

Appendix 1.

Table 1. ICD-9 codes and operational definitions

Conditions	ICD-9 Code	CPT Code
Morbid Obesity	278.x	
Hypertension	401.x	
	402.x	
	403.x	
	404.x	
	405.x	
	437.2	
Diabetes	250.xx	
Dyslipidemia	272.4	
Sleep Apnea	780.5x	
	327.2x	
Gastroesophageal Reflux Disease	530.81	
Osteoarthritis	716.9	
Metabolic Syndrome	277.x	
Coronary Disease	410.x	
	411.x	
	412.x	
	413.x	
	414.x	
	429.2 V45.81	
Myocardial Infarction	410.X0	
	410.X1	
Depression	311.xx	
Bariatric Procedures		
Gastrojejunostomy; without vagotomy		43820
Gastrojejunostomy; with vagotomy, any type		43825
Gastric restrictive procedure, without gastric bypass, for morbid obesity; vertical-banded gastroplasty		43842
Gastric restrictive procedure, without gastric bypass, for morbid obesity; other than vertical-banded gastroplasty		43843
Gastric restrictive procedure with partial gastrectomy, pylorus-preserving duodenoileostomy and ileoileostomy (50 to 100 cm common channel) to limit absorption (biliopancreatic diversion with duodenal switch)		43845
Gastric restrictive procedure, with gastric bypass for morbid obesity; with short limb (150 cm or less) Roux-en-Y gastroenterostomy		43846
Gastric restrictive procedure with gastric bypass for morbid obesity; with short limb (150 cm or less) Roux-en-Y gastroenterostomy with small intestine reconstruction to limit absorption		43847

Laparoscopy, surgical, gastric restrictive procedure; with gastric bypass and Roux-en-Y gastroenterostomy (roux limb 150 cm or less)		43644
Laparoscopy, surgical, gastric restrictive procedure; with gastric bypass and Roux-en-Y gastroenterostomy (roux limb 150 cm or less) with gastric bypass and small intestine reconstruction to limit absorption		43645
Unlisted laparoscopy procedure, stomach		43659
Laparoscopy, surgical, gastric restrictive procedure; placement of adjustable gastric band		43770
Gastroduodenostomy		43810
Unlisted procedure, stomach		43999
High gastric bypass	44.31	
Laposcopic gastroenterostomy	44.38	
Other gastroenterostomy	44.39	
Ineligible Gastrointestinal Malignancies		
Malignant neoplasm of esophagus	150.x	
Malignant neoplasm of stomach	151.x	
Malignant neoplasm of small intestine	152.x	
Other Exclusionary Diagnoses		
Pregnancy	V22.2	
Lactation	676.x	
Dementia	290.x	
Psychosis	298.9	
HIV	42.0	
Cancer	199.1	
Inflammatory Bowel Disease	558.9	
Cirrhosis	571.x	
Dialysis	V56.0	
Reoperation after bariatric surgery		
Exploration for postoperative hemorrhage abdomen		35840
Unlisted laparoscopy procedure, stomach		43659
Laposcopic gastrostomy		43653
Percutaneous placement of gastrostomy tube		43750
Suture of gastric injury		43840
Suture of small bowel for injury		44602
Suture of small bowel for injury		44604
Suture of large intestine		49002
Reopening of recent laparotomy		49329
Adverse outcomes		
Bleeding	998.11	
Abdominal Abscess	567.22	
pneumonia, respiratory failure or respiratory arrest	519.X	
	997.X	
	518.X	
	799.X	
prolonged mechanical ventilation		94656
		94657
tracheostomy		31600

		31603
pulmonary embolus	415.1	
wound infection	998.59	
percutaneous abscess drainage-abdomen, pelvis and/or peritoneum		49020
		49021
		49040
		49041
		58823
		26990
		26992
		26993
		45000

Operational Definitions:

Reoperation after bariatric operations will be determined if a patient had any of the following CPT codes within 30 days after index admission:

Any of the above listed index CPT codes (above section C.2.a.3.a) or CPT 35840 Exploration for postoperative hemorrhage abdomen, CPT 43659 Unlisted laparoscopy procedure, stomach, CPT 43653 Laparoscopic gastrostomy, CPT 43750 Percutaneous placement of gastrostomy tube, CPT 43840 Suture of gastric injury, CPT 44602 Suture of small bowel for injury, CPT 44604 Suture of large intestine, CPT 49002 Reopening of recent laparotomy, CPT 49329 Unlisted laparoscopy procedure abdomen.

