### Supplementary Online Content

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**eReferences**

This supplementary material has been provided by the authors to give readers additional information about their work.

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### eTable 1. Centers for Disease Control and Prevention (CDC)–Defined Severe Maternal Morbidities (SMMs)

| Perioperative outcomes                              | Codes                                                                 |
|-----------------------------------------------------|------------------------------------------------------------------------|
| Acute myocardial infarction                         | I220, I221, I222, I228, I229, I2101, I2102, I2109, I2111, I2119, I2121, I2129, I213, I214, I219, I21A1, I21A9 |
| Aneurysm                                            | I711, I712, I713, I714, I715, I716, I718, I719, I790, I7100, I7101, I7102, I7103 |
| Acute renal failure                                 | N170, N171, N172, N178, N179, O904                                     |
| Adult respiratory distress syndrome                 | J80, J951, J952, J953, R092, J9600, J9601, J9602, J9620, J9621, J9622, J95821, J95822 |
| Amniotic fluid embolism                             | O8812, O8813, O88111, O88112, O88113                                  |
| Cardiac arrest/ventricular fibrillation             | I462, I468, I469, I4901, I4902                                       |
| Conversion of cardiac rhythm                        | 5A2204Z, 5A12012                                                    |
| Disseminated intravascular coagulation              | D65, D688, D689, O723                                                |
| Eclampsia                                           | O151, O152, O159, O1500, O1502, O1503                                |
| Heart failure/arrest during surgery or procedure    | I97120, I97121, I97130, I97131, I97710, I97711                        |
| Puerperal cerebrovascular disorders                 | I600, I601, I602, I603, I604, I605, I606, I607, I608, I609, I611, I612, I613, I614, I615, I616, I617, I618, I619, I620, I621, I629, I630, I631, I632, I633, I634, I635, I636, I638, I639, I650, I651, I652, I655, I658, I659, I660, I661, I662, I668, I669, I670, I671, I672, I673, I674, I675, I676, I677, I678, I679, I680, I682, I688, O873, O2251, O2252, O2253, I97800, I97811, I97820, I97821 |
| Pulmonary edema and Acute heart failure             | J810, I501, I509, I5020, I5021, I5023, I5030, I5031, I5033, I5040, I5041, I5043 |
| Severe anesthesia complications                     | O740, O741, O742, O743, O819, O892, O8901, O8909                      |
| Sepsis                                              | O85, A327, A400, A401, A403, A408, A409, A419, A4101, A4102, A411, A412, A413, A414, A4150, A4151, A4152, A4153, A4159, A4181, A4189, O8604, R6520, T8144, T80211A, T814XXA, T8144XA, T8144XD, T8144XS |
| Shock                                               | O751, R570, R571, R578, R579, R6521, T782XXA, T882XXA, T886XXA, T8110XA, T8111XA, T8119XA |
| Sickle cell disease with crisis                     | D5700, D5701, D5702, D5721, D57212, D57215, D57411, D57412, D57419, D57811, D57812, D57819 |

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| Perioperative outcomes                  | Codes                                                                 |
|----------------------------------------|----------------------------------------------------------------------|
| Air and thrombotic embolism            | I2601, I2602, I2609, I2690, I2692, I2699, 08802, 08803, O8822, O8823, O8832, O8833, O8881, O8882, O8883, O88111, O88112, O88113, O88114, O88115, O88116, O88117, O88118, O88119, O88211, O88212, O88213, O88214, O88215, O88216, O88217, O88218, O88219, O88311, O88312, O88313, O88314, O88315, O88316, O88317, O88318, O88319 |
| Blood products transfusion             | 30233H1, 30233L1, 30233K1, 30233M1, 30233N1, 30233P1, 30233R1, 30233T1, 30233H0, 30233L0, 30233K0, 30233M0, 30233N0, 30233P0, 30233R0, 30233T0, 30230H1, 30230L1, 30230K1, 30230M1, 30230N1, 30230P1, 30230R1, 30230T1, 30230H0, 30230L0, 30230K0, 30230M0, 30230N0, 30230P0, 30230R0, 30230T0, 30240H1, 30240L1, 30240K1, 30240M1, 30240N1, 30240P1, 30240R1, 30240T1, 30240H0, 30240L0, 30240K0, 30240M0, 30240N0, 30240P0, 30240R0, 30240T0, 30243H1, 30243L1, 30243K1, 30243M1, 30243N1, 30243P1, 30243R1, 30243T1, 30243H0, 30243L0, 30243K0, 30243M0, 30243N0, 30243P0, 30243R0, 30243T0, 30250H1, 30250L1, 30250K1, 30250M1, 30250N1, 30250P1, 30250R1, 30250T1, 30250H0, 30250L0, 30250K0, 30250M0, 30250N0, 30250P0, 30250R0, 30250T0, 30253H1, 30253L1, 30253K1, 30253M1, 30253N1, 30253P1, 30253R1, 30253T1, 30253H0, 30253L0, 30253K0, 30253M0, 30253N0, 30253P0, 30253R0, 30253T0, 30260H1, 30260L1, 30260K1, 30260M1, 30260N1, 30260P1, 30260R1, 30260T1, 30260H0, 30260L0, 30260K0, 30260M0, 30260N0, 30260P0, 30260R0, 30260T0, 30263H1, 30263L1, 30263K1, 30263M1, 30263N1, 30263P1, 30263R1, 30263T1, 30263H0, 30263L0, 30263K0, 30263M0, 30263N0, 30263P0, 30263R0, 30263T0 |
| Hysterectomy                           | 0UT90ZZ, 0UT94ZZ, 0UT97ZZ, 0UT98ZZ, 0UT9FZZ                          |
| Temporary tracheostomy                | 0B110Z4, 0B110F4, 0B113Z4, 0B113F4, 0B114Z4, 0B114F4                  |
| Ventilation                            | 5A1935Z, 5A1945Z, 5A1955Z                                             |
**eTable 2. Previous Study–Defined Surgical Morbidities (SMs)**

| Peripartum outcomes                                      | Codes                                                                 |
|-----------------------------------------------------------|----------------------------------------------------------------------|
| Hemorrhage (antepartum, intrapartum, postpartum)         | O46, O72, O67, O441, O443, O445, R58                                  |
| Chorioamnionitis or Endometritis                         | O411, O8612                                                          |
| Disseminated intravascular coagulopathy or other coagulopathy | D65, D684, D688, D689, R791, O723, O670, O4502, O4602                 |
| Systemic inflammatory syndrome or sepsis                  | A40, A41, O85, A021, A227, A267, A327, A427, B377, R651, R652, O0337, O0387, O0487, B377, R651, R652, O0337, O0387, O0487, O0737, O0882, O8604, T8144 |
| Hypotension                                               | I95, O265                                                            |
| Shock                                                     | R57, T882, T811, O751, T794, R6521, O2650, O0331, O0381, O0481, O0731 |
| Pelvic hematoma                                           | O717                                                                |
| Maternal distress                                        | O750                                                                |
| Anesthesia complications                                  | O29, O74, O89, T41, T882, T883, T885                                 |
| Myocardial infarction                                     | I21, I22, I23, I252, I9771                                          |
| Respiratory failure                                       | J96, R092, J9582                                                     |
| Pulmonary edema                                           | J81, J681                                                           |
| Prolonged intubation                                      | Z991                                                                |
| Pneumonia                                                 | J12, J13, J14, J15, J16, J17, J18, B012, B052, J100, J110, J842, J851, A0103, A0222, A3711, A3781, A3791, A5484, B0681, B7781, J09X1, J8281, J8282, J8411, J95851 |
| Amniotic fluid embolism                                   | O881                                                                |
| Venous thromboembolism or pulmonary embolism              | I26, I81, I82, O032, O047, O082, O223, O882, O883, O888, I2724, I2782 |
| Arterial embolism                                         | I74, I75, I76                                                       |
| Cerebrovascular disease or stroke                         | I60, I61, I62, I63, I65, I66, I67, I68, I69 G45, G46, O873, I978    |
| Acute kidney injury                                       | N17, N19, N990, O904                                                 |
| Pyelonephritis                                            | N10, N11, O230, O862, N137, A0225, D8684                             |
| Wound complications or abscess                            | L76, L02, L03, O860, O900, O902, T813, T814, N151, K681, K651        |
| Urinary tract injury                                      | S371, S372, N997, N9981                                              |

