**Supplemental Table 1.** Bariatric Surgery by International Classification of Diseases (ICD) – 9 and 10 Procedure and Current Procedural Terminology (CPT) Codes

|  |  |
| --- | --- |
|  | **ICD-9-P, ICD-10-P and CPT Billing Codes** |
| **Vertical Sleeve Gastrectomy (VSG)** | ***ICD-9-P:*** 4382***ICD-10-P:*** 0DB60Z3, 0DB63Z3, 0DB64Z3, 0DB67Z3, 0DB68Z3***CPT:*** 43775 |
| **Roux-en-Y Gastric Bypass (RYGB)** | **ICD-9-P:** 4438**ICD-10-P:** 0D1647A, 0D164ZA, 0D168ZA**CPT:** 43644, 43846, 43847 |

**Supplemental Table 2.** Comorbidities by International Classification of Diseases (ICD) – 9 and 10 Diagnostic Codes

|  |  |
| --- | --- |
| **Comorbidities** | **ICD-9 and ICD-10 Billing Codes** |
| **BMI 35 to 39** | ICD-9: V8535, V8536, V8537, V8538, V8539ICD-10: Z6835, Z6836, Z6837, Z6838, Z6839 |
| **BMI >40** | ICD-9: V8540, V8541, V8542, V8543, 27801, V8544, V8545ICD-10: E6601, Z6841, Z6842, Z6843, Z6844, Z6845 |
| **Hypertension** | ICD-9: 4010, 4011, 4019, 40200, 40201, 40210, 40211, 40290, 40291, 40300, 40301, 40310, 40311, 40390, 40391, 40400, 40401, 40402, 40403, 40410, 40411, 40412, 40413, 40490, 40491, 40492, 40493, 40501, 40509, 40511, 40519, 40591, 40599, 4372, 64200, 64201, 64202, 64203, 64204, 64210, 64211, 64212, 64213, 64214, 64220, 64221, 64222, 64223, 64224, 64270, 64271, 64272, 64273, 64274, 64290, 64291, 64292, 64293, 64294ICD-10: G932, H40051, H40052, H40053, H40059, I10, I110, I119, I120, I129, I130, I1310, I1311, I132, I150, I151, I152, I158, I159, I270, I272, I2781, I674, K766, O10011, O10012, O10013, O10019, O1002, O1003, O10111, O10112, O10113, O10119, O1012, O1013, O10211, O10212, O10213, O10219, O1022, O1023, O10311, O10312, O10313, O10319, O1032, O1033, O10411, O10412, O10413, O10419, O1042, O1043, O10911, O10912, O10913, O10919, O1092, O1093, O111, O112, O113, O119 |
| **Coronary artery disease** | ICD-9: 4110, 4149ICD-10: I25, I259 |
| **Congestive heart failure** | ICD-9: 39891, 4280, 4281, 42820, 42821, 42822, 42823, 42830, 42831, 42832, 42833, 42840, 42841, 42842, 42843, 4289,ICD-10-: I150, I159 |
| **Diabetes mellitus, type II** | ICD-9: 25000, 25002, 25010, 25012, 25020, 25022, 25030, 25032, 25040, 25042, 25050, 25052, 25060, 25062, 25070, 25072, 25080, 25082, 25090, 25092ICD-10: E1100, E1101, E1121, E1122, E1129, E11311, E11319, E11321, E113211, E113212, E113213, E113219, E11329, E113291, E113292, E113293, E113299, E11331, E113311, E113312, E113313, E113319, E11339, E113391, E113392, E113393, E113399, E11341, E113411, E113412, E113413, E113419, E11349, E113491, E113492, E113493, E113499, E11351, E113511, E113512, E113513, E113519, E113521, E113522, E113523, E113529, E113531, E113532, E113533, E113539, E113541, E113542, E113543, E113549, E113551, E113552, E113553, E113559, E11359, E113591, E113592, E113593, E113599, E1136, E1137X1, E1137X2, E1137X3, E1137X9, E1139, E1140, E1141, E1142, E1143, E1144, E1149, E1151, E1152, E1159, E11610, E11618, E11620, E11621, E11622, E11628, E11630, E11638, E11641, E11649, E1165, E1169, E118, E119 |
| **Chronic kidney disease**  | ICD-9: 585, 5851, 5852, 5853, 5854, 5855, 5856, 5859, 7925ICD-10: N18, N189 |
| **Non-alcoholic fatty liver disease** | ICD-9: 5715ICD-10: K7581, K760 |
| **Osteoarthritis** | ICD-9: 71500, 71599ICD-10: M1911, M1993 |
| **Obstructive sleep apnea** | ICD-9: 32723ICD-10: G4733 |
| **Chronic obstructive pulmonary disease** | ICD-9: 490, 49699ICD-10: D-J44, DJ449 |
| **Smoking**  | ICD-9: 3051, V1582ICD-10: F17220, F17221, F17223, F17228, F17229, F17290, F17291, F17293, F17298, F17299, Z720 |