Secondary adverse outcomes include any of the following: pneumonia and/or respiratory failure and/or respiratory arrest (ICD-9 diagnostic code 519.8, 997.3, 518.5, 518.81, 518.82, 518.84, 799.1), prolonged mechanical ventilation (CPT codes 94656 or 7), tracheostomy (CPT codes 31600, 31603), pulmonary embolus (ICD-9 diagnostic code 415.1), wound infection (ICD-9 diagnostic code 998.59), percutaneous abscess drainage - abdomen, pelvis and/or peritoneum (CPT codes 49020, 49021, 49040, 49041, 58823, 26990, 26992, 26993, 45000).

Appendix 2

Table 1. All sample of adults initially identified in the database

	Year	Freq.	Percent	Cum.
No Surgery	2004	8,535	18.15	18.15
	2005	14,469	30.76	48.91
	2006	8,874	18.87	67.77
	2007	6,727	14.30	82.07
	2008	4,958	10.54	92.61
	2009	3,474	7.39	100.00
	Total	47,037	100.00	
Surgery	2004	120	10.63	10.63
	2005	137	12.13	22.76
	2006	145	12.84	35.61
	2007	185	16.39	51.99
	2008	274	24.27	76.26
	2009	268	23.74	100.00
	Total	1,129	100.00	

Table 2. Eligible subjects included in the cohort

	Year	Freq.	Percent	Cum.
No Surgery	2004	5,535	19.39	19.39
	2005	9,394	32.90	52.29
	2006	5,319	18.73	70.92
	2007	3,799	13.31	84.23
	2008	2,717	9.52	93.74

	2009	1,786	6.26	100.00
	Total	28,550	100.00	
Surgery	2004	115	10.81	10.81
	2005	128	12.03	22.84
	2006	135	12.69	35.53
	2007	173	16.26	51.79
	2008	257	24.15	75.94
	2009	256	24.06	100.00
	Total	1,064	100.00	

Appendix 3

Table 1. Description of unadjusted total costs in Non surgery subjects (All Sample-Unadjusted)

Year from Index	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	
N	3668	7260	13860	17955	21084	24286	28369	12320	5638	2939	1548	767	188	
Min	-	-	-	-	-	-	-	-	-	-	-	-	-	
Mean	8.318	9.504	9.058	8.280	7.538	7.078	5.821	5.693	5.239	5.500	5.321	4.682	4.493	
Max	332.116	861.346	616.003	738.734	590.978	1.183.001	541.802	530.540	237.193	232.610	229.791	99.832	76.486	
P25	1.649	1.672	1.550	1.404	1.316	1.211	1.067	950	956	902	925	884	823	
P50	7.731	8.649	8.136	7.500	7.007	2.706	2.284	2.233	2.223	2.118	2.193	2.025	2.209	
P75	7.731	8.649	8.136	7.500	7.007	6.494	5.306	5.434	5.269	5.039	4.789	4.598	4.919	
P99	82.988	89.795	89.053	86.144	74.979	71.366	56.827	57.608	49.703	60.093	48.994	41.002	46.118	
							Median (CPI adjusted 2010)	1.978	2.000	2.054	2.015	2.164	1.992	2.209
							Mean (CPI adjusted 2010)	5.041	5.101	4.841	5.231	5.252	4.607	4.493

Table 2. Description of unadjusted total costs in surgery subjects (All Sample-Unadjusted)