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**eTable 3. ICD-10 Codes for Specific Outcomes and Procedures**

| Specific outcomes                                                                 | Codes                                                                 |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------|
| Hemorrhage (antepartum, intrapartum and postpartum)                              | O46, O72, O67, O441, O443, O445, R58                                |
| Blood products transfusion                                                         | 30233H1, 30233L1, 30233K1, 30233M1, 30233N1, 30233P1, 30233R1, 30233T1, 30233H0, 30233L0, 30233K0, 30233M0, 30233N0, 30233P0, 30233R0, 30233T0, 30233H1, 30233L1, 30233K1, 30233M1, 30233N1, 30233P1, 30233R1, 30233T1, 30233H0, 30233L0, 30233K0, 30233M0, 30233N0, 30233P0, 30233R0, 30233T0, 30240H1, 30240L1, 30240K1, 30240M1, 30240N1, 30240P1, 30240R1, 30240T1, 30240H0, 30240L0, 30240K0, 30240M0, 30240N0, 30240P0, 30240R0, 30240T0, 30243H1, 30243L1, 30243K1, 30243M1, 30243N1, 30243P1, 30243R1, 30243T1, 30243H0, 30243L0, 30243K0, 30243M0, 30243N0, 30243P0, 30243R0, 30243T0, 30250H1, 30250L1, 30250K1, 30250M1, 30250N1, 30250P1, 30250R1, 30250T1, 30250H0, 30250L0, 30250K0, 30250M0, 30250N0, 30250P0, 30250R0, 30250T0, 30253H1, 30253L1, 30253K1, 30253M1, 30253N1, 30253P1, 30253R1, 30253T1, 30253H0, 30253L0, 30253K0, 30253M0, 30253N0, 30253P0, 30253R0, 30253T0, 30260H1, 30260L1, 30260K1, 30260M1, 30260N1, 30260P1, 30260R1, 30260T1, 30260H0, 30260L0, 30260K0, 30260M0, 30260N0, 30260P0, 30260R0, 30260T0, 30263H1, 30263L1, 30263K1, 30263M1, 30263N1, 30263P1, 30263R1, 30263T1, 30263H0, 30263L0, 30263K0, 30263M0, 30263N0, 30263P0, 30263R0, 30263T0 |
| Shock                                                                             | R57, T882, T811, O751, T794, R6521, O2650, O0331, O0381, O0481, O0731 |
| Acute kidney injury                                                               | N17, N19, N990, O904                                                |
| Disseminated intravascular coagulation or other coagulopathy                     | D65, D684, D688, D689, R791, O723, O670, O4502, O4602               |
| Urinary tract injury                                                              | S371, S372, N997, N9981                                            |
| **Surgical procedure use**                                                        |                                                                     |
| Cesarean section                                                                  | O82                                                                 |
| Hysterectomy                                                                      | 0UB9, 0UT9, 0UT90ZL, 0UT97ZL, 0UT98ZL, 0UT9FZL                       |
| Oophorectomy                                                                       | 0UB0, 0UB1, 0UB2, 0UT0, 0UT1, 0UT2                                  |
| Cystoscopy                                                                        | 0TJB7ZZ, 0TJB8ZZ, 0T768DZ, 0T778DZ, 0T788DZ                        |
| Urinary system repair & cystectomy                                                 | 0TQB0ZZ, 0TQB7ZZ, 0TBB0ZZ, 0TTB0ZZ                                  |
| Intra-arterial balloon occlusion                                                   | 04LE3DT, 04LE3DZ, 04LE3ZT, 04LE3ZZ, 04LF3DU, 04LF3DZ, 04LF3ZU, 04LF3ZZ, 04LC3DZ, 04LC3ZZ, 04LD3DZ, 04LD3ZZ, 04L03DJ, 04L03DZ, 04L03ZZ |
eTable 4. *ICD-10* Codes for Placenta Accreta Spectrum (PAS) Disorders and Placenta Previa (PP)

| ICD-10   | Description                                              |
|----------|----------------------------------------------------------|
| **ICD-10 codes for placenta accrete spectrum** |                                                          |
| O43211   | Placenta accreta, first trimester                         |
| O43212   | Placenta accreta, second trimester                        |
| O43213   | Placenta accreta, third trimester                         |
| O43219   | Placenta accreta, unspecified trimester                   |
| O43221   | Placenta increta, first trimester                         |
| O43222   | Placenta increta, second trimester                        |
| O43223   | Placenta increta, third trimester                         |
| O43229   | Placenta increta, unspecified trimester                   |
| O43231   | Placenta percreta, first trimester                        |
| O43232   | Placenta percreta, second trimester                       |
| O43233   | Placenta percreta, third trimester                        |
| O43239   | Placenta percreta, unspecified trimester                  |
| **ICD-10 codes for placenta previa**              |                                                          |
| O4400    | Complete placenta previa NOS or without hemorrhage, unspecified trimester |
| O4401    | Complete placenta previa NOS or without hemorrhage, first trimester |
| O4402    | Complete placenta previa NOS or without hemorrhage, second trimester |
| O4403    | Complete placenta previa NOS or without hemorrhage, third trimester |
| O4410    | Complete placenta previa with hemorrhage, unspecified trimester |
| O4411    | Complete placenta previa with hemorrhage, first trimester |
| O4412    | Complete placenta previa with hemorrhage, second trimester |
| O4413    | Complete placenta previa with hemorrhage, third trimester |
| O4420    | Partial placenta previa NOS or without hemorrhage, unspecified trimester |
| O4421    | Partial placenta previa NOS or without hemorrhage, first trimester |
| O4422    | Partial placenta previa NOS or without hemorrhage, second trimester |
| O4423    | Partial placenta previa NOS or without hemorrhage, third trimester |
| O4430    | Partial placenta previa with hemorrhage, unspecified trimester |
| O4431    | Partial placenta previa with hemorrhage, first trimester |
| O4432    | Partial placenta previa with hemorrhage, second trimester |
| O4433    | Partial placenta previa with hemorrhage, third trimester |
| O4440    | Low lying placenta NOS or without hemorrhage, unspecified trimester |
| O4441    | Low lying placenta NOS or without hemorrhage, first trimester |
| O4442    | Low lying placenta NOS or without hemorrhage, second trimester |
| O4443    | Low lying placenta NOS or without hemorrhage, third trimester |
| O4450    | Low lying placenta with hemorrhage, unspecified trimester |
| O4451    | Low lying placenta with hemorrhage, first trimester        |
| O4452    | Low lying placenta with hemorrhage, second trimester       |
| O4453    | Low lying placenta with hemorrhage, third trimester        |
**eTable 5. Demographic Characteristics and ICD-10 Codes for Patients With Placenta Accreta Spectrum (PAS) Disorders**

| Variables                              | ICD-10 codes |
|----------------------------------------|--------------|
| **Pregnancy history**                  |              |
| Grand multiparity                      | O094, Z641   |
| Previous cesarean section              | O3421, O3422, O6641 |
| **Current pregnancy status**           |              |
| Assisted reproductive technology       | O0981        |
| Obesity                                | E660, E661, E662, E668, E669, Z683, Z684, O9921, E662, Z684, E6601 |
| Tobacco use                            | F1721, F1722, F1729, O9933, T6522 |
| PAS type                               |              |
| Accreta                                | O4321        |
| Invasive PAS                            | O4322, O4323 |
| Increta                                | O4322        |
| Percreta                               | O4323        |
| **Gestation weeks**                    |              |
| <27 weeks                              | Z3A26, Z3A25, Z3A24, Z3A23, Z3A22, Z3A21, Z3A20, Z3A19, Z3A18, Z3A17, Z3A16, Z3A15, Z3A14, Z3A13, Z3A12, Z3A11, Z3A10, Z3A9, Z3A8, Z3A7 |
| 28-31 weeks                            | Z3A31, Z3A31, Z3A30, Z3A29, Z3A28, Z3A27 |
| 32-33 weeks                            | Z3A32, Z3A33 |
| 34-36 weeks                            | Z3A34, Z3A35, Z3A36 |
| >36 weeks                              | Z3A37, Z3A38, Z3A39, Z3A40, Z3A41, Z3A42, Z3A49 |
| **Pregnancy complications**            |              |
| Preterm birth                          | Defined as <37 gestation weeks |
| Multiple gestation                     | O30, O31, O632, O661, Z372, Z373, Z374, Z375, Z376, O4302 |
| Gestational diabetes mellitus          | O11, O244    |
| Hypertensive disorder of pregnancy     | O14          |
| Breech presentation                    | O321, O641   |
| Preterm premature rupture of membrane  | O4201, O4211, O4291 |
| Fetal growth restriction               | O365, Z364   |
eTable 6. *ICD-10-CM* Codes in Elixhauser and Charlson Comorbidity Indices