**Supplemental Table 3.** Cancer Type by International Classification of Diseases (ICD) – 9 and 10 Diagnostic Codes

|  |  |
| --- | --- |
| **Cancer** | **ICD-9 and ICD-10 Billing Codes** |
| **Breast cancer** | ICD-9: 217, 6108, 6109, 6110, V163, V840ICD-10: D241, N6089, N6099, N61, Z803, Z150 |
| **Colorectal cancer** | ICD-9: 2113, 2114, 20950, 20951, 20952, 20953, 20954, 20955, 20956, 20957ICD-10: D120, D121, D126, D127, D128, D129, D3A029, D3A020, D3A021, D3A022, D3A023, D3A024, D3A025, D3A026, K635 |
| **Esophageal adenocarcinoma** | ICD-9: 1505, 1502ICD-10: C155 |
| **Gallbladder cancer** | ICD-9: 1560, 1561, 1568ICD-10: C23, C240 |
| **Gastric cancer** | ICD-9: 1510, 1511, 1512, 1513, 1514, 1515, 1516, 1518, 1519, V1004ICD-10: Z85028, C49A2, C7A092, Z85020, C160, C161, C162, C163, C164, C165, C166, C168, C169 |
| **Liver cancer** | ICD-9: 1550, 1552, 1977, 20972, 2115, 2308, 2353, V1007ICD-10: C220, C222, C227, C228, C229, C787, C7B02, D134, D135, D015, D376, Z8505 |
| **Lung cancer** | ICD-9: 1623, 1624, 1625, 1628, 1629, 1630, 1631, 1638, 1639, 1764, 1970, 1972, 1984, 20961, 2123, 2312, 2357ICD-10: C3410, C342, C3430, C3480, C3490, C384, C4650, C7800, C782, C7932, D3A090, D1430, D0220, D381 |
| **Meningioma** | ICD-9: 1921ICD-10: C700 |
| **Multiple myeloma** | ICD-9: 20300, 20301, 20302ICD-10: C9000, C9001, C9002 |
| **Ovarian cancer** | ICD-9: V1043, 1830ICD-10: Z8543, C561, C562, C569 |
| **Pancreatic cancer** | ICD-9: 1570, 1571, 1572, 1573, 1574, 1578, 1579, 2116, 2117ICD-10: C250, C251, C252, C253, C254, C257, C258, C259, D136, D137 |
| **Prostate cancer** | ICD-9: 185, 2222, 2334, 2365, 6023, V1046, V1642, V7644, V8403ICD-10: C61, D291, D075, D400, N423, Z8546, Z8042, Z125, Z1503 |
| **Renal cancer** | ICD-9: 1890, 1891, 1980, 20924, 20964, 2230, 2231, 23691, 23699, 75315, V1052, V1053, V1651ICD-10: C649, C659, C7900, C7A093, D-D3A093, D3000, D3010, D4100, D4120, D418, Q614, Z85528, Z8553, Z8051 |
| **Thyroid cancer** | ICD-9: 193, 226ICD-10: C73, D34, Z85850 |
| **Uterine cancer** | ICD-9: V1042, 179, 1809, 1820, 1821, 1828ICD-10: Z8541, Z8542, C538, C539, C540, C541, C542, C543, C548, C549, C55 |