Year from Index	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	
N	199	263	353	467	648	914	1128	1040	839	667	474	246	43	
Min	103	67	-	-	20	-	1.016	-	17	-	-	-	327	
Mean	9.967	9.125	9.115	9.892	10.367	9.405	33.510	8.578	7.964	7.471	6.715	6.987	5.701	
Max	135.174	101.119	219.753	155.760	175.405	231.712	425.673	168.336	254.889	137.602	93.730	94.765	29.218	
P25	1.665	1.747	1.525	1.587	1.808	2.099	23.068	2.820	1.832	1.723	1.558	1.597	1.277	
P50	4.593	4.601	3.724	4.155	4.537	4.328	30.223	5.318	3.801	3.684	3.437	3.306	3.024	
P75	12.109	10.873	9.750	11.992	13.395	10.125	38.207	10.520	8.862	8.268	7.880	8.528	8.195	
P99	118.817	69.232	84.834	79.597	58.012	76.564	120.149	45.256	57.789	67.714	52.949	53.610	29.218	
							Median (CPI adjusted 2010)	26.173	4.765	3.512	3.503	3.392	3.253	3.024
							Mean (CPI adjusted 2010)	29.019	7.686	7.359	7.105	6.627	6.876	5.701

Table 3. Propensity-matched total annual cost by cohort

No surgery cohort

Year from Index	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	
N	46	127	319	515	808	1,077	1,529	856	586	410	302	191	55	
Min	408	199	105	91	-	-	105	-	-	-	-	-	-	
Mean	6.615	8.204	8.456	8.108	6.887	6.051	5.736	5.369	4.391	5.076	4.576	4.369	4.071	
Max	39.736	89.354	219.664	188.837	151.469	217.381	481.109	118.360	44.654	63.060	84.900	99.832	46.118	
P25	1.177	1.446	1.549	1.292	1.347	1.187	1.053	768	672	738	685	745	489	
P50	2.919	3.216	3.429	3.062	2.714	2.672	2.207	2.052	1.824	1.999	1.860	1.715	2.160	
P75	6.516	8.569	8.390	8.282	6.266	6.103	4.993	5.276	4.836	4.981	4.400	4.547	4.431	
P99	39.736	82.753	95.865	71.812	63.352	52.072	53.816	49.141	35.243	41.806	38.258	71.079	46.118	
							Median	1.912	1.839	1.686	1.901	1.836	1.688	2.160
							Mean	4.968	4.811	4.058	4.827	4.516	4.299	4.071

Surgery cohort

Year from Index	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	
N	197	254	340	451	622	871	1,064	982	780	607	425	215	34	
Min	103	67	-	-	20	-	1.027	-	17	-	-	-	327	
Mean	10.036	9.202	9.079	9.920	10.501	9.444	33.735	8.624	7.735	7.617	6.865	7.155	6.062	
Max	135.174	101.119	219.753	155.760	175.405	231.712	425.673	168.336	126.893	137.602	93.730	94.765	29.218	
P25	1.665	1.773	1.551	1.603	1.818	2.107	23.386	2.824	1.822	1.783	1.529	1.451	1.747	
P50	4.712	4.875	3.765	4.155	4.641	4.352	30.443	5.302	3.851	3.733	3.500	3.276	3.278	
P75	12.109	10.898	9.753	12.083	13.455	10.125	38.207	10.427	8.844	8.284	7.934	8.492	8.342	
P99	118.817	69.232	84.834	79.597	58.012	82.440	124.760	45.947	57.789	67.714	52.949	53.610	29.218	
							Median	26.363	4.750	3.558	3.550	3.455	3.224	3.278
							Mean	29.215	7.727	7.147	7.244	6.776	7.040	6.062

Propensity Score Match: gender, age, bmi at index, diabetes, dyslipidemia, CCI, hypertension, bariatric surgery rider, and index date