| Elixhauser comorbidity index | ICD-10 codes |
|------------------------------|--------------|
| Congestive heart failure     | I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5-I42.9, I43, I50, P29.0 |
| Cardiac arrhythmias          | I44.1-I44.3, I45.6, I45.9, I47-I49, R00.0, R00.1, R00.8, T82.1, Z45.0, Z95.0 |
| Valvular disease             | A52.0, I05-I08, I09.1, I09.8, I34-I39, Q23.0- Q23.3, Z95.2-Z95.4 |
| Pulmonary circulation disorders | I26, I27, I28.0, I28.8, I28.9 |
| Peripheral vascular disease  | I70, I71, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9 |
| Hypertension, uncomplicated  | I10 |
| Hypertension, complicated    | I11-I13, I15 |
| Paraplegia                   | G04.1, G11.4, G80.1, G80.2, G81, G82, G83.0-G83.4, G83.9 |
| Other neurological disorders | G10-G13, G20-G22, G25.4, G25.5, G31.2, G31.8, G31.9, G32, G35-G37, G40, G41, G93.1, G93.4, R47.0, R56 |
| Chronic pulmonary disease    | I27.8, I27.9, J40-J47, J60-J67, J68.4, J70.1, J70.3 |
| Diabetes without chronic complication | E10.0, E10.1, E10.9, E11.0, E11.1, E11.9, E12.0, E12.1, E12.9, E13.0, E13.1, E13.9, E14.0, E14.1, E14.9 |
| Diabetes with chronic complication | E10.2-E10.8, E11.2-E11.8, E12.2-E12.8, E13.2-E13.8, E14.2- E14.8 |
| Hypothyroidism               | E00-E03, E89.0 |
| Renal failure                | I12.0, I13.1, N18, N19, N25.0, Z49.0- Z49.2, Z94.0, Z99.2 |
| Liver disease                | B18, I85, I86.4, I98.2, K70, K71.1, K71.3-K71.5, K71.7, K72-K74, K76.0, K76.2-K76.9, Z94.4 |
| Peptic ulcer disease, excluding bleeding | K25.7, K25.9, K26.7, K26.9, K27.7, K27.9, K28.7, K28.9 |
| AIDS/HIV                     | B20-B22, B24 |
| Lymphoma                     | C81-C85, C88, C96, C90.0, C90.2 |
| Metastatic cancer            | C77-C80 |
| Solid tumor without metastasis | C00-C26, C30- C34, C37-C41, C43, C45-C58, C60-C76, C97 |
| Rheumatoid arthritis/collagen vascular diseases | L94.0, L94.1, L94.3, M05, M06, M08, M12.0, M12.3, M30, M31.0-M31.3, M32-M35 |
| Coagulopathy                 | D65-D68, D69.1, D69.3-D69.6 |
| Obesity                      | E66 |
| Weight loss                  | E40-E46, R63.4, R64 |
| Fluid and electrolyte disorders | E22.2, E86, E87 |
| Blood loss anemia            | D50.0 |
| Elixhauser comorbidity index | ICD-10 codes |
|-------------------------------|--------------|
| Deficiency anemia             | D50.8, D50.9, D51-D53 |
| Alcohol abuse                 | F10, E52, G62.1, I42.6, K29.2, K70.0, K70.3, K70.9, T51, Z50.2, Z71.4, Z72.1 |
| Drug abuse                    | F11-F16, F18, F19, Z71.5, Z72.2 |
| Psychoses                     | F20, F22-F25, F28, F29, F30.2, F31.2, F31.5 |
| Depression                    | F20.4, F31.3-F31.5, F32, F33, F34.1, F41.2, F43.2 |

| Charlson comorbidity index  | ICD-10 codes |
|------------------------------|--------------|
| Myocardial infarction        | I21, I22, I25.2 |
| Congestive heart failure     | I09.9, I11.0, I13.0, I13.2, I25.2, I42.0, I42.5-I42.9, I43, I50, P29.0 |
| Peripheral vascular disease  | I70, I71, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, K95.9 |
| Cerebrovascular disease      | G45, G46, H34.0, I60-169 |
| Dementia                     | F00-F03, F05.1, G30, G31.1 |
| Chronic pulmonary disease    | I27.8, I27.9, J40-J47, J60-J67, J68.4, J70.1, J70.3 |
| Rheumatic disease            | M05, M06, M31.5, M32-M34, M35.1, M35.3, M36.0 |
| Peptic ulcer disease         | K25-K28 |
| Mild liver disease           | B18, K70.0-K70.3, K70.9, K71.3-K71.5, K71.7, K73, K74, K76.0, K76.2-K76.4, K76.8, K76.9, Z94.4 |
| Diabetes without chronic complication | E10.0, E10.1, E10.6, E10.8-E11.1, E11.6, E11.8-E12.1, E12.6, E12.8-E13.1, E13.6, E13.8-E14.1, E14.6, E14.8, E14.9 |
| Diabetes with chronic complication | E10.2-E10.5, E10.7, E11.2-E11.5, E11.7, E12.2-E12.5, E12.7, E13.2-E13.5, E13.7, E14.2-E14.5, E14.7 |
| Hemiplegia or paraplegia     | G04.1, G11.4, G80.2, G81, G82, G83.0-G83.4, G83.9 |
| Renal disease                | I12.0, I13.1, N03.2-N03.7, N05.2-N05.7, N18, N19, N25.0, Z49.0-Z49.2, Z94.0, Z99.2 |
| Any malignancy, including lymphoma and leukemia, except malignant neoplasm of skin | C00-C26, C30-C34, C37-C41, C43, C45-C58, C60-C76, C81- C85, C88, C90-C97 |
| Moderate or severe liver disease | I85.0, I85.9, I86.4, I98.2, K70.4, K71.1, K72.1, K72.9, K76.5, K76.6, K76.7 |
| Metastatic solid tumor       | C77-C80 |
| AIDS/HIV                     | B20-B22, B24 |
| Comorbidity Diagnosis Group                                      | ICD-10 codes                                                                 |
|----------------------------------------------------------------|--------------------------------------------------------------------------------|
| Gestational diabetes mellitus                                  | O24.4                                                                          |
| HIV/AIDS                                                       | O98.7, B20                                                                     |
| Preexisting diabetes mellitus                                  | E08-E13, O24.0, O24.1, O24.3, O24.8, O24.9, Z79.4                            |
| Previous cesarean birth                                        | O34.21                                                                        |
| Pulmonary hypertension                                         | I27.0, I27.2                                                                   |
| Twin/multiple pregnancy                                        | O30, O31, Z37.2-Z37.7                                                         |
| Asthma, acute or moderate/severe (limited to moderate or severe asthma) | O99.5, J45.21, J45.22, J45.31, J45.32, J45.4, J45.5, J45.901, J45.902         |
| Bleeding disorder, preexisting (added bleeding disorders—but not DIC or sickle cell with crisis) | D66-D69                                                                     |
| BMI at delivery (categorized as ≥40)                           | Z68.4                                                                          |
| Cardiac disease, preexisting (broader set of codes)            | I05-I09, I11-I13, I15, I16, I20, I25, I27.8, I30-I41, I44-I49, I50.22, I50.23, I50.32, I50.33, I50.42, I50.43, I50.812, I50.813 O99.41, O99.42, Q20-Q24 |
| Chronic hypertension                                           | O10, O11, I10                                                                  |
| Chronic renal disease (broader set of codes)                   | O26.83, I12, I13, N03- N05, N07, N08, N11.1, N11.8, N11.9, N18, N25.0, N25.1, N25.81, N25.89, N25.9, N26.9 |
| Connective tissue or autoimmune disease (broad range of diseases that includes systemic lupus erythematosus) | M30-M36                                                                        |
| Placenta previa, complete or partial                           | O44.03, O44.13, O44.23, O44.33                                                 |
| Preeclampsia with severe features (excludes eclampsia as eclampsia is included in SMM) | O14.1, O14.2, O11                                                             |
| Preeclampsia without severe features or gestational hypertension| O13, O14.0, O14.9                                                             |
| Substance use disorder (much broader set of codes)             | F10-F19, O99.31, O99.32                                                        |
| Maternal age                                                   | Birth certificate (categorized as ≥35)                                         |
| Anemia, preexisting (limited to codes that are likely present on delivery admission) | O99.01, O99.02, D50, D55, D56, D57.1, D57.20, D57.3, D57.40, D57.80, D55, D56, D58, D59 |
| Bariatric surgery                                              | O99.84                                                                        |
| Gastrointestinal disease K (entire block),                     | O99.6, O26.6                                                                   |
| Major mental health disorder                                   | O99.34, F20-F39                                                                |
| Neuromuscular disease                                          | O99.35, G40, G70                                                              |
| Placental abruption                                            | O45                                                                           |
| Placenta accreta spectrum                                      | O43.2                                                                         |
| Preterm birth (<37 weeks)                                      | Z3A.20-Z3A.36                                                                 |
| Thyrotoxicosis                                                 | E05                                                                           |
| Model description                          | Dependent variable | Independent variables                                                                 | Notes                                                                                                                                                                                                 |
|-------------------------------------------|--------------------|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Predefined adjustment models              | Any SMM            | Exposure: PP                                                                           | 1. Multivariable Poisson regression with robust error variance built in the general estimating equation (GEE) framework to control for the clustering effect of hospitals (exchangeable or the independent correlation were used as the within-group correlation structure in GEE models). |
|                                           | Any SMM (exclude only transfusion) | Adjusted for: age, data collection year, race (Black, Hispanic, Other, Unknown, White. (Other racial category included Asian, Pacific Islander, Native American)), obesity, CCI, PAS severity, previous cesarean delivery, multiparity, gestational weeks, the use of ART, multiple gestation, hospital bed size, hospital teaching status | 2. Since the hospital indicator in the NIS database can no longer be used to link hospital across years after the NIS redesign in 2012, we constructed a new hospital variable by combining the NIS hospital number and the year to identify hospitals. |
|                                           | Any SMM (exclude only hysterectomy) |                                                                                       |                                                                                                                                                                                                       |
|                                           | Any SM             |                                                                                       |                                                                                                                                                                                                       |
|                                           | Any SM (exclude only transfusion) |                                                                                       |                                                                                                                                                                                                       |
|                                           | Any SM (exclude only hysterectomy) |                                                                                       |                                                                                                                                                                                                       |
|                                           | Hemorrhage         |                                                                                       |                                                                                                                                                                                                       |
|                                           | Blood products transfusion |                                                                                       |                                                                                                                                                                                                       |
|                                           | Shock              |                                                                                       |                                                                                                                                                                                                       |
|                                           | Acute kidney injury |                                                                                       |                                                                                                                                                                                                       |
|                                           | DIC or other coagulopathy |                                                                                       |                                                                                                                                                                                                       |
|                                           | Urinary tract injury |                                                                                       |                                                                                                                                                                                                       |
|                                           | Cesarean section   |                                                                                       |                                                                                                                                                                                                       |
|                                           | Hysterectomy       |                                                                                       |                                                                                                                                                                                                       |
|                                           | Oophorectomy       |                                                                                       |                                                                                                                                                                                                       |
|                                           | Cystoscopy         |                                                                                       |                                                                                                                                                                                                       |
|                                           | Urinary system repair & cystectomy |                                                                                       |                                                                                                                                                                                                       |
|                                           | Intra-arterial balloon occlusion |                                                                                       |                                                                                                                                                                                                       |
|                                           | LOS ≥ 6 days       |                                                                                       |                                                                                                                                                                                                       |
|                                           | Total adjusted cost ≥ $ 21000 |                                                                                       |                                                                                                                                                                                                       |
| Stepwise regression models                 | Any SMM            | Exposure: PP                                                                           | 1. Stepwise logistic regressions                                                                                                                                                                          |

