

Online-Only Supplement

**Cardiovascular Outcomes in Patients with Type 2 Diabetes and Obesity:
Comparison of Gastric Bypass, Sleeve Gastrectomy, and Usual Care**

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eTable 1. Diagnosis and Procedure Codes	
Atrial fibrillation	<u>ICD9</u> : 427.31 <u>ICD10</u> : i48.0, i48.1, i48.2, i48.91 <u>CPT</u> : 93650, 93653, 93656, 93657
Bariatric surgery	<u>CPT-4</u> : 43633, 43634, 43770, 43775, 43644, 43645, 43659, 43842, 43843, 43844, 43845, 43846, 43847 <u>ICD9</u> : 44.31, 43.82, 44.95, 43.89, 44.38, 44.39, 44.68 <u>HCPCS</u> : S2082, S2085
Cancer	<u>ICD9</u> : 140.XX-172.XX, 174.XX-209.XX <u>ICD10</u> : C00.XX-C43.XX, C45.XX-C96.XX, D03.XX, D3A.XX, D45.XX
Cerebrovascular event	<u>ICD9 (diagnoses)</u> : 433.X1, 434.X1, 436.0, 430.X, 431.X <u>ICD9 (procedure)</u> : 38.12, 0.61, 0.63 <u>CPT-4</u> : 37215, 37216, 0075T, 0076T, 35301, 37205, 37206
COPD	<u>ICD9</u> : 491.0, 491.1, 491.2X, 491.8, 491.9, 492.0, 492.8, 496
Coronary artery disease	<u>ICD9 (diagnoses)</u> : 410.X, 411.X , 411.X AND 414.X <u>ICD9 (procedure)</u> : 36.01, 36.02, 36.03, 36.05, 36.06, 36.07, 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.17, 36.19, 36.31, 36.32, 36.33, 36.64 <u>CPT-4</u> : 92982, 92984, 92995, 92996, 92980, 92981, 33510, 33511, 33512, 33513, 33514, 33516, 33517, 33518, 33519, 33521, 33522, 33523, 33530, 33533, 33534, 33535, 33536, 93539, 93540
Diabetic neuropathy	<u>ICD9</u> : 250.6, 357.2
Dyslipidemia	<u>ICD9</u> : 272.0, 272.1, 272.2, 272.3, 272.4
GI Cancer	<u>ICD9</u> : 150.X, 151.X, 152.X, 157.X, 199.X, 531.X, 532.X, 533.X
Heart failure	<u>ICD9</u> : 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9
Hypertension	<u>ICD9</u> : 401.X, 402.X, 403.X, 404.X, 405.X
Ischemic stroke	<u>ICD-9</u> : 433.X1, 434.X1 <u>ICD-10</u> : i63.X and i63.XX and i63.XXX
Liver, lung, heart transplant	<u>ICD9</u> : V42.1, V42.6, V42.7, V42.83, V42.84
Myocardial infarction	<u>ICD-9</u> : 410.X, 410.XX <u>ICD-10</u> : i21.X and i21.XX, i22.X and i22.XX, i23.X and i23.XX
Nephropathy	>= two (2) measures of eGFR less than 60 mL/min separated by at least 90 days without any intervening values >= 60 mL/min. The eGFR is approximated using MDRD equation.
Peripheral arterial disease	<u>ICD9</u> : 440.20, 440.21, 440.22, 440.23, 440.24, 440.29, 440.31, 440.32, 443.81, 443.89, 443.9, 447.1, 249.7, 250.7
* Bolded text indicates it must be a primary diagnosis	
Adopted from: Aminian A, Zajichek A, Arterburn DE, et al. Association of Metabolic Surgery With Major Adverse Cardiovascular Outcomes in Patients With Type 2 Diabetes and Obesity. JAMA. 2019;322:1271–82.	