Table 4. Survival and mean total annual costs by cohort

Time Total	Fail (Death)	Survivor Functions	SE	[95% Confidence Interval]	
<i>No Surgery</i>					
1	401	0,9829	0,0008	0.9812	0.9845
2	122	0,9722	0,0013	0.9695	0.9746
3	55	0,9624	0,0018	0.9586	0.9658
4	17	0,9559	0,0024	0.9509	0.9604
5	4	0,9519	0,0031	0.9454	0.9576
6	1	0,9469	0,0059	0.9341	0.9573

Surgery

1	11	0,9967	0,001	0.9940	0.9982
2	5	0,9945	0,0014	0.9909	0.9966
3	4	0,9917	0,002	0.9868	0.9948
4	2	0,9891	0,0027	0.9823	0.9933
5	2	0,9823	0,0055	0.9674	0.9904

Removing Deaths

No Surgery	N	min	mean cost	max	P25	P50	P75	P99
0	27526	-	5.366	541.802	1.043	2.222	5.050	49.590
1	11919	-	5.439	530.540	929	2.169	5.258	53.567
2	5516	-	5.105	237.193	941	2.184	5.183	47.980
3	2884	-	5.395	232.610	889	2.079	4.923	59.239
4	1531	-	5.279	229.791	919	2.171	4.710	48.994
5	763	-	4.689	99.832	882	2.025	4.594	41.002
6	187	-	4.493	76.486	823	2.160	4.992	46.118

Removing Deaths

Surgery	N	min	mean cost	max	P25	P50	P75	P99
0	27526	1.016	32.810	232.791	22.970	30.131	37.924	107.136
1	11919	-	8.577	168.336	2.847	5.307	10.502	45.256
2	5516	17	7.973	254.889	1.832	3.813	8.862	57.789
3	2884	-	7.500	137.602	1.733	3.691	8.284	67.714
4	1531	-	6.740	93.730	1.564	3.453	7.896	52.949
5	763	-	7.022	94.765	1.598	3.306	8.551	53.610
6	187	327	5.701	29.218	1.277	3.024	8.195	29.218

Table 5. Propensity score-matched survival and mean total annual costs by cohort

Time Total	Fail (Death)	Survivor Functions	SE	[95% Confidence Interval]	
<i>No Surgery</i>					
1	21	0,9913	0,0019	0.9867	0.9943
2	13	0,983	0,003	0.9761	0.9879
3	8	0,9748	0,0041	0.9653	0.9817
4	3	0,9695	0,0051	0.9577	0.9781
5	0	0,9695	0,0051	0.9577	0.9781
6	0	0,9695	0,0051	0.9577	0.9781

<i>Surgery</i>					
1	11	0,9964	0,0011	0.9935	0.9980
2	4	0,9945	0,0015	0.9907	0.9967
3	3	0,9921	0,002	0.9871	0.9952
4	1	0,9907	0,0025	0.9844	0.9944
5	1	0,9867	0,0047	0.9736	0.9933
6	0	0,9867	0,0047	0.9736	0.9933

<i>Removing Deaths</i>								
No Surgery	N	min	mean cost	max	P25	P50	P75	P99
0	843	213	20.659	445.770	3.420	7.992	20.896	183.480
1	401	133	13.254	435.601	2.521	5.140	13.390	104.933
2	122	340	11.304	124.865	2.138	4.439	12.375	104.220
3	55	240	11.010	63.199	3.010	6.369	13.430	63.199
4	17	140	9.142	29.533	2.383	7.731	11.278	29.533
5	4	1.323	3.229	5.406	1.423	3.093	5.034	5.406
6	1	4.500	4.500	4.500	4.500	4.500	4.500	4.500

<i>Removing Deaths</i>								
Surgery	N	min	mean cost	max	P25	P50	P75	P99
0	15	16.796	85.439	425.673	29.209	39.656	102.150	425.673
1	11	1.332	8.620	33.359	1.882	6.427	15.050	33.359
2	5	148	6.510	22.971	2.247	2.578	4.606	22.971
3	4	551	2.673	6.914	711	1.613	4.634	6.914
4	2	647	809	971	647	809	971	971
5	2	718	2.742	4.766	718	2.742	4.766	4.766