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| Model description                          | Dependent variable                                                                 | Independent variables                                                                 | Notes                                                                                                                                 |
|-------------------------------------------|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| (Candidate variables)                     | Any SMM (exclude only transfusion)                                                  | Adjusted for: age, data collection year, race, obesity, CCI, PAS severity, previous cesarean delivery, multiparity, gestational weeks, the use of ART, multiple gestation, hospital bed size, hospital teaching status, elective admission, gestational diabetes, breech, obesity, smoking, selected comorbidities from the 27 maternal comorbidity list, the use of cesarean delivery, hysterectomy, oophorectomy, cystoscopy, intra-arterial balloon occlusion as well as urinary system repair and cystectomy, hospital region, expected payer, patients estimated income quartile | (backward methods) were used on a pool of exposure variables to retain only the significant factors by setting the removal P value at 0.05. 2. If PP was excluded by the stepwise process, it would be manually entered into the final models. 3. The final models were fitted using multivariable Poisson regression with robust error variance built in the general estimating equation (GEE) framework to control for the clustering effect of hospitals (exchangeable or the independent correlation structures were used in the GEE models). |
| Stepwise regression models for surgical procedure use outcomes (Candidate variables) | Cesarean section                                                                     | Exposure: PP                                                                           | Same as above.                                                                                                                    |
|                                            | Hysterectomy                                                                         | Adjusted for: age, data collection year, race, obesity, smoking, previous cesarean delivery, multiparity, gestational weeks, the use of ART, multiple gestation, gestational diabetes, breech, obesity, smoking, selected comorbidities from the 27 maternal comorbidity list, hospital region, expected payer, patients estimated income quartile |                                                                                                                                    |
|                                            | Oophorectomy                                                                         |                                                                                        |                                                                                                                                    |
|                                            | Cystoscopy                                                                           |                                                                                        |                                                                                                                                    |
|                                            | Urinary system repair & cystectomy                                                   |                                                                                        |                                                                                                                                    |
|                                            | Intra-arterial balloon occlusion                                                    |                                                                                        |                                                                                                                                    |
| Model description | Dependent variable | Independent variables | Notes |
|-------------------|--------------------|-----------------------|-------|
| Multivariable Poisson regression on factors associated with being PP-complicated PAS patients (Candidate variables) | PP (Patients with PP complication in the PAS population) | Age (per 5-year increase), data collection year, race, obesity, CCI, PAS severity, previous cesarean delivery, multiparity, the use of ART, multiple gestation, gestational diabetes, breech, obesity, selected comorbidities from the 27 maternal comorbidity list | We first conducted univariable Poisson regressions between being PP and each of the candidate variables. Factors with P value of 0.20 or less in the univariable models were then included in the multivariable model. The final models were fitted using multivariable Poisson regression with robust error variance built in the general estimating equation (GEE) framework to control for the clustering effect of hospitals (exchangeable or the independent correlation structures were used in the GEE models). |

Details for sensitivity analyses:

1) Sensitivity analyses on the sets of adjusted covariates: Conducted using stepwise regressions reported above. Although we had a predefined adjustment model, we only included a minimum number of covariates and the adjusted variables were the same for all the outcomes. For the stepwise regression, the pool of candidate variables expanded and through stepwise variable selection, we might be able to adjust for different sets of variables in the adjustment model for different outcomes variables.
2) Sensitivity analyses on the sample: the predefined and stepwise models were conducted in both all the included PAS patients (N=3793) and in those who underwent hysterectomy (N=1475)
**eTable 9.** Characteristics of Placenta Previa (PP) by Severity of Placenta Accreta Spectrum (PAS)

| Factor                                    | Total (n = 1323) | Accreta (n = 918) | Increta (n = 181) | Percreta (n = 224) | P value |
|-------------------------------------------|------------------|-------------------|-------------------|-------------------|---------|
| PP type                                   |                  |                   |                   |                   |         |
| Complete                                  | 1212 (91.6)      | 828 (90.2)        | 170 (93.9)        | 214 (95.5)        | .03     |
| Partial                                   | 45 (3.4)         | 40 (4.4)          | NR\(^a\)          | NR\(^a\)          |         |
| Low-lying                                 | 66 (5.0)         | 50 (5.5)          | NR\(^a\)          | NR\(^a\)          |         |
| PP with or without hemorrhage             |                  |                   |                   |                   |         |
| No or not specified                       | 664 (50.2)       | 472 (51.4)        | 79 (43.6)         | 113 (50.4)        | .16     |
| With hemorrhage                           | 659 (49.8)       | 446 (48.6)        | 102 (56.4)        | 111 (49.6)        |         |
| Trimester for PP diagnosis                |                  |                   |                   |                   |         |
| First trimester                           | NR\(^a\)         | NR\(^a\)         | NR\(^a\)         | NR\(^a\)         | .04     |
| Second trimester                          | 99 (7.5)         | 57 (6.2)          | 18 (9.9)          | 24 (10.7)         |         |
| Third trimester                           | 1200 (90.7)      | 848 (92.4)        | 160 (88.4)        | 192 (85.7)        |         |
| Unspecified trimester                     | 23 (1.7)         | 12 (1.3)          | NR\(^a\)         | NR\(^a\)         |         |

NR, not reported.

\(^a\) Data were suppressed for categories with fewer than 10 patients per requirements of the Healthcare Cost and Utilization Project.

