

# A Monte-Carlo Simulation of Benefits After Bariatric Surgery on Obese Patients with Type-2 Diabetes —A Reanalysis

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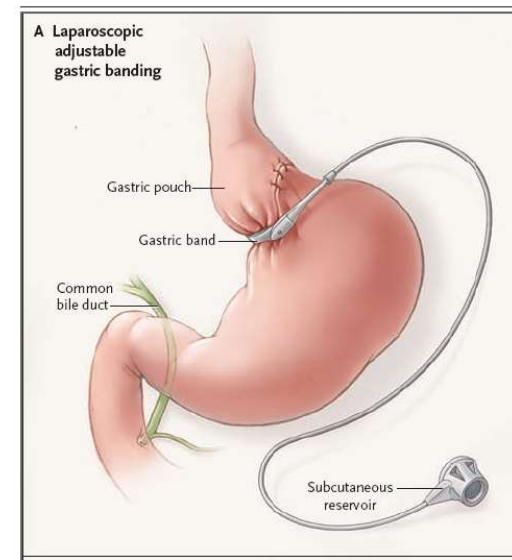
Assisted By Dr Mohammad Maruf

A summer project —*slide excerpts*

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# Surgery to Control Obesity

- Laparoscopic gastric banding is **surgery to help with weight loss**. The surgeon places a band around the upper part of your stomach to create a small pouch to hold food. The band limits the amount of food you can eat by making you feel full after eating small amounts of food.



# Simulation analysis of the study below

- An Australian study (Monash University) looked at the efficacy of Gastric By-Pass Surgery in weight management of Type-2 diabetes<sup>1</sup>.
- The study was a Randomized Control Trial<sup>2</sup> over a 2-year period and evaluated the
  - Costs of Gastric By-Pass Surgery
    - Surgery Costs, Post-Surgery monitoring etc.
  - Benefits of Gastric By-Pass Surgery
    - Higher remission rates

# Using Simulation For Lifetime Analysis

- **Objective:** Using a simulation approach to extrapolate results of the Australian 2-year trial, to a lifetime analysis, i.e. *until simulated death or ninety-nine years of age, whichever is earlier.*

Now	Year1	Year2	Year3	Year4	Year5	Year6	Year7	.	.	.	EndOfSimulationPeriod
0	Trial	Trial	simulation	simulation	simulation	simulation	simulation	simulation	simulation	simulation	simulation

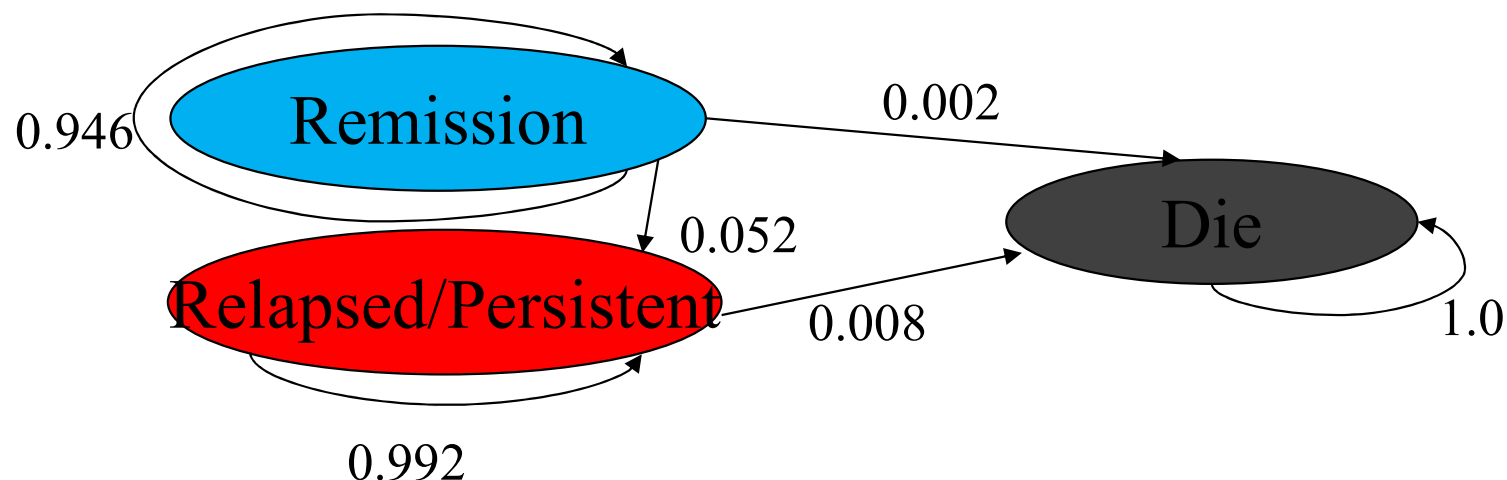
- **Why Simulate:**
  - If properly done, can help model very long term costs and benefits, with some degree of confidence.
  - Sometimes, it may be difficult to get ethical consent for certain sample control approaches –simulation is one way to continue to do analysis.

# Markov Transitional Probabilities for a “Typical” patient

Presently, an obese patient may not have Type-2 diabetes. It’s also possible that he may have had Type-2 diabetes in the past but is presently not diabetic. Presently, not having Type-2 diabetes is depicted as the “Remission” state and is shown in blue.