**Supplemental Table 4.** Total Unmatched Population Descriptive Characteristics of Bariatric Patients

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Total**n=572,371 | **Vertical Sleeve Gastrectomy (VSG)**n=17,115 | **Roux-en-Y Gastric Bypass (RYGB)**n=11,005 | **Bariatric Eligible No Surgery**n=544,251 | **p-value** |
| **Age** *n (%)* | <0.005 |
|  34 or less | 120,435 (21.0) | 4,258 (24.9) | 2,459 (22.3) | 113,718 (20.9) |
|  35 – 44  | 125,238 (21.9) | 5,186 (30.3) | 3,195 (29.0) | 116,857 (21.5) |
|  45 – 54 | 155,417 (27.2) | 4,749 (27.7) | 3,142 (28.6) | 147,526 (27.1) |
|  55 – 64 | 157,509 (27.5) | 2,771 (16.2) | 2,079 (18.9) | 152,659 (28.0) |
|  65 – 69 | 13,772 (2.4) | 151 (0.9) | 130 (1.2) | 13,491 (2.5) |
| **Gender** *n (%)* | <0.005 |
|  Female | 390,279 (68.2) | 13,546 (79.1) | 8,792 (79.9) | 367,941 (67.6) |
|  Male | 182,092 (31.8) | 3,569 (20.9) | 2,213 (20.1) | 176,310 (32.4) |
| **Comorbidities** *n (%)* |
|  Hypertension | 277,781 (48.5) | 9,288 (54.3) | 5,784 (52.6) | 262,709 (48.3) | <0.005 |
|  Coronary artery disease | 63,153 (11.0) | 1,618 (9.5) | 995 (9.0) | 60,540 (11.1) | <0.005 |
|  Congestive heart failure | 35,686 (6.2) | 646 (3.8) | 427 (3.9) | 34,613 (6.4) | <0.005 |
|  Diabetes mellitus, type II | 204,902 (35.8) | 6,419 (37.5) | 4,918 (44.7) | 193,565 (35.6) | <0.005 |
|  Chronic kidney disease  | 32,595 (5.7) | 585 (3.4) | 395 (3.6) | 31,615 (5.8) | <0.005 |
|  Non-alcoholic fatty liver disease | 17,558 (3.1) | 1,098 (6.4) | 550 (5.0) | 15,910 (2.9) | <0.005 |
|  Osteoarthritis | 145,886 (25.5) | 5,272 (30.8) | 3,518 (32.0) | 137,096 (25.2) | <0.005 |
|  Obstructive sleep apnea | 135,540 (23.7) | 7,414 (43.3) | 4,430 (40.3) | 123,696 (22.7) | <0.005 |
|  Chronic obstructive pulmonary disease | 135,707 (23.7) | 4,084 (23.9) | 2,520 (22.9) | 129,103 (23.7) | 0.1187 |
|  Smoking  | 109,990 (19.2) | 2,835 (16.6) | 1,791 (16.3) | 105,364 (19.4) | <0.005 |
| **5-Year Cancer Outcome** *n (%)* |
|  Any cancer type  | 29,365 (5.1) | 642 (3.8) | 454 (4.1) | 28,269 (5.2) | 0.002 |
|  Breast cancer | 9,013 (1.6) | 227 (1.3) | 167 (1.5) | 8,619 (1.6) | 0.009 |
|  Colorectal cancer | 4,438 (0.8) | 83 (0.5) | 33 (0.3) | 4,322 (0.8) | 0.002 |
|  Esophageal adenocarcinoma | 192 (0.0) | 0 (0.0) | 3 (0.0) | 189 (0.0) | 0.016 |
|  Gallbladder cancer | 176 (0.0) | 1 (0.0) | 1 (0.0) | 174 (0.0) | 0.022 |
|  Gastric cancer | 675 (0.1) | 31 (0.2) | 11 (0.1) | 633 (0.1) | 0.015 |
|  Liver cancer | 2,218 (0.4) | 24 (0.1) | 21 (0.2) | 2,173 (0.4) | 0.002 |
|  Lung cancer | 3,514 (0.6) | 43 (0.3) | 33 (0.3) | 3,438 (0.6) | 0.002 |
|  Meningioma | 52 (0.0) | 1 (0.0) | 1 (0.0) | 50 (0.0) | 0.301 |
|  Multiple Myeloma | 714 (0.1) | 14 (0.1) | 7 (0.1) | 693 (0.1) | 0.016 |
|  Ovarian cancer | 1,641 (0.3) | 35 (0.2) | 21(0.2) | 1,585 (0.3) | 0.006 |
|  Pancreatic cancer | 724 (0.1) | 7 (0.0) | 9 (0.1) | 708 (0.1) | 0.001 |
|  Prostate cancer | 2,388 (0.4) | 42 (0.2) | 36 (0.3) | 2,310 (0.4) | 0.002 |
|  Renal cancer | 2,183 (0.4) | 50 (0.3) | 35 (0.3) | 2,098 (0.4) | 0.026 |
|  Thyroid cancer | 2,463 (0.4) | 83 (0.5) | 60 (0.5) | 2,320 (0.4) | 0.030 |
|  Uterine cancer | 4,702 (0.8) | 92 (0.5) | 71 (0.6) | 4,539 (0.8) | 0.002 |