Data are n (%) unless otherwise specified.
**eTable 10.** Characteristics of Patients With Placenta Accreta Spectrum (PAS) Disorders With and Without Placenta Previa (PP) in the Invasive PAS and Cesarean Delivery Subgroups

|                        | Invasive PAS (n = 768) | Cesarean section (n = 3079) | Hysterectomy (N=1475) |
|------------------------|------------------------|-----------------------------|-----------------------|
|                        | All (n = 768)          | No PP (n = 363)             | With PP (n = 405)     | All (n = 3079) | No PP (n = 1787) | With PP (n = 1292) | All (n = 1475) | No PP (n = 689) | With PP (n = 786) | P value |
| Demographics           |                        |                             |                       |                       |                     |                       |                       |                     |                       |         |
| Year                   |                        |                             |                       |                       |                     |                       |                       |                     |                       |         |
| 2015 (4<sup>th</sup> quarter) | 43 (5.6)               | 19 (5.2)                    | 24 (5.9)              | .54                   | 177 (5.7)           | 97 (5.4)              | 80 (6.2)              | .79                   | 99 (6.7)           | 43 (6.2) | 56 (7.1) | .12         |
| 2016                   | 185 (24.1)             | 94 (25.9)                   | 91 (22.5)             |                       | 676 (22.0)          | 397 (22.2)            | 279 (21.6)            |                       | 398 (27.0)          | 200 (29.0) | 198 (25.2) |         |
| 2017                   | 158 (20.6)             | 79 (21.8)                   | 79 (19.5)             |                       | 722 (23.4)          | 429 (24.0)            | 293 (22.7)            |                       | 364 (24.7)          | 176 (25.5) | 188 (23.9) |         |
| 2018                   | 186 (24.2)             | 87 (24.0)                   | 99 (24.4)             |                       | 752 (24.4)          | 433 (24.2)            | 319 (24.7)            |                       | 307 (20.8)          | 145 (21.0) | 162 (20.6) |         |
| 2019                   | 196 (25.5)             | 84 (23.1)                   | 112 (27.7)            |                       | 752 (24.4)          | 431 (24.1)            | 321 (24.8)            |                       | 307 (20.8)          | 125 (18.1) | 182 (23.2) |         |
| Age at admission, median (IQR), y | 33 (29, 37)           | 32 (29, 37)               | 33 (29, 37)           | .42                   | 33 (30, 37)         | 33 (30, 37)           | 33 (29, 37)           | .35                   | 33 (30, 37)         | 33 (30, 37) | 33 (30, 37) | .45         |
| Advanced maternal age (≥35y) | 296 (38.5)            | 137 (37.7)                 | 159 (39.3)            | .67                   | 1303 (42.3)         | 765 (42.8)            | 538 (41.6)            | .52                   | 621 (42.1)          | 300 (43.5) | 321 (40.8) | .29         |
| Race                   |                        |                             |                       |                       |                     |                       |                       |                       |                     |                       |         |
| Black                  | 142 (18.5)             | 77 (21.2)                   | 65 (16.0)             | .20                   | 538 (17.5)          | 331 (18.5)            | 207 (16.0)            | <.001                  | 256 (17.4)          | 141 (20.5) | 115 (14.6) | .02         |
| Hispanic               | 181 (23.6)             | 78 (21.5)                   | 103 (25.4)            |                       | 671 (21.8)          | 342 (19.1)            | 329 (25.5)            |                       | 380 (25.8)          | 161 (23.4) | 219 (27.9) |         |
| White                  | 325 (42.3)             | 158 (43.5)                  | 167 (41.2)            |                       | 1367 (44.4)         | 834 (46.7)            | 533 (41.3)            |                       | 607 (41.2)          | 287 (41.7) | 320 (40.7) |         |

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|                         | Invasive PAS (n = 768) | Cesarean section (n = 3079) | Hysterectomy (N=1475) | P value |
|-------------------------|------------------------|----------------------------|------------------------|----------|
|                         | All (n = 768) | No PP (n = 363) | With PP (n = 405) | All (n = 3079) | No PP (n = 1787) | With PP (n = 1292) | All (n = 1475) | No PP (n = 689) | With PP (n = 786) | P value |
| **C Other**            | 87 (11.3) | 35 (9.6) | 52 (12.8) | 365 (11.9) | 198 (11.1) | 167 (12.9) | 167 (11.3) | 75 (10.9) | 92 (11.7) | .009 |
| **Unknown**            | 33 (4.3) | 15 (4.1) | 18 (4.4) | 138 (4.5) | 82 (4.6) | 56 (4.3) | 65 (4.4) | 25 (3.6) | 40 (5.1) | .59 |
| **Elective admission** | 360 (46.9) | 182 (50.1) | 178 (44.0) | .10 | 1584 (51.4) | 980 (54.8) | 604 (46.7) | .001 | 726 (49.2) | 365 (53.0) | 361 (45.9) |
| **Emergency department service use** | 85 (11.1) | 36 (9.9) | 49 (12.1) | .34 | 335 (10.9) | 179 (10.0) | 156 (12.1) | .07 | 179 (12.1) | 87 (12.6) | 92 (11.7) |
| **Expected payers**    |                      |                           |                           |                           |                           |                           |                      |                  |                      |                  |
| Medicare/Medic aid     | 441 (57.4) | 202 (55.6) | 239 (59.0) | .64 | 1449 (47.1) | 789 (44.2) | 660 (51.1) | .001 | 794 (53.8) | 372 (54.0) | 422 (53.7) |
| Private insurance      | 293 (38.2) | 144 (39.7) | 149 (36.8) | 1452 (47.2) | 891 (49.9) | 561 (43.4) | .07 | 607 (41.2) | 279 (40.5) | 328 (41.7) |
| Other                  | 34 (4.4) | 17 (4.7) | 17 (4.2) | 178 (5.8) | 107 (6.0) | 71 (5.5) | 74 (5.0) | 38 (5.5) | 36 (4.6) | .59 |
| **Hospital bed size**  |                      |                           |                           |                           |                           |                           |                      |                  |                      |                  |
| Small                  | 64 (8.3) | 44 (12.1) | 20 (4.9) | .001 | 343 (11.1) | 229 (12.8) | 114 (8.8) | .02 | 141 (9.6) | 82 (11.9) | 59 (7.5) |
| Medium                 | 145 (18.9) | 70 (19.3) | 75 (18.5) | 1452 (23.6) | 470 (26.3) | 256 (19.8) | .001 | 292 (19.8) | 136 (19.7) | 156 (19.8) |
| Large                  | 559 (72.8) | 249 (68.6) | 310 (76.5) | 2010 (65.3) | 1088 (60.9) | 922 (71.4) | .001 | 1042 (70.6) | 471 (68.4) | 571 (72.6) |
| **Hospital location/teaching status** |                      |                           |                           |                           |                           |                           |                      |                  |                      |                  |
| Rural                  | 33 (4.3) | 23 (6.3) | 10 (2.5) | <.001 | 118 (3.8) | 92 (5.1) | 26 (2.0) | <.001 | 35 (2.4) | 25 (3.6) | 10 (1.3) |
| Urban                  | 62 (8.1) | 40 (11.0) | 22 (5.4) | 373 | 256 | 117 (9.1) | 142 (9.6) | 79 (11.5) | 63 (8.0) | <.001 |

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|                  | Invasive PAS (n = 768) | Cesarean section (n = 3079) | Hysterectomy (N=1475) |
|------------------|------------------------|-----------------------------|------------------------|
|                  | All (n = 768)          | No PP (n = 363)            | With PP (n = 405)      | All (n = 3079) | No PP (n = 1787) | With PP (n = 1292) | P value |
|                  |                        |                            |                        | All (n = 1475) | No PP (n = 689) | With PP (n = 786) | P value |
| nonteaching      |                        |                            |                        |                |                |                |            |
| Urban teaching   | 673 (87.6)             | 300 (82.6)                 | 373 (92.1)             | 2588 (84.1)    | 1439 (80.5)    | 1149 (88.9)     | .02 |
|                  |                        |                            |                        |                |                |                |            |
| Hospital region  |                        |                            |                        |                |                |                |            |
| Northeast        | 134 (17.4)             | 61 (16.8)                  | 73 (18.0)              | 584 (19.0)     | 331 (18.5)     | 253 (19.6)      | .22 |
|                  |                        |                            |                        |                |                |                |            |
| Midwest          | 166 (21.6)             | 76 (20.9)                  | 90 (22.2)              | 604 (19.6)     | 338 (18.9)     | 266 (20.6)      | .22 |
|                  |                        |                            |                        |                |                |                |            |
| South            | 281 (36.6)             | 137 (37.7)                 | 144 (35.6)             | 1123 (36.5)    | 679 (38.0)     | 444 (34.4)      | .22 |
|                  |                        |                            |                        |                |                |                |            |
| West             | 187 (24.3)             | 89 (24.5)                  | 98 (24.2)              | 768 (24.9)     | 439 (24.6)     | 329 (25.5)      | .22 |
|                  |                        |                            |                        |                |                |                |            |
| Pregnancy history|                        |                            |                        |                |                |                |            |
| Grand multiparity|                        |                            |                        | .81            | 36 (1.2)       | 23 (1.3)        | .47 |
|                  |                        |                            |                        |                | 13 (1.0)       |                |            |
| Previous cesarean section |      | .01                        |                           | 2089 (67.8)    | 1150 (64.4)    | 939 (72.7)      | <.001 |
| Current pregnancy status |      |                            |                           |                |                |                |            |
| Obesity          |                        |                            |                        |                |                |                |            |
| Class 0 (Non-obesity) | 607 (79.0)        | 295 (81.3)                 | 312 (77.0)             | 2544 (82.6)    | 1500 (83.9)    | 1044 (80.8)     | .02 |
|                  |                        |                            |                        |                |                |                |            |
| Class I-II       | 93 (12.1)              | 35 (9.6)                   | 58 (14.3)              | 302 (9.8)      | 153 (8.6)      | 149 (11.5)      | .02 |
|                  |                        |                            |                        |                |                |                |            |
| Class III        | 68 (8.9)               | 33 (9.1)                   | 35 (8.6)               | 233 (7.6)      | 134 (7.5)      | 99 (7.7)        | .02 |
|                  |                        |                            |                        |                |                |                |            |
| ART              | NR²                    | NR²                        | NR³                    | .57            | 45 (1.5)       | 32 (1.8)        | .07 |
|                  |                        |                            |                        |                | 13 (1.0)       |                |            |
| Charlson         | NR²                    | NR²                        | NR³                    | .57            | 45 (1.5)       | 32 (1.8)        | .07 |
|                  |                        |                            |                        |                | 13 (1.0)       |                |            |