(A) From “Remission” it’s possible to go to a Type-2 diabetic stage. That state is called “Relapsed” and is shown in red. The probability of doing so, within a year, is 0.052. It’s also possible to go to a “Die” state with a probability of 0.002, in a year, the “Die” state is shown in dark grey. Finally it’s possible to persist in “Remission”.

(B) From “Relapsed” state, it’s possible to either persist in that state, with probability 0.992 or go to the “Die” state with probability 0.008, in a year.



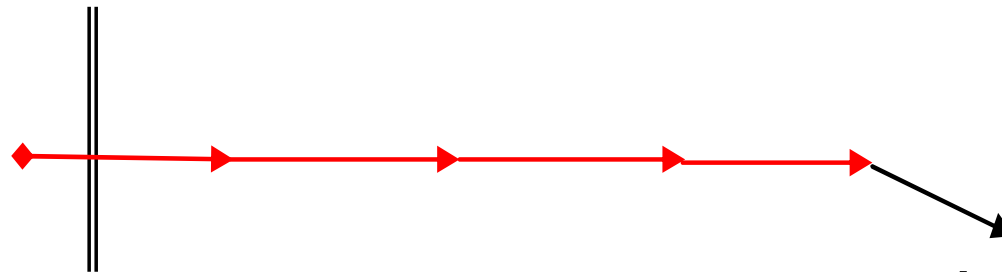
# Costs, Mortality and QALY Benefits for the Simulation Run

## **Simulation2**

Remission

Persistent(Relapsed)

Die



### **FORECASTED YEARS**

	1	2	3	4	TOTAL
COSTS(AUD)	3800	3900	4000	4100	
Discount Factors	0.971	0.943	0.915	0.888	
Discounted COSTS (AUD)	3689	3676	3661	3643	14669
Discounted Years				3.55	3.55
Quality of Life Years(QALY)				0.8	2.84

In the previous run, the patient lived for 4 years after the trial and died after that. The costs, the discounting factors and the discounted costs are shown. They total AUD 14669. The total life years are 4, discounted to 3.55 and quality adjusted to 2.84. Years in remission is 0.

# Benefits (used from the Australian 2-year RCT.)

- Quality-adjusted life-years (QALYs) utility weight 0.67 to 0.81 for patient with diabetes and 0.84 for patients in remission
- Surgical patients gained additional 9.4 years in remission and 1.6 additional life years. The discounted QALY was 1.2 years.
- **Surgical therapy was the dominant treatment as it was both cheaper and provided more QALYs.**
- Worst case scenarios for intervention effect and cost of treatment of Type 2 diabetes shifted the economic status of the surgical therapy from dominant to cost effective. A similar result was obtained by combining the intervention effect and duration of diabetes remission in worst-case scenarios

# Results

<b>Model results-lifetime means per patient</b>	<b>Surgical</b>	<b>Conventional</b>	<b>Difference</b>
<i>Undiscounted</i>			
Years in diabetes remission	11.4	2.1	9.4
Total life-years	32.1	30.5	1.6
QALYs	24.9	22.6	2.3
<i>Discounted at 3% for both costs and benefits (Costs AUD)</i>			
2-year RCT intervention	13,383	3,397	9,987
Surgical intervention maintenance	6,477		6,477
Surgical intervention complications	1,768		1,768
Type 2 diabetes remission—monitoring costs	16,479	2,874	13,605
Health care costs to treat type 2 diabetes	60,824	95,105	-34,281
Total cost	98,931	101,376	-2,444



# Conclusion

- From a cost perspective, disregarding quality of life and life expectancy benefits of diabetes remission, this analysis suggests that after 10 years the return on investment of surgical therapy is fully recovered through saving in health care costs to treat type 2 diabetes.

# Appendix II

## Acknowledgements

- Dr. Mohammad Maruf helped with step-wise mentoring and detailed explanation of medical concepts, terms and practices.
- Journal Articles
  - Karlsson J, Taft C, Ryden A, Sjostrom L, Sullivan M: Ten-year trends in health-related quality of life after surgical and conventional treatment for severe obesity: the SOS intervention study. *Int J Obesity (Lond)* 31:1248–1261, 2007
  - Dixon et. al. *JAMA*, 2008- Surgical therapy induced weight loss results in better glycemic control and less need for diabetes medications
  - Keating et al. *Diabetes Care*, Cost-efficacy of surgically induced weight loss for the management of type 2 diabetes: a randomized controlled trial  
<https://pubmed.ncbi.nlm.nih.gov/19171726/>
  - Keating et al. *Diabetes Care*, April 2009. Cost-effectiveness of surgically induced weight loss for the management of type 2 diabetes: modeled lifetime analysis
  - Brianna N. Lauren, BS; Francesca Lim, MS; Abraham Krikhely, MD; Elsie M. Taveras, MD, MPH; Jennifer A. Woo Baidal, MD, MPH; Brandon K. Bellows, PharmD, MS; Chin Hur, MD, <https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2789003>  
Estimated Cost-effectiveness of Medical Therapy, Sleeve Gastrectomy, and Gastric Bypass in Patients With Severe Obesity and Type 2 Diabetes.
- Mr. Mike Miller for being a superb teacher of Simulation and other Computer Science techniques in my AP Computer Science classes.