eTable 2. Intervention Codes for Adverse Events of Metabolic Surgery*	
Total parenteral nutrition	ICD-9 procedure code 99.15
Endoscopic intervention	43200-04, 43215-28, 43232-36, 43239, 43243, 43245-51, 43255-58, 43450, 43453, 43456, 43458, 44360, 44361, 44376. 42.21-42.29, 44.22, 44.43, 45.11-45.14
Interventional radiology	36000, 36556, 36558, 36561, 36563, 36565, 36566, 36569, 36571-36590
Cholecystectomy	47490, 47562-47564, 47600-47610
Repair of abdominal wall hernia	44050, 49560-49572, 49585-49590, 49650-49659, 49900, 43659, S2075, S2077 53.1x-53.8x
Abdominal surgical procedure	<p>Diagnostic laparoscopy (ICD-9 54.21) and exploratory laparotomy (54.11)</p> <p>Lysis of adhesions: ICD-9 54.51, 54.59</p> <p>Repair of internal hernia: ICD-9 53.9</p> <p>RYGB, AGB, sleeve and VGB: ICD-9: 43.82, 43.89, 44.31, 44.38, 44.39, 44.68, 44.95 CPT-4: 43633, 43644, 43645, 43770, 43773, 43775, 43776, 43842, 43843, 43844, 43846, 43847, 43848, 43888, S2082, S2085</p> <p>Duodenal switch: ICD-9: 43.7, 45.51, 45.91</p> <p>Revision GJ: CPT-4: 43860,43865</p> <p>Additional revisional bariatric procedures: ICD-9: 44.0 to 44.03, 44.89, 45.28, 45.29, 45.51, 46.01 to 46.03, 46.2, 46.64, 54.5, 54.75, 54.95 CPT-4: 43610, 44850</p> <p>Percutaneous/laparoscopic: ICD-9: 39.41, 39.98, 46.71, 46.73, 46.75, 46.94, 50.61, 54.0, 54.12, 54.19, 54.20, 54.22-.29, 54.91, 54.92 CPT-4: 43653, 44180, 44186, 44200,44202, 44203, 44238, 49000, 49002, 49010, 49020, 49021, 49040, 49041, 49060, 49061, 49320, 49322, 49323, 49329</p> <p>Abscess: CPT-4: 49020,49406</p> <p>Reoperation ulcers: CPT-4: 43840, 44180, 44602, 49905</p> <p>PEG tube/revision NOS/VGB: CPT-4: 43750, 43760, 43761, 43848, 43860, 44373</p> <p>Other procedures: ICD-9: 42.81, 42.84, 42.9, 42.92, 43.0, 43.11, 43.19, 43.42, 43.5, 43.7, 43.99, 44.13, 44.29, 44.49, 44.5, 44.62, 44.63, 44.99, 45.02, 45.19, 45.61, 45.62, 45.91, 46.39, 46.62, 46.71, 46.73, 46.75, 46.79, 46.81, 46.82, 46.85, 46.93, 46.99 CPT-4: 10022, 10030, 10160, 43300, 43305, 43310, 43312, 43500, 43631, 43752,</p>

	43832, 43840, 43845, 43850, 43870, 43880, 43999, 44005, 44021, 44055, 44120, 44121, 44125, 44130, 44500, 44602, 44620, 44799, 48000, 49080, 49407, 49440, 49441, 49446, 49451, 49460, 49999
<p>* ICD-9 and CPT-4 diagnosis and procedure codes were adapted and modified from:</p> <ul style="list-style-type: none"> • Li RA, Liu L, Arterburn D, et al. Five-year Longitudinal Cohort Study of Reinterventions After Sleeve Gastrectomy and Roux-en-Y Gastric Bypass. <i>Ann Surg.</i> 2019 Jun 7. doi:10.1097/SLA.0000000000003401. • Flum D, Belle S, King W, et al. Longitudinal Assessment of Bariatric Surgery (LABS) Consortium. Perioperative safety in the Longitudinal Assessment of bariatric Surgery. <i>N Engl J Med.</i> 2009;361:445-54. • Aminian A, Zajichek A, Arterburn DE, et al. Association of Metabolic Surgery With Major Adverse Cardiovascular Outcomes in Patients With Type 2 Diabetes and Obesity. <i>JAMA.</i> 2019;322:1271–82. 	

eTable 3. Cause-specific event rates (%) per 100 patient-years of follow-up at 5 years, for each study outcome stratified by treatment group

	RYGB	SG	Nonsurgical Group
Primary composite	3.74	5.35	7.45
Secondary composite	1.69	2.29	3.64
All-cause mortality	0.98	1.04	2.22
Heart failure	0.74 (1.5)	1.07 (1.95)	2.49 (3.7)
Coronary artery disease	0.82 (1.68)	1.41 (2.15)	1.55 (3.36)
Cerebrovascular disease	0.38 (1.26)	0.6 (1.52)	0.73 (2.74)
Nephropathy	0.71 (1.39)	1.48 (2.52)	2.07 (3.47)
Atrial fibrillation	1.01 (1.87)	1.06 (2)	1.77 (3.42)

The composite rates of death with each individual outcome are also shown in parentheses.

eTable 4. P-values testing the proportional-hazards assumption for the treatment variable for each outcome

Outcome	PH P-value
Primary composite	0.677
Secondary composite	0.534
All-cause mortality	0.578
Heart failure	0.396
Coronary artery disease	0.193
Cerebrovascular disease	0.302
Nephropathy	0.677
Atrial fibrillation	0.094

eTable 5. Comparison of difference in weight loss and glycated hemoglobin (HbA1c) between the study groups at 5 years

