**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, V8539  ICD-10: Z6835, Z6836, Z6837, Z6838, Z6839 |
| **BMI >40** | ICD-9: V8540, V8541, V8542, V8543, 27801, V8544, V8545  ICD-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, 64294  ICD-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, 4149  ICD-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, 25092  ICD-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, 7925  ICD-10: N18, N189 |
| **Non-alcoholic fatty liver disease** | ICD-9: 5715  ICD-10: K7581, K760 |
| **Osteoarthritis** | ICD-9: 71500, 71599  ICD-10: M1911, M1993 |
| **Obstructive sleep apnea** | ICD-9: 32723  ICD-10: G4733 |
| **Chronic obstructive pulmonary disease** | ICD-9: 490, 49699  ICD-10: D-J44, DJ449 |
| **Smoking** | ICD-9: 3051, V1582  ICD-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, V840  ICD-10: D241, N6089, N6099, N61, Z803, Z150 |
| **Colorectal cancer** | ICD-9: 2113, 2114, 20950, 20951, 20952, 20953, 20954, 20955, 20956, 20957  ICD-10: D120, D121, D126, D127, D128, D129, D3A029, D3A020, D3A021, D3A022, D3A023, D3A024, D3A025, D3A026, K635 |
| **Esophageal adenocarcinoma** | ICD-9: 1505, 1502  ICD-10: C155 |
| **Gallbladder cancer** | ICD-9: 1560, 1561, 1568  ICD-10: C23, C240 |
| **Gastric cancer** | ICD-9: 1510, 1511, 1512, 1513, 1514, 1515, 1516, 1518, 1519, V1004  ICD-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, V1007  ICD-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, 2357  ICD-10: C3410, C342, C3430, C3480, C3490, C384, C4650, C7800, C782, C7932, D3A090, D1430, D0220, D381 |
| **Meningioma** | ICD-9: 1921  ICD-10: C700 |
| **Multiple myeloma** | ICD-9: 20300, 20301, 20302  ICD-10: C9000, C9001, C9002 |
| **Ovarian cancer** | ICD-9: V1043, 1830  ICD-10: Z8543, C561, C562, C569 |
| **Pancreatic cancer** | ICD-9: 1570, 1571, 1572, 1573, 1574, 1578, 1579, 2116, 2117  ICD-10: C250, C251, C252, C253, C254, C257, C258, C259, D136, D137 |
| **Prostate cancer** | ICD-9: 185, 2222, 2334, 2365, 6023, V1046, V1642, V7644, V8403  ICD-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, V1651  ICD-10: C649, C659, C7900, C7A093, D-D3A093, D3000, D3010, D4100, D4120, D418, Q614, Z85528, Z8553, Z8051 |
| **Thyroid cancer** | ICD-9: 193, 226  ICD-10: C73, D34, Z85850 |
| **Uterine cancer** | ICD-9: V1042, 179, 1809, 1820, 1821, 1828  ICD-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 |