Appendix 1. Data Sources Used to Ascertain Individual Study Variables and Their Definitions

Variable	Data source and definition
Cohort identification	
Gestational age	Birth certificate clinical estimate of gestational age in weeks. Length of gestation in days was estimated by assuming the delivery occurred mid-week at 4/7 days.
Year of delivery	Health plan record of infant's date of birth.
Start of pregnancy	Delivery date (health plan records) minus gestational age (birth certificate)
Multiple gestation	State birth certificate information or health plan ICD-9 diagnosis codes (651.x, 652.6X, 660.5x, 662.3x, 678.1x, 761.5, V27.2-V27.7, V31-V37, and V91.x) between start of pregnancy and delivery.
Pregestational (Type 1 or Type 2) diabetes	Health plan ICD-9 diagnosis codes (249.xx, 250.xx, 357.2, 362.01-362.07, 366.41, and 648.0) during the 365 days prior to start of pregnancy.
Prenatal care received from internal or external providers	Women were designated as receiving their prenatal care from internal providers if, among their outpatient visits during pregnancy to family practice and obstetrics & gynecology departments, at least 50% were to a Kaiser Permanente Washington provider; otherwise they were designated as receiving their prenatal care from external providers.
Diabetes-related process of care outcomes	
Hemoglobin A1c test (HbA1c)	Health plan procedure code CPT 83036, or CPT 80055 (OB panel) among patients cared for by internal providers from December 2010 through December 2014 (HbA1c was added to the OB prenatal blood test panel of internal providers in December 2010), prior to 16 weeks gestational age.
Screening for GDM using 2-step approach	Health plan CPT procedure codes 82950 (50-gram glucose challenge test) or 82947 (serum fasting glucose test), between 24 weeks gestation and delivery.
Diagnostic testing for GDM using the 2-step approach	Health plan CPT procedure codes 82951 and 82952 (both required) between 24 weeks gestation and delivery.
Diagnostic testing for GDM using the 1-step approach	Health plan CPT procedure code 82951 and absence of CPT code 82952, between 24 weeks gestation and delivery
Diabetes medication use during pregnancy	Health plan outpatient pharmacy dispensing for insulin, sulfonylureas, or metformin between 12 weeks gestation and day before delivery.
Primary maternal and neonatal outcomes	
Gestational diabetes	Health plan ICD-9 diagnosis code 648.8x from delivery hospitalization.
Induction of labor	Birth certificate, or health plan ICD-9 diagnosis codes 659.0x, 659.1x or procedure codes 73.01, 73.1, 73.4.

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Variable	Data source and definition
Primary cesarean	Cesarean delivery was defined based on health plan procedure codes (ICD-9 74.0 -74.2, 74.4, 74.99 or CPT 59510, 59514, 59515, 59525, 59618, 59620, 59622) during the delivery hospitalization, or birth certificate information. History of a prior cesarean was defined based on birth certificate information, or health plan diagnosis codes (ICD-9 654.2) from start of pregnancy through day before delivery or procedure codes (CPT 59610, 59612, 59614, 59618, 59620, 59622) from delivery hospitalization. Women who received a primary cesarean were those who had a cesarean delivery but had no prior history of cesarean delivery.
Birthweight	Infant birthweight based on the birth certificate.
Macrosomia	Infant birthweight ≥4,500 grams based on the birth certificate.
Large-for-gestational age	>90th percentile of birthweight (birth certificate) for gestational age (birth certificate) using Washington state sex-specific data as the reference population.[1]
Small-for-gestational age	<10th percentile of birthweight (birth certificate) for gestational age (birth certificate) using Washington state sex-specific data as the reference population.[1]
Neonatal hypoglycemia	Health plan ICD-9 diagnosis code 775.6 from delivery hospitalization.
Neonatal intensive care using admission (levels 3-4)	Health plan procedure codes (CPT 99468, 99469, 99477, 99478, 99479, 99480, or revenue code 0173 or 0174) within 28 days of delivery.
Secondary maternal and neonatal outcomes	
Cesarean delivery	Health plan procedure codes (ICD-9 74.0 -74.2, 74.4, 74.99 or CPT 59510, 59514, 59515, 59525, 59618, 59620, 59622) during the delivery hospitalization, or birth certificate.
Cesarean delivery among nulliparous, term, singleton, vertex gestations	Cesarean delivery (defined above) among nulliparous (birth certificate) singleton deliveries (defined above) at 37 weeks gestation or greater in a vertex presentation. A vertex presentation at birth was defined as one that did not have a non-vertex presentation based on the birth certificate, or health plan diagnosis (ICD-9 652.2x,, 652.3x, 652.4x, or 669.6x) or procedure codes (ICD-9 72.5x or 75.6) during the delivery hospitalization.
Vaginal delivery among women who had a prior cesarean	Defined as women who did not have a cesarean delivery (defined above) and had a prior history of cesarean (defined above)
Nonstress testing	Health plan procedure code (CPT 59020, 59205, 76818, 76819, or 99500) from an outpatient encounter during pregnancy.
Third trimester ultrasound	Health plan procedure code (CPT 76801, 76802, 76805, 76810, 76811, 76812-76814, 76815-76817, 76820, 76821, 76825-76828, or ICD-9 88.78) from 28 weeks gestation through delivery.
Preterm birth	Delivery at less than 37 weeks gestation.
Shoulder dystocia	Health plan diagnosis code (ICD-9 660.4x) from delivery hospitalization.
Severe perineal tear (third or fourth degree) among vaginal deliveries	Birth certificate, or health plan diagnosis codes (ICD-9 664.2 [0,1,4], 664.3 [0,1,4], or 664.6 [0,1,4]) or procedure codes (ICD-9 75.62) within 28 days of delivery.