Table 5. Assessment of costs distribution for a two-part model

Any Cost				
No Surgery	No Costs reported	Any Cost Reported	%	Total
-6	4	3.664	99,89%	3.668
-5	13	7.247	99,82%	7.260
-4	27	13.833	99,81%	13.860
-3	23	17.932	99,87%	17.955
-2	22	21.062	99,90%	21.084
-1	24	24.262	99,90%	24.286
0	3	28.366	99,99%	28.369
1	34	12.286	99,72%	12.320
2	27	5.611	99,52%	5.638
3	10	2.929	99,66%	2.939
4	9	1.539	99,42%	1.548
5	3	764	99,61%	767
6	3	185	98,40%	188

Any Cost				
No Surgery	No Costs reported	Any Cost Reported	%	Total
-6	0	199	100,00%	199
-5	0	263	100,00%	263
-4	3	350	99,15%	353
-3	2	465	99,57%	467
-2	0	648	100,00%	648
-1	2	912	99,78%	914
0	0	1.128	100,00%	1.128
1	3	1.037	99,71%	1.040
2	0	839	100,00%	839
3	1	666	99,85%	667

4	1	473	99,79%	474
5	1	245	99,59%	246
6	0	43	100,00%	43

Appendix 4.

Table 1. Clinical and cost inputs for the initial 5-year period post-surgery (53 year old female with a BMI of 44 kg/m² and no post-surgical complications).

	LRYGB	ORYGB	LAGB
Total Cost (<31 days)	\$ 16,691	\$ 20,675	\$ 14,159
Total Cost (31-365 days)	\$ 9,494	\$ 12,849	\$ 7,835
Total Cost (Year 2)	\$ 9,478	\$ 12,302	\$ 8,551
Total Cost (Year 3)	\$ 8,507	\$ 11,237	\$ 7,917
Total Cost (Year 4)	\$ 5,622	\$ 9,887	\$ 6,291
Total Cost (Year 5)	\$ 1,221	\$ 5,764	\$ 2,685
Cost of Death (All periods)	\$38,049	\$ 38,049	\$ 38,049
Utility (0-31 days)	0.75	0.75	0.75
Utility (31-365 days)	0.78	0.78	0.75
Utility (Year 2)	0.74	0.74	0.73
Utility (Year 3)	0.73	0.73	0.70
Utility (Year 4)	0.70	0.70	0.67
Utility (Year 5)	0.67	0.67	0.65

LRYGB=Laparoscopic Roux-en-Y Gastric Bypass ORYGB= Open Roux-en-Y Gastric Bypass

LAGB= Laparoscopic Adjustable Gastric Banding

Table 2. Results of the lifetime simulation for the base case (53 year old Female with BMI 44 kg/m², using Medicare data)

Lifetime Outcomes				
Intervention	Non-surgical	LRYGB	LAGB	ORYGB
<i>Standard BMI Trajectory</i>				
Direct Medical Costs	\$150,934	\$169,074	\$164,313	\$194,858
QALY	10.6	13.4	12.8	13.2
Life-years	16.7	18.0	17.7	17.8
Expected Age of Death	78	81	80	80
ICER		\$6,600	\$6,200	\$17,300
<i>Weight Stable Model</i>				
Direct Medical Costs	\$150,934	\$169,091	\$164,076	\$194,874
QALY	10.6	13.7	12.7	13.5
Life-years	16.7	18.2	17.7	18.0
Expected Age of Death	78	81	80	81
ICER		\$6,000	\$6,300	\$15,600
<i>Maximum Weight Regain</i>				
Direct Medical Costs	\$150,934	\$175,815	\$171,001	\$201,493
QALY	10.6	11.7	11.4	11.5
Life-years	16.7	16.8	16.7	16.5
Expected Age of Death	78	78	78	77
ICER		\$24,100	\$26,700	\$59,500

LRYGB=Laparoscopic Roux-en-Y Gastric Bypass ORYGB= Open Roux-en-Y Gastric Bypass
LAGB= Laparoscopic Adjustable Gastric Banding