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|                          | Invasive PAS (n = 768) | Cesarean section (n = 3079) | Hysterectomy (N=1475) |
|--------------------------|------------------------|-----------------------------|------------------------|
|                          | All (n = 768) No PP (n = 363) With PP (n = 405) | All (n = 3079) No PP (n = 1787) With PP (n = 1292) | All (n = 1475) No PP (n = 689) With PP (n = 786) |
| **Comorbidity index (CCI)** |                        |                             |                        |
| =0                       | 651 (84.8) 310 (85.4) 341 (84.2) | 2702 (87.8) 1569 (87.8) 1133 (87.7) | 1267 (85.9) 589 (85.5) 678 (86.3) |
| =1                       | 109 (14.2) 48 (13.2) 61 (15.1) | 345 (11.2) 197 (11.0) 148 (11.5) | 194 (13.2) 93 (13.5) 101 (12.8) |
| =2                       | NR a NR a NR a | 23 (0.7) 14 (0.8) NR a | 13 (0.9) NR a NR a |
| >=3                      | NR a NR a NR a | NR a NR a NR a | NR a NR a NR a |
| **Elixhauser comorbidity index (ECI)** |                        |                             |                        |
| =0                       | 356 (46.4) 190 (52.3) 166 (41.0) | 1671 (54.3) 1031 (57.7) 640 (49.5) | <.001 676 (45.8) 333 (48.3) 343 (43.6) |
| =1                       | 240 (31.3) 101 (27.8) 139 (34.3) | 880 (28.6) 485 (27.1) 395 (30.6) | 472 (32.0) 210 (30.5) 262 (33.3) |
| =2                       | 116 (15.1) 51 (14.0) 65 (16.0) | 377 (12.2) 199 (11.1) 178 (13.8) | 232 (15.7) 106 (15.4) 126 (16.0) |
| >=3                      | 56 (7.3) 21 (5.8) 35 (8.6) | 151 (4.9) 72 (4.0) 79 (6.1) | 95 (6.4) 40 (5.8) 55 (7.0) |
| **Tobacco use**           | 82 (10.7) 32 (8.8) 50 (12.3) | 255 (8.3) 140 (7.8) 115 (8.9) | .29 157 (10.6) 70 (10.2) 87 (11.1) |
| **PAS type**             |                         |                             |                        |
| Accreta                  | NA NA NA | 2364 (76.8) 1470 (82.3) 894 (69.2) | <.001 973 (66.0) 494 (71.7) 479 (60.9) |
| Increta                  | 339 (44.1) 158 (43.5) 181 (44.7) | 313 (10.2) 135 (7.6) 178 (13.8) | 215 (14.6) 80 (11.6) 135 (17.2) |
| Percreta                 | 429 205 224 | 402 182 220 | 287 115 172 |

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|                                | Invasive PAS (n = 768) | Cesarean section (n = 3079) | Hysterectomy (N=1475) |
|--------------------------------|------------------------|----------------------------|-----------------------|
|                                | All (n = 768)          | No PP (n = 363)            | With PP (n = 405)     |
|                                |                        |                           |                       |
|                                | (55.9)                 | (56.5)                    | (55.3)                |
|                                | (13.1)                 | (10.2)                    | (17.0)                |
|                                | (19.5)                 | (16.7)                    | (21.9)                |
| Trimester of PAS diagnosis     | First trimester        | NR<sup>a</sup>            | NR<sup>a</sup>         | NR<sup>a</sup>       |
|                                |                        |                           |                        |                        |
|                                | Second trimester       | 66 (8.6)                  | 28 (7.7)              | 38 (9.4)              |
|                                |                        | 159 (5.2)                 | 82 (4.6)              | 77 (6.0)              |
|                                |                        | 117 (7.9)                 | 57 (8.3)              | 60 (7.6)              |
|                                |                        | 1309 (88.7)               | 609 (88.4)            | 700 (89.1)            |
|                                | Third trimester        | 670 (87.2)                | 325 (89.5)            | 345 (85.2)            |
|                                |                        | 2808 (91.2)               | 1639 (91.7)           | 1169 (90.5)           |
|                                |                        | 1309 (88.7)               | 609 (88.4)            | 700 (89.1)            |
|                                | Unspecified trimester  | 31 (4.0)                  | NR<sup>a</sup>        | 22 (5.4)              |
|                                |                        | 111 (3.6)                 | 65 (3.6)              | 46 (3.6)              |
|                                |                        | 49 (3.3)                  | 23 (3.3)              | 26 (3.3)              |
| Gestation weeks                | <32 weeks              | 157 (20.4)                | 52 (14.4)             | 105 (25.9)            |
|                                |                        | 414 (13.4)                | 172 (9.6)             | 242 (18.7)            |
|                                |                        | 274 (18.6)                | 91 (13.2)             | 183 (23.2)            |
|                                | 32-33 weeks            | 120 (15.6)                | 39 (10.7)             | 81 (20.0)             |
|                                |                        | 343 (11.1)                | 129 (7.2)             | 214 (16.6)            |
|                                |                        | 210 (14.2)                | 72 (10.4)             | 138 (17.6)            |
|                                | 34-36 weeks            | 314 (40.9)                | 141 (38.8)            | 173 (42.7)            |
|                                |                        | 1133 (36.8)               | 528 (29.5)            | 605 (46.8)            |
|                                |                        | 640 (43.4)                | 274 (39.8)            | 366 (46.6)            |
|                                | >36 weeks              | 148 (19.3)                | 125 (34.4)            | 23 (5.7)              |
|                                |                        | 1111 (36.1)               | 927 (51.9)            | 184 (14.2)            |
|                                |                        | 303 (20.5)                | 236 (34.3)            | 67 (8.5)              |
|                                | Unknown                | 29 (3.8)                  | NR<sup>a</sup>        | 23 (5.7)              |
|                                |                        | 78 (2.5)                  | 31 (1.7)              | 47 (3.6)              |
|                                |                        | 48 (3.3)                  | 16 (2.3)              | 32 (4.1)              |

| Pregnancy complications        | Preterm birth           | 629 (81.9)                | 256 (70.5)            | 373 (92.1)            |
|                                |                        | 2254 (73.2)               | 1079 (60.4)           | 1175 (90.9)           |
|                                |                        | 1225 (83.1)               | 499 (72.4)            | 726 (92.4)            |
|                                | Multiple gestation     | 21 (2.7)                  | NR<sup>a</sup>        | 12 (3.0)              |
|                                |                        | 141 (4.6)                 | 104 (5.8)             | 37 (2.9)              |
|                                |                        | 44 (3.0)                  | 24 (3.5)              | 20 (2.5)              |
|                                | GDM                    | 94 (12.2)                 | 33 (9.1)              | 61 (15.1)             |
|                                |                        | 406 (13.2)                | 236 (13.2)            | 170 (13.2)            |
|                                |                        | 193 (13.1)                | 74 (10.7)             | 119 (15.1)            |
|                                | HDP                    | 30 (3.9)                  | 17 (4.7)              | 13 (3.2)              |
|                                |                        | 204 (6.6)                 | 154 (8.6)             | 50 (3.9)              |