Comparison	Outcome	Estimate (95% CI)	P-value*
RYGB vs. SG	Weight loss (%)	-9.70 (-10.12, -9.27)	<0.001
	HbA1c (%)	-0.31 (-0.47, -0.16)	<0.001
RYGB vs. Nonsurgical group	Weight loss (%)	-18.26 (-18.46, -18.05)	<0.001
	HbA1c (%)	-1.00 (-1.07, -0.92)	<0.001
SG vs. Nonsurgical group	Weight loss (%)	-8.56 (-8.95, -8.17)	<0.001
	HbA1c (%)	-0.68 (-0.82, -0.55)	<0.001

*Wald test p-values comparing study groups at 5-years.

eTable 6. Average change in percentage of patients taking diabetes and cardiovascular medications between the study groups at 5 years

Comparison	Medication	Estimate	95% CI		P-value*
			Lower	Upper	
RYGB vs. SG	Non-Insulin Diabetes medication (%)	-19	-29	-9	<0.001
	Insulin (%)	-4	-14	5	>0.99
	ACE-I/ARB (%)	-14	-23	-3	0.027
	Other antihypertensives (%)	-8	-17	2	0.382
	Cholesterol-lowering (%)	-19	-29	-9	<0.001
	Aspirin (%)	-15	-25	-5	0.002
RYGB vs. Nonsurgical controls	Non-Insulin Diabetes medication (%)	-53	-56	-49	<0.001
	Insulin (%)	-11	-14	-6	<0.001
	ACE-I/ARB (%)	-32	-36	-27	<0.001
	Other antihypertensives (%)	-9	-14	-6	<0.001
	Cholesterol-lowering (%)	-31	-35	-27	<0.001
	Aspirin (%)	-29	-33	-25	<0.001
SG vs. Nonsurgical controls	Non-Insulin Diabetes medication (%)	-33	-43	-24	<0.001
	Insulin (%)	-6	-15	3	0.633
	ACE-I/ARB (%)	-19	-28	-9	<0.001
	Other antihypertensives (%)	-2	-11	6	>0.99
	Cholesterol-lowering (%)	-12	-21	-62	0.035
	Aspirin (%)	-41	-23	-5	0.008

*Two sample proportion test comparing group difference at year 5; pairwise testing with Bonferroni adjustment.

ACE-I/ARB: Angiotensin converting enzyme inhibitors and angiotensin-receptor blockers.

eTable 7. Cumulative incidence estimates (%) and 95% CI's for interventions at 1, 2, and 5 years after RYGB and SG

Intervention	Surgery	Years since metabolic surgery			P Value [^]
		1	2	5	
Total parenteral nutrition	RYGB	1.5 (0.9, 2.2)	1.5 (0.9, 2.2)	1.9 (1.1, 2.6)	0.20
	SG	1.1 (0.3, 1.9)	1.1 (0.3, 1.9)	1.1 (0.3, 1.9)	
Endoscopy	RYGB	28.8 (26.3, 31.3)	33.7 (31, 36.3)	45.8 (42.5, 48.9)	<0.001
	SG	15 (12.1, 17.7)	20.4 (16.8, 23.7)	35.6 (29.6, 41)	
Interventional radiology	RYGB	1.4 (0.7, 2)	1.8 (1, 2.5)	5 (3.5, 6.5)	0.12
	SG	2.6 (1.3, 3.9)	3.4 (1.8, 4.9)	6 (3.3, 8.6)	
Abdominal surgical procedure*	RYGB	6.7 (5.3, 8)	8 (6.5, 9.5)	10.8 (8.8, 12.7)	0.001
	SG	3.9 (2.4, 5.4)	4.7 (3, 6.4)	5.4 (3.4, 7.3)	
Abdominal wall hernia repair	RYGB	2.5 (1.6, 3.4)	4.6 (3.4, 5.9)	7.4 (5.7, 9.1)	0.21
	SG	3 (1.6, 4.5)	6.2 (4, 8.3)	8.3 (5.5, 11)	
Cholecystectomy	RYGB	1.4 (0.7, 2.1)	3.8 (2.6, 4.9)	7.5 (5.8, 9.3)	0.29
	SG	1.2 (0.3, 2.1)	3.4 (1.7, 5.1)	5.9 (3.1, 8.6)	

Cumulative incidence estimates (%) by the Kaplan-Meier method.

*Not including repair of abdominal wall hernia and cholecystectomy.

[^]Log-rank test p-values comparing RYGB vs SG at 5-years.