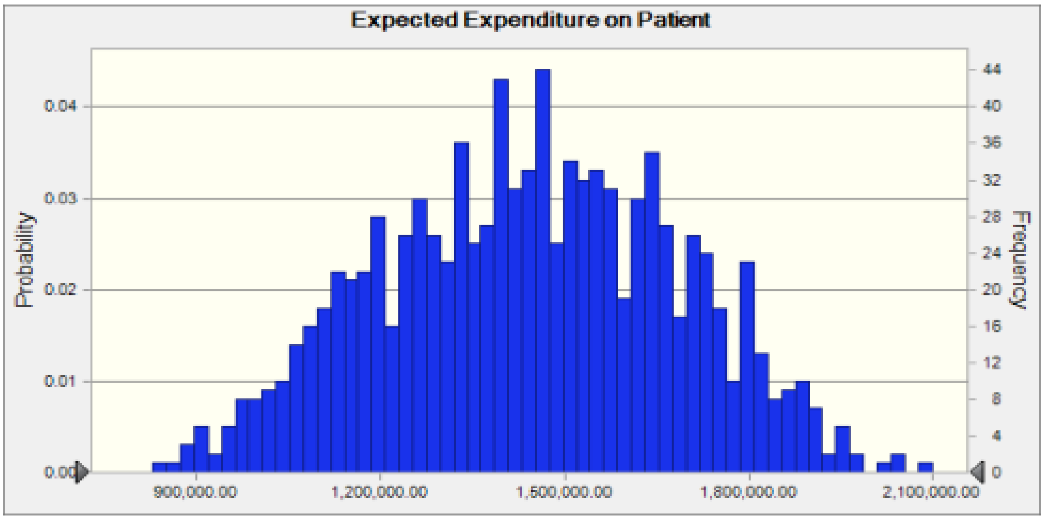

Statistics:	Forecast values
Trials	1,000
Base Case	1,265,800.00
Mean	1,441,465.18
Median	1,445,951.05
Mode	---
Standard Deviation	242,496.24
Variance	58,804,425,387.80
Skewness	-0.0106
Kurtosis	2.47
Coeff. of Variation	0.1682
Minimum	760,596.46
Maximum	2,144,125.00
Range Width	1,383,528.54
Mean Std. Error	7,668.40

Percentiles:	Forecast values
0%	760,596.46
10%	1,114,964.60
20%	1,217,813.57
30%	1,303,994.48
40%	1,382,867.79
50%	1,445,564.51

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60%	1,508,595.45
70%	1,575,494.81
80%	1,655,256.84
90%	1,757,121.07
100%	2,144,125.00

Forecast: Expected Payout per Insuree at 21% (70% of 30%) Occurrence Rate

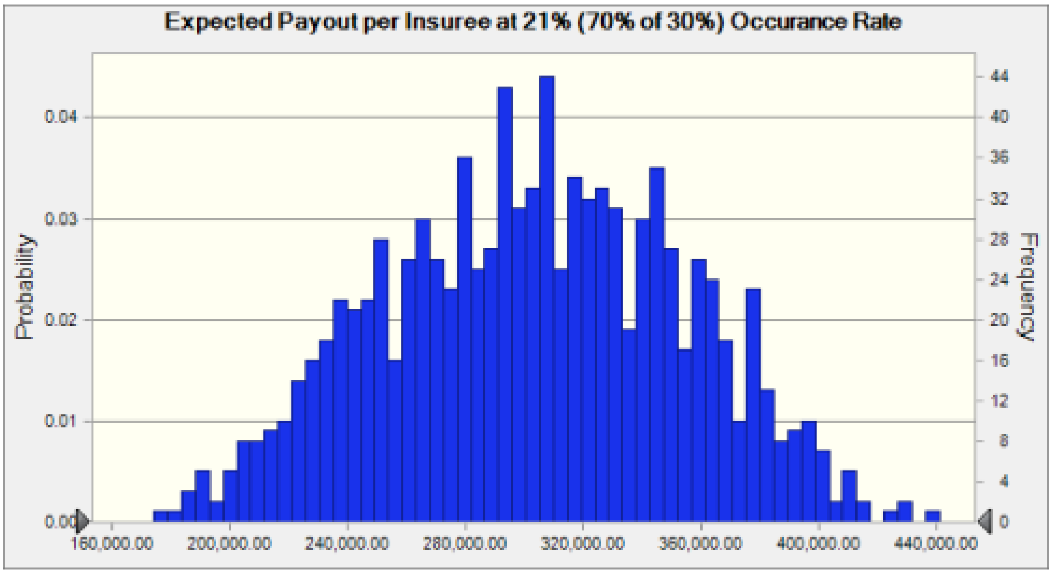
Cell: B28

Summary:

Entire range is from 159,725.26 to 450,266.25

Base case is 265,818.00

After 1,000 trials, the std. error of the mean is 1,610.36



Statistics:	Forecast values
Trials	1,000
Base Case	265,818.00
Mean	302,707.69
Median	303,649.72
Mode	---
Standard Deviation	50,924.21
Variance	2,593,275,159.60
Skewness	-0.0106

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Kurtosis	2.47
Coeff. of Variation	0.1682
Minimum	159,725.26
Maximum	450,266.25
Range Width	290,540.99
Mean Std. Error	1,610.36

Percentiles:	Forecast values
0%	159,725.26
10%	234,142.57
20%	255,740.85
30%	273,838.84
40%	290,402.24
50%	303,568.55
60%	316,805.05
70%	330,853.91
80%	347,603.94
90%	368,995.42
100%	450,266.25

Forecast: Operating Profit per Insuree Cell: B30

Summary:

Entire range is from -66,746.25 to 223,794.74

Base case is 117,702.00

After 1,000 trials, the std. error of the mean is 1,610.36

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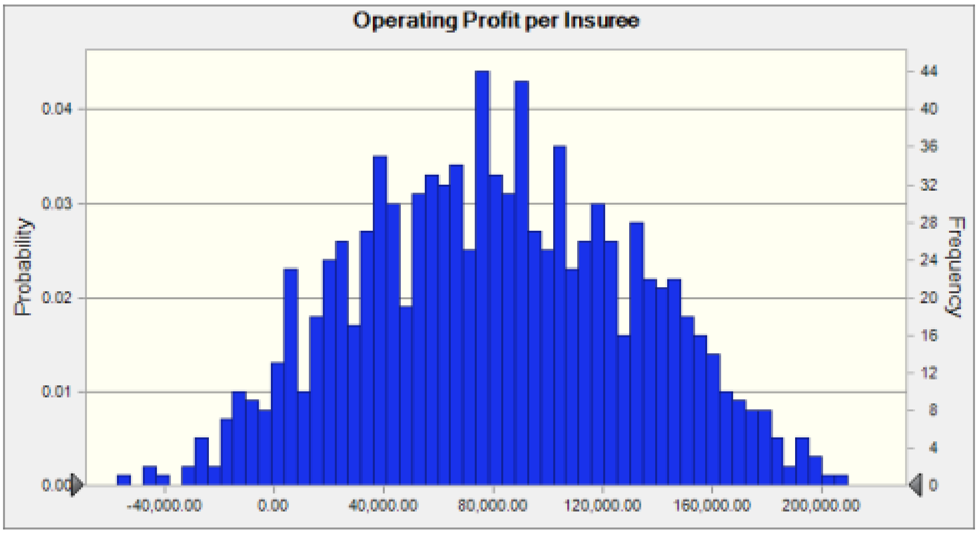

Statistics:	Forecast values
Trials	1,000
Base Case	117,702.00
Mean	80,812.31
Median	79,870.28
Mode	---
Standard Deviation	50,924.21
Variance	2,593,275,159.60
Skewness	0.0106
Kurtosis	2.47
Coeff. of Variation	0.6302
Minimum	-66,746.25
Maximum	223,794.74
Range Width	290,540.99
Mean Std. Error	1,610.36

Percentiles:	Forecast values
0%	-66,746.25
10%	14,289.14
20%	35,845.18
30%	52,124.23
40%	66,632.26

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50%	79,789.11
60%	92,813.93
70%	109,447.25
80%	127,621.82
90%	148,822.31
100%	223,794.74

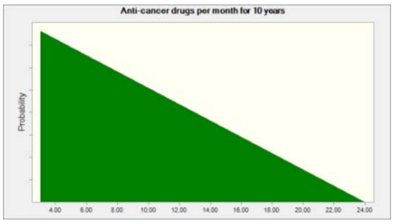
End of Forecasts

Assumptions

Assumption: Anti-cancer drugs per month for 10 years Cell: B17

Triangular distribution with parameters:

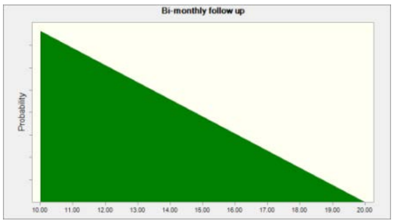
Minimum	3.00
Likeliest	3.00
Maximum	24.00



Assumption: Bi-monthly follow-up Cell: B18

Triangular distribution with parameters:

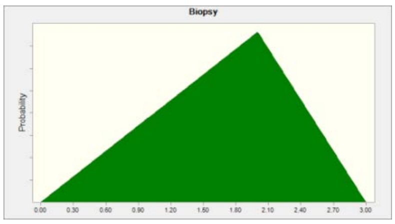
Minimum	10.00
Likeliest	10.00
Maximum	20.00



Assumption: Biopsy Cell: B6

Triangular distribution with parameters:

Minimum	0.00
Likeliest	2.00
Maximum	3.00



Assumption: Blood Test Cell: B13

Triangular distribution with parameters:

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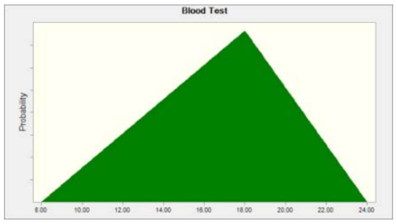
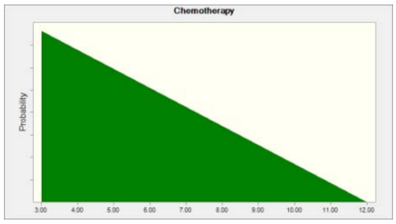
Minimum	8.00
Likeliest	18.00
Maximum	24.00



Assumption: Chemotherapy Cell: B9

Triangular distribution with parameters:

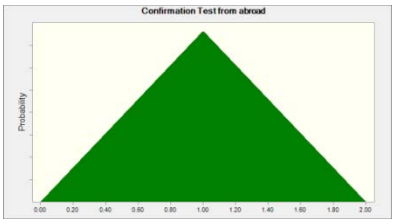
Minimum	3.00
Likeliest	3.00
Maximum	12.00



Assumption: Confirmation Test from abroad Cell: B14

Triangular distribution with parameters:

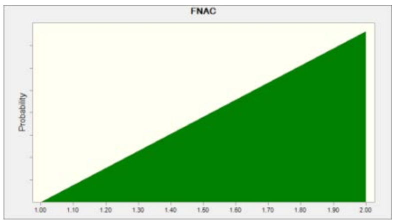
Minimum	0.00
Likeliest	1.00
Maximum	2.00



Assumption: FNAC Cell: B5

Triangular distribution with parameters:

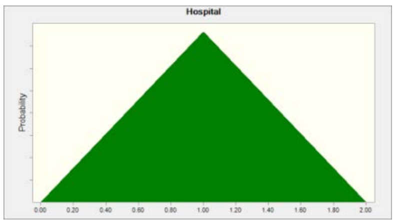
Minimum	1.00
Likeliest	2.00
Maximum	2.00



Assumption: Hospital Cell: B10

Triangular distribution with parameters:

Minimum	0.00
Likeliest	1.00
Maximum	2.00



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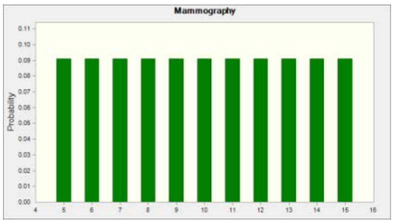
Assumption: Mammography Cell: B8

Discrete Uniform distribution with parameters:

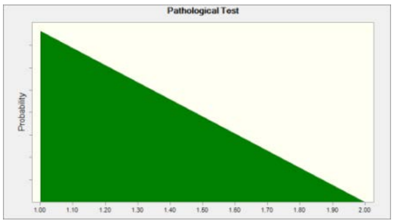
Minimum	5.00
Maximum	15.00



Assumption: Pathological Test Cell: B7

Triangular distribution with parameters:

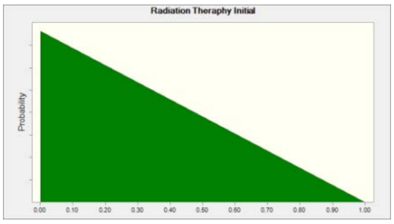
Minimum	1.00
Likeliest	1.00
Maximum	2.00



Assumption: Post Surgery Pathological Tests Cell: B16

Triangular distribution with parameters:

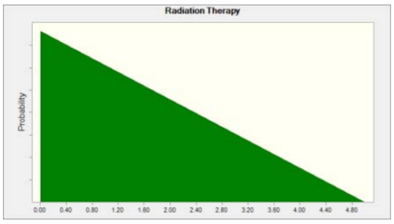
Minimum	0.00
Likeliest	0.00
Maximum	1.00



Assumption: Radiation Therapy Cell: B15

Triangular distribution with parameters:

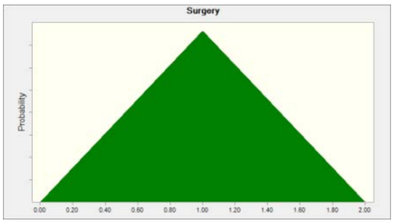
Minimum	0.00
Likeliest	0.00
Maximum	5.00



Assumption: Surgery Cell: B11

Triangular distribution with parameters:

Minimum	0.00
Likeliest	1.00
Maximum	2.00



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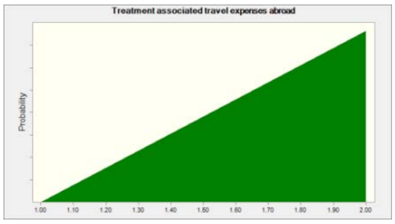
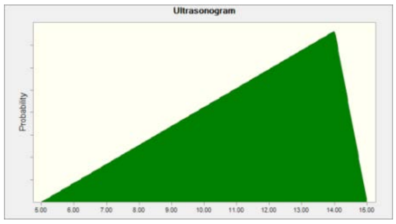
Assumption: Treatment associated travel expenses abroad Cell: B19

Triangular distribution with parameters:	
Minimum	1.00
Likeliest	2.00
Maximum	2.00



Assumption: Ultra sonogram Cell: B20

Triangular distribution with parameters:	
Minimum	5.00
Likeliest	14.00
Maximum	15.00



End of Assumptions

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REFERENCES

[1] American Cancer Society. (2016, March 23). *Lifetime Risk of Developing or Dying from Cancer.* Retrieved from http://www.cancer.org/cancer/cancerbasics/lifetime-probability-of-developing-or-dying-from-cancer
Last Access: May 10, 2016.

[2] Bangladesh Bureau of Statistics. (2013). *Health and Morbidity Status Survey- 2012*. Ministry of Planning, Government of the People's Republic of Bangladesh. Retrieved from http://www.bbs.gov.bd/WebTestApplication/userfiles/Image/Health_Demo/HMSS.pdf
Last Access: May 10, 2016.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

[1] Bloom, D.E., et al. (2011). The Global Economic Burden of Non-communicable Diseases. Geneva: World Economic Forum and Harvard School of Public Health. Retrieved from *http://www.hsph.harvard.edu/program-on-the-global-demography-of-aging/WorkingPapers/2012/PGDA_WP_87.pdf*
Last Access: May 10, 2016.

[3] Centers for Disease Control and Prevention. (2010). *Top 10 Causes of Death.* Global Health – Bangladesh. Retrieved from http://www.cdc.gov/globalhealth/countries/Bangladesh/
Last access: March 10, 2016.

[4] Frieden, T.R. (2010). A Framework for Public Health Action: The Health Impact Pyramid. *American Journal of Public Health*, 100(4), 590-595. Retrieved from http://ipc.ipha.com/Documents/ContentAttachments/11142014021449-H3%20Frieden%27s%20Pyramid%20Article.pdf
Last Access: May 10, 2016.

[5] Glover, L. (2015, July 1). Oncologists Worry about Rising Costs of Cancer Treatment. *U.S. News & World Report*. Retrieved from http://health.usnews.com/health-news/patient-advice/articles/2015/07/01/oncologists-worry-about-rising-costs-of-cancer-treatment
Last Access: May 10, 2016.

[6] Thomas, R.J.S., Callahan, R., Bartlett, R. and Geissler, J. (2015). *Delivering Affordable Cancer Care: A Value Challenge to Health Systems*. Report of the WISH Delivering Affordable Cancer Care Forum 2015. Qatar Foundation. Retrieved from https://www.imperial.ac.uk/media/imperial-college/institute-of-global-health-innovation/public/Affordable-cancer-care.pdf
Last Access: May 10, 2016.

[7] World Bank. (2016). *GDP per capita (Current US$)*. Retrieved from http://data.worldbank.org/indicator/NY.GDP.PCAP.CD
Last Access: May 10, 2016.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)