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|                      | Invasive PAS (n = 768) | Cesarean section (n = 3079) | Hysterectomy (N=1475) |
|----------------------|------------------------|-----------------------------|------------------------|
|                      | All (n = 768) No PP (n = 363) With PP (n = 405) | All (n = 3079) No PP (n = 1787) With PP (n = 1292) | All (n = 1475) No PP (n = 689) With PP (n = 786) |
|                      | P value |                      | P value |                      | P value |
| Breech presentation  | 141 (18.4) 64 (17.6) 77 (19.0) | .62 529 (17.2) 299 (16.7) 230 (17.8) | .44 272 (18.4) 118 (17.1) 154 (19.6) | .22 |
| PPROM                | 47 (6.1) 28 (7.7) 19 (4.7) | .08 172 (5.6) 117 (6.5) 55 (4.3) | .006 90 (6.1) 55 (8.0) 35 (4.5) | .005 |
| FGR                  | 34 (4.4) 18 (5.0) 16 (4.0) | .50 165 (5.4) 112 (6.3) 53 (4.1) | .008 64 (4.3) 38 (5.5) 26 (3.3) | .04 |

PAS, placenta accreta spectrum; ART, assisted reproductive technology; GDM, gestational diabetes mellitus; HDP, hypertensive disorders of pregnancy; PPROM, preterm premature rupture of membranes; FGR, fetal growth restriction; IQR, interquartile range. Data are n (%) unless otherwise specified. NR, not reported.

Data were suppressed for categories with fewer than 10 patients per requirements of the Healthcare Cost and Utilization Project.

Records with evidence of emergency service use, per HCUP criteria.

Other races and/or ethnicities included American Indian, Asian or Pacific Islander, and multiple or other races and/or ethnicities.
### eTable 11. Maternal Outcomes of Placenta Previa (PP) and Non-PP Placenta Accreta Spectrum (PAS) Groups in the Invasive PAS and Cesarean Delivery Subgroups

| Perioperative outcomes              | Invasive PAS (N=768) | Cesarean section (N=3079) |
|-------------------------------------|----------------------|---------------------------|
|                                     | All (N=768)          | Without PP (n=363)        | With PP (n=405) | $P$ value | All (N=3079) | Without PP (n=1787) | With PP (n=1292) | $P$ value |
| Study-defined surgical morbidities  |                      |                          |                  |            |            |                |                  |            |
| Any                                 | 669 (87.1)           | 286 (78.8)               | 383 (94.6)       | <.001      | 2323 (21.7) | 1175 (65.8)     | 1148 (88.9)     | <.001      |
| Any (exclude only transfusion)     | 653 (85.0)           | 278 (76.6)               | 375 (92.6)       | <.001      | 2255 (21.2) | 1128 (63.1)     | 1127 (87.2)     | <.001      |
| Any (exclude only hysterectomy)    | 562 (73.2)           | 228 (62.8)               | 334 (82.5)       | <.001      | 2008 (18.3) | 1000 (56.0)     | 1008 (78.0)     | <.001      |
| Any (exclude transfusion and/or hysterectomy) | 505 (65.8) | 195 (53.7)               | 310 (76.5)       | <.001      | 1815 (16.4) | 870 (48.7)      | 945 (73.1)      | <.001      |
| CDC-defined severe maternal morbidities |                      |                          |                  |            |            |                |                  |            |
| Any                                 | 586 (76.3)           | 248 (68.3)               | 338 (83.5)       | <.001      | 1770 (19.0) | 849 (47.5)      | 921 (71.3)      | <.001      |
| Any (exclude only transfusion)     | 533 (69.4)           | 214 (59.0)               | 319 (78.8)       | <.001      | 1473 (17.3) | 661 (37.0)      | 812 (62.8)      | <.001      |
| Any (exclude only hysterectomy)    | 334 (43.5)           | 146 (40.2)               | 188 (46.4)       | .09        | 1034 (10.9) | 529 (29.6)      | 505 (39.1)      | <.001      |
| Any (exclude transfusion and/or hysterectomy) | 123 (16.0) | 51 (14.0)                | 72 (17.8)        | .17        | 319 (4.0)   | 153 (8.6)       | 166 (12.8)      | <.001      |
| Specific outcomes                   |                      |                          |                  |            |            |                |                  |            |
| Hemorrhage                          | 444 (57.8)           | 166 (45.7)               | 278 (68.6)       | <.001      | 1614 (14.4) | 751 (42.0)      | 863 (66.8)      | <.001      |
| Blood products transfusion          | 267 (34.8)           | 123 (33.9)               | 144 (35.6)       | .65        | 857 (8.7)   | 448 (25.1)      | 409 (31.7)      | <.001      |
| Shock                               | 59 (7.7)             | 25 (6.9)                 | 34 (8.4)         | .50        | 149 (1.9)   | 69 (3.9)        | 80 (6.2)        | .004       |
| Acute kidney injury                 | 15 (2.0)             | NR                      | NR               | .61        | 31 (0.5)    | 15 (0.8)        | 16 (1.2)        | .28        |
| DIC or other coagulopathy           | 60 (7.8)             | 26 (7.2)                 | 34 (8.4)         | .59        | 154 (2.0)   | 80 (4.5)        | 74 (5.7)        | .13        |
| Urinary tract injury                | 25 (3.3)             | NR                      | NR               | .15        | 79 (0.8)    | 35 (2.0)        | 44 (3.4)        | .02        |
| Surgical procedure use              |                       |                          |                  |            |            |                |                  |            |
| Cesarean section                   | 715 (93.1)           | 317 (87.3)               | 398 (98.3)       | <.001      | 3079 (23.2) | 1787 (100.0)    | 1292 (100.0)    | NA         |

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Invasive PAS (N=768) | Cesarean section (N=3079)
--- | ---
### Perioperative outcomes

| | All (N=768) | Without PP (n=363) | With PP (n=405) | P value | All (N=3079) | Without PP (n=1787) | With PP (n=1292) | P value |
|---|---|---|---|---|---|---|---|---|
| Hysterectomy | 502 (65.4) | 195 (53.7) | 307 (75.8) | <.001 | 1374 (16.3) | 597 (33.4) | 777 (60.1) | <.001 |
| Oophorectomy | 56 (7.3) | 27 (7.4) | 29 (7.2) | .89 | 136 (1.8) | 71 (4.0) | 65 (5.0) | .18 |
| Cystoscopy | 218 (28.4) | 76 (20.9) | 142 (35.1) | <.001 | 476 (7.1) | 178 (10.0) | 298 (23.1) | <.001 |
| Urinary system repair & cystectomy | 132 (17.2) | 45 (12.4) | 87 (21.5) | .001 | 245 (4.3) | 91 (5.1) | 154 (11.9) | <.001 |
| Intra-arterial balloon occlusion | 89 (11.6) | 30 (8.3) | 59 (14.6) | .007 | 182 (2.9) | 62 (3.5) | 120 (9.3) | <.001 |

### Length of stay

| | Length of stay, median (IQR) | LOS after cesarean section, median (IQR) | P value |
|---|---|---|---|
| All (N=3079) | 4 (3, 7) | 4 (3, 5) | 5 (4, 11) | <.001 |
| Without PP (n=1787) | 3 (3, 4) | 3 (3, 4) | 4 (3, 4) | <.001 |

### Charges

| | Total charges, median (IQR), USD (2019) b | Total costs, median (IQR), USD c | P value |
|---|---|---|---|
| All (N=3079) | 79 935 (41 752, 136 043) | 20 629 (11 584, 34 132) | <.001 |
| Without PP (n=1787) | 60 632 (30 197, 111 197) | 15 071 (8 661, 27 746) | 13 179 (8 158, 22 659) | 92 975 (41 662, 119 504) | 17 445 (10 970, 30 619) | <.001 |
| With PP (n=1292) | 96 898 (59 407, 164 408) | 24 911 (16 186, 38 580) | 10 675 (6 946, 18 052) | 69 178 (41 662, 119 504) | 17 445 (10 970, 30 619) | <.001 |

SM, surgical morbidity concept defined by the previous studies; SMM, severe maternal morbidity defined by the Centers for Disease Control and Prevention (CDC).
DIC, disseminated intravascular coagulation; LOS, length of stay; IQR, interquartile range. Data are n (%) unless otherwise specified. NR, not reported.

b Data were suppressed for categories with fewer than 10 patients per requirements of the Healthcare Cost and Utilization Project.