**Supplemental Table 5.** Demographics of Patients included in Mariner 15

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | **Total Patients**  | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** |
| **Total** |  14,811,235  |  9,873,293  |  10,547,678  |  10,827,706  |  11,158,039  |  11,304,111  |  11,299,825  |  11,179,859  |  11,010,096  |  9,204,604  |
|   |  |  |  |  |  |  |  |  |  |   |
| **Age Categories** |
| *00-12mo* |  1,022,104  |  159,030  |  152,950  |  152,632  |  144,362  |  132,248  |  114,782  |  94,757  |  65,120  |  6,223  |
| *01 year (s)* |  1,451,654  |  195,927  |  202,200  |  194,845  |  191,314  |  177,985  |  161,671  |  140,381  |  118,337  |  68,994  |
| *02-04 year (s)* |  1,946,105  |  433,327  |  507,123  |  545,364  |  563,258  |  546,176  |  520,743  |  480,671  |  434,624  |  312,217  |
| *05-09 year (s)* |  2,045,450  |  478,794  |  544,340  |  596,911  |  668,828  |  728,599  |  781,445  |  802,275  |  803,737  |  605,299  |
| *10-14 year (s)* |  1,567,583  |  431,102  |  458,315  |  466,910  |  485,096  |  495,264  |  510,933  |  530,642  |  563,650  |  455,197  |
| *15-19 year (s)* |  1,471,604  |  456,463  |  488,371  |  498,188  |  510,486  |  510,791  |  509,382  |  499,877  |  492,329  |  384,112  |
| *20-24 year (s)* |  1,453,973  |  394,592  |  442,171  |  461,665  |  480,275  |  494,942  |  497,494  |  493,933  |  482,742  |  370,885  |
| *25-29 year (s)* |  1,514,049  |  433,012  |  463,680  |  471,160  |  486,562  |  499,220  |  503,152  |  500,803  |  490,133  |  384,126  |
| *30-34 year (s)* |  1,604,616  |  494,773  |  529,533  |  540,077  |  551,268  |  554,281  |  545,899  |  532,723  |  511,130  |  406,432  |
| *35-39 year (s)* |  1,711,920  |  538,098  |  553,171  |  558,684  |  572,119  |  581,774  |  587,820  |  585,107  |  572,689  |  465,096  |
| *40-44 year (s)* |  1,859,609  |  622,205  |  655,306  |  656,969  |  660,240  |  653,001  |  627,843  |  604,771  |  589,424  |  490,767  |
| *45-49 year (s)* |  2,098,403  |  721,337  |  738,276  |  727,914  |  725,435  |  719,962  |  717,744  |  710,043  |  691,363  |  576,543  |
| *50-54 year (s)* |  2,303,361  |  779,865  |  817,501  |  824,151  |  839,156  |  843,361  |  825,475  |  796,935  |  764,739  |  645,523  |
| *55-59 year (s)* |  2,380,524  |  758,232  |  805,003  |  826,567  |  851,717  |  866,842  |  868,884  |  862,780  |  850,783  |  746,745  |
| *60-64 year (s)* |  2,268,278  |  715,480  |  755,909  |  763,765  |  788,742  |  810,603  |  821,977  |  830,203  |  835,625  |  755,166  |
| *65-69 year (s)* |  2,026,003  |  604,442  |  655,682  |  693,975  |  723,679  |  747,996  |  766,772  |  767,155  |  759,879  |  693,429  |
|   |  |  |  |  |  |  |  |  |  |   |
| **Genders** |
| *Female* |  8,408,833  |  5,789,409  |  6,157,760  |  6,313,139  |  6,486,537  |  6,561,466  |  6,547,819  |  6,471,535  |  6,363,701  |  5,390,296  |