b Total charges were charges converted to 2019 US dollars using annual consumer price indexes. c Total costs were charges converted to 2019 US dollars and adjusted using the Healthcare Cost and Utilization Project cost-to-charges ratio.
### eTable 12. Multivariable Poisson Regression Analysis of Association Between Placenta Previa (PP) and Risk of Maternal Outcomes in Patients With Placenta Accreta Spectrum (PAS) Disorders (N = 3793)

| Outcomes                                      | RR (95% CI) | Predefined regression model * Adjusted RR (95% CI) | Stepwise regression model Adjusted RR (95% CI) |
|-----------------------------------------------|-------------|-------------------------------------------------|-----------------------------------------------|
| **Study-defined SM**                          |             |                                                 |                                               |
| Any                                           | 1.30 (1.26-1.35) | **1.18** (1.13-1.23) | **1.16** (1.11-1.20) |
| (exclude only transfusion)                    | 1.32 (1.28-1.37) | **1.20** (1.15-1.25) | **1.17** (1.12-1.22) |
| (exclude only hysterectomy)                   | 1.29 (1.23-1.35) | **1.25** (1.19-1.32) | **1.23** (1.17-1.29) |
| (exclude transfusion and/or hysterectomy)     | 1.34 (1.27-1.40) | **1.36** (1.28-1.44) | **1.33** (1.26-1.41) |
| **CDC-defined SMM**                           |             |                                                 |                                               |
| Any                                           | 1.58 (1.49-1.68) | **1.19** (1.12-1.27) | **1.16** (1.09-1.23) |
| (exclude only transfusion)                    | 1.90 (1.76-2.05) | **1.27** (1.18-1.37) | **1.22** (1.14-1.32) |
| (exclude only hysterectomy)                   | 1.30 (1.19-1.42) | **1.12** (1.02-1.24) | 1.08 (0.98-1.19) |
| (exclude transfusion and/or hysterectomy)     | 1.45 (1.20-1.74) | 1.18 (0.96-1.46) | 1.13 (0.92-1.38) |
| **Surgical procedure use**                    |     |                                                 |                                               |
| Caesarean section                             | 1.34 (1.31-1.38) | **1.15** (1.12-1.17) | **1.16** (1.13-1.19) |
| Hysterectomy                                  | 2.08 (1.91-2.25) | **1.33** (1.23-1.44) | **1.34** (1.24-1.45) |
| Oophorectomy                                  | 1.47 (1.06-2.04) | 1.02 (0.71-1.45) | 1.02 (0.72-1.44) |
| Cystoscopy                                    | 2.63 (2.13-3.24) | **1.39** (1.16-1.67) | **1.37** (1.13-1.66) |
| Urinary system repair & cystectomy            | 2.96 (2.30-3.82) | **1.55** (1.16-2.08) | **1.63** (1.22-2.18) |
| Intra-arterial balloon occlusion              | 2.74 (1.92-3.91) | **1.78** (1.30-2.45) | **1.62** (1.18-2.23) |
| **Specific outcomes**                         |             |                                                 |                                               |
| Hemorrhage                                    | 1.35 (1.27-1.42) | **1.44** (1.35-1.54) | **1.42** (1.33-1.51) |
| Blood products transfusion                    | 1.25 (1.13-1.38) | 1.11 (0.99-1.24) | 1.07 (0.97-1.19) |
| Shock                                         | 1.44 (1.09-1.90) | 1.18 (0.87-1.61) | 1.20 (0.87-1.64) |
| Acute kidney injury                           | 1.11 (0.60-2.07) | 0.87 (0.42-1.80) | 0.97 (0.47-2.01) |
| DIC or other coagulopathy                     | 1.36 (1.01-1.84) | 1.07 (0.77-1.48) | 1.03 (0.76-1.38) |
| Urinary tract injury                          | 2.01 (1.31-3.09) | 1.22 (0.76-1.97) | 0.92 (0.61-1.40) |
| Hospital LOS (≥ 6 days)                       | 2.52 (2.26-2.81) | **1.38** (1.25-1.52) | **1.38** (1.25-1.52) |
| Total cost (≥ $21000)                         | 2.10 (1.86-2.36) | **1.28** (1.15-1.43) | **1.18** (1.06-1.31) |

SM, surgical morbidity; CDC, Centers for Disease Control; SMM, severe maternal morbidity; DIC, disseminated intravascular coagulopathy; LOS, length of stay.
Statistically significant RR and 95% CI were presented in bold font.
* Adjusted for: age, data collection year, race, obesity, Charlson comorbidity index, PAS severity, previous cesarean delivery, multiparity, gestational weeks, the use of ART, multiple gestation, hospital bed size, hospital teaching status.
**eTable 13. Multivariable Poisson Regression Analysis of Association Between Placenta Previa (PP) and Risk of Maternal Outcomes in Patients With Placenta Accreta Spectrum (PAS) Disorders Who Received Hysterectomy (n = 1475)**

| Outcomes                                      | RR (95% CI) | Predefined regression model * Adjusted RR (95% CI) | Stepwise regression model Adjusted RR (95% CI) |
|------------------------------------------------|-------------|---------------------------------------------------|-----------------------------------------------|
| **Study-defined surgical SM**                  |             |                                                   |                                               |
| Any                                            | NA          | NA                                                | NA                                            |
| Any (exclude only transfusion)                 | NA          | NA                                                | NA                                            |
| Any (exclude only hysterectomy)               | 1.12 (1.06-1.18) | 1.16 (1.09-1.23)                                | 1.14 (1.07-1.20)                             |
| Any (exclude only transfusion and/or hysterectomy) | 1.25 (1.17-1.35) | 1.32 (1.22-1.43)                                | 1.28 (1.20-1.38)                             |
| **CDC-defined SMM**                            |             |                                                   |                                               |
| Any                                            | NA          | NA                                                | NA                                            |
| Any (exclude only transfusion)                 | NA          | NA                                                | NA                                            |
| Any (exclude only hysterectomy)               | 1.00 (0.90-1.11) | 1.04 (0.93-1.16)                                | 1.01 (0.92-1.12)                             |
| Any (exclude only transfusion and/or hysterectomy) | 1.02 (0.81-1.27) | 1.1 (0.86-1.40)                                | 1.10 (0.88-1.36)                             |
| **Surgical procedure use**                     |             |                                                   |                                               |
| Caesarean section                              | 1.14 (1.11-1.18) | 1.09 (1.06-1.11)                               | 1.09 (1.07-1.12)                             |
| Hysterectomy                                   | -           | -                                                 | -                                             |
| Oophorectomy                                   | 0.81 (0.57-1.16) | 0.81 (0.55-1.20)                               | 0.88 (0.62-1.26)                             |
| Cystoscopy                                     | 1.45 (1.18-1.77) | 1.18 (0.97-1.42)                               | 1.16 (0.96-1.41)                             |
| Urinary system repair & cystectomy             | 1.40 (1.07-1.83) | 1.20 (0.90-1.60)                               | 1.27 (0.98-1.66)                             |
| Intra-arterial balloon occlusion               | 2.05 (1.39-3.01) | 1.64 (1.12-2.42)                               | 1.83 (1.10-3.05)                             |
| **Specific outcomes**                         |             |                                                   |                                               |
| Hemorrhage                                     | 1.32 (1.22-1.44) | 1.44 (1.31-1.58)                               | 1.41 (1.30-1.53)                             |
| Blood products transfusion                     | 0.98 (0.87-1.11) | 1.03 (0.90-1.17)                               | 1.03 (0.91-1.16)                             |
| Shock                                          | 0.91 (0.66-1.26) | 1.04 (0.74-1.46)                               | 1.06 (0.75-1.49)                             |
| Acute kidney injury                            | 0.71 (0.35-1.48) | 0.63 (0.27-1.47)                               | 0.79 (0.33-1.87)                             |
| DIC or other coagulopathy                      | 0.83 (0.57-1.19) | 0.95 (0.66-1.37)                               | 0.92 (0.68-1.25)                             |
| Urinary tract injury                           | 0.93 (0.57-1.50) | 0.87 (0.52-1.44)                               | 0.82 (0.53-1.27)                             |
| Hospital LOS (≥ 6 days)                       | 1.62 (1.42-1.84) | 1.24 (1.10-1.40)                               | 1.22 (1.09-1.37)                             |
| Total cost (≥ $21000)                          | 1.35 (1.19-1.53) | 1.12 (0.99-1.27)                               | 1.05 (0.93-1.18)                             |

SM, surgical morbidity; CDC, Centers for Disease Control; SMM, severe maternal morbidity; DIC, disseminated intravascular coagulopathy; LOS, length of stay; NA, not applicable. Statistically significant RR and 95% CI were presented in bold font. * Adjusted for: age, data collection year, race, obesity, Charlson comorbidity index, PAS severity, previous cesarean delivery, multiparity, gestational weeks, the

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use of ART, multiple gestation, hospital bed size, hospital teaching status.
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