| *Male* |  6,400,917  |  4,083,884  |  4,389,918  |  4,514,567  |  4,671,502  |  4,742,645  |  4,752,006  |  4,708,306  |  4,645,353  |  3,813,387  |
| *Unknown* |  1,485  |  -  |  -  |  -  |  -  |  -  |  -  |  18  |  1,042  |  921  |
|   |  |  |  |  |  |  |  |  |  |   |
| **Plan Types** |
| *CASH* |  8,872,321  |  2,203,764  |  2,426,009  |  2,520,340  |  3,257,422  |  3,322,523  |  3,011,342  |  2,826,824  |  2,668,843  |  1,575,586  |
| *COMMERCIAL* |  13,683,844  |  6,569,644  |  7,133,182  |  7,425,831  |  7,724,535  |  8,004,727  |  7,952,783  |  7,710,924  |  7,359,734  |  5,206,363  |
| *EMPLOYER GROUP* |  2,433,245  |  608,625  |  742,892  |  785,712  |  980,646  |  1,133,691  |  1,086,620  |  1,091,634  |  1,136,036  |  952,895  |
| *GOVERNMENT* |  939,749  |  112,652  |  154,493  |  266,751  |  283,530  |  282,450  |  274,693  |  266,605  |  253,817  |  134,982  |
| *MEDICAID* |  5,477,947  |  1,587,014  |  1,882,086  |  2,118,930  |  2,250,540  |  2,670,782  |  2,834,993  |  2,866,586  |  2,822,290  |  2,019,503  |
| *MEDICARE* |  4,743,972  |  2,125,666  |  2,366,605  |  2,587,000  |  2,770,691  |  2,776,146  |  2,806,039  |  2,805,411  |  2,822,502  |  2,379,347  |
| *PBM* |  7,683,157  |  2,740,254  |  3,372,896  |  3,492,893  |  3,330,558  |  2,537,913  |  2,357,141  |  2,474,770  |  2,472,705  |  1,899,707  |
| *PROCESSORS* |  1,760,274  |  384,503  |  433,144  |  434,902  |  493,366  |  284,025  |  266,926  |  291,103  |  340,954  |  174,884  |
| *TPA* |  168,171  |  30,337  |  32,144  |  32,453  |  33,916  |  31,550  |  34,725  |  48,769  |  49,503  |  35,114  |
| *UNKNOWN* |  14,799,551  |  8,095,957  |  8,682,185  |  8,944,476  |  9,256,354  |  9,521,433  |  9,436,762  |  9,092,625  |  8,668,428  |  6,049,164  |
| *UNSPECIFIED* |  6,592,147  |  2,217,704  |  2,709,507  |  2,775,811  |  2,728,370  |  2,916,911  |  2,843,765  |  2,752,415  |  2,634,027  |  1,584,255  |
| *WORKERS COMPENSATION* |  158,987  |  32,055  |  37,205  |  37,784  |  33,088  |  30,262  |  23,758  |  21,337  |  21,805  |  13,212  |
|   |  |  |  |  |  |  |  |  |  |   |
| **Regions** |
| *MW* |  3,181,709  |  2,212,539  |  2,356,786  |  2,403,748  |  2,471,948  |  2,496,015  |  2,503,962  |  2,487,875  |  2,447,642  |  2,060,698  |
| *NE* |  3,084,777  |  2,144,423  |  2,269,140  |  2,321,864  |  2,375,434  |  2,398,593  |  2,388,720  |  2,358,408  |  2,312,369  |  1,937,304  |
| *SO* |  6,065,155  |  3,983,239  |  4,283,343  |  4,423,693  |  4,575,793  |  4,639,317  |  4,644,049  |  4,584,003  |  4,509,882  |  3,784,740  |
| *UNKNOWN* |  77,557  |  26,570  |  28,838  |  29,702  |  31,393  |  31,813  |  30,638  |  30,093  |  49,187  |  45,828  |
| *WE* |  2,402,037  |  1,506,522  |  1,609,571  |  1,648,699  |  1,703,471  |  1,738,373  |  1,732,456  |  1,719,480  |  1,691,016  |  1,376,034  |