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Variable	Data source and definition
Operative vaginal delivery	Birth certificate, or health plan diagnosis codes (ICD-9 669.5x, 763.2, 763.3) or procedure codes (72.0, 72.1, 72.2x, 72.3x, 72.51, 72.53, 72.6, 72.7x, 72.8, or 72.9) from the delivery hospitalization.
Gestational hypertension	Health plan diagnosis codes (642.9x or 642.3x) without a diagnosis of chronic hypertension (below) from the delivery hospitalization.
Preeclampsia	Health plan diagnosis codes (642.4x, 642.5x, or 642.7x) from the delivery hospitalization.
Neonatal jaundice	Health plan diagnosis codes (774.2, 774.6, or 774.7) within the first 28 days of delivery.
Neonatal birth injury	Birth certificate or health plan diagnosis code ICD-9 767.xx.
Neonatal intensive care unit admission (levels 2-4)	Health plan procedure codes (CPT 99468, 99469, 99477, 99478, 99479, 99480, or revenue code 0172, 0173 or 0174) within 28 days of delivery.
Infant mortality	A health plan or state death certificate indicator of an infant's death within the first 365 days after birth.
Covariates	
Maternal age at delivery	Health plan
Maternal race-ethnicity	Birth certificate
Maternal education	Birth certificate
Maternal marital status	Birth certificate
Maternal Medicaid health insurance during pregnancy	Health plan data on insurance type
Maternal smoking during pregnancy	Birth certificate
Maternal prepregnancy body mass index	Birth certificate
Maternal chronic hypertension	Health plan diagnosis codes (ICD-9 642.9x from start of pregnancy through 20 weeks gestation, or ≥2 codes for 401.0x, 402.x, 403.x, 404.x, 405.x, 642.0x, 642.1x, 642.2x, or 642.7x between 1 year prior to start of pregnancy and delivery date)
Parity	Birth certificate
Infant sex	Birth certificate

The delivery hospitalization included the mother's and infant's records.

Appendix 2. Comparison of Kaiser Permanente Washington's Gestational Diabetes Mellitus Clinical Guideline Before and After the 2011 Change

Guideline recommendations	Kaiser Permanente Washington's GDM Clinical Guideline	
	Before March 2011	**After March 2011**
Pregestational diabetes screening	Optional testing with HbA1c during first trimester for women with a history of gestational diabetes (≥7% was a positive result)	Required testing for all women with HbA1c at initial prenatal visit as of December 2010 (≥6.5% was a positive result).
Gestational diabetes screening and diagnostic testing	**Screening at 24-28 weeks gestation**: • 50 gram 1-hour glucose challenge test (positive result was blood glucose ≥135 mg/dL) or • Fasting serum glucose test (positive result was blood glucose ≥85 mg/dL) **Diagnostic testing (in women who screened positive):** • 100 gram 3-hour oral glucose tolerance test A positive result was two or more plasma glucose values exceeding:[2] Fasting ≥105 mg/dL 1-hour ≥190 mg/dL 2-hour ≥165 mg/dL 3-hour ≥145 mg/dL	**Diagnostic testing at 24-28 weeks gestation:** • 75 gram 2-hour oral glucose tolerance test. A positive result was any one blood glucose value exceeding:[3] Fasting ≥92 mg/dL 1-hour ≥180 mg/dL 2-hour ≥153 mg/dL
Treatment of women diagnosed with gestational diabetes	• Dietary modification, nutritional counseling, and monitoring of blood glucose values. • Target blood glucose values above which medication was recommended: Fasting <105 mg/dL 1-hour postprandial <155 mg/dL 2-hour postprandial <130 mg/dL • Medication: Insulin or glyburide if patient's compliance would be enhanced with glyburide.	• Dietary modification, nutritional counseling, and monitoring of blood glucose values. • Target values above which medication was recommended: Fasting <90 mg/dL 1-hour postprandial <120 mg/dL • Medication: Insulin was first line. Oral agents were discouraged. For women not willing to take insulin, metformin was preferred over glyburide.
Follow-up after delivery	• In women diagnosed with GDM, optional testing with fasting serum glucose at 6 weeks postpartum and every 3 years thereafter.	• In women diagnosed with GDM, testing with HbA1C at 3 months postpartum. • In women with a history of GDM, annual testing with HbA1C.

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Appendix 3. Associations Between Secondary Perinatal Outcomes and Kaiser Permanente Washington's Gestational Diabetes Guideline Change, According to Prenatal Care Setting*

Secondary Perinatal Outcomes	Before Incidence, % (95% CI)†	After Incidence, % (95% CI)†	Unadjusted Relative Risk After versus Before (95% CI)‡	Adjusted Relative Risk After versus Before (95% CI)†‡	Difference-in- Difference, Relative Risk ($RR_{Internal}/RR_{External}$) (95% CI)†§
Gestational hypertension‖					
Care from internal providers	5.0 (4.4-5.6)	5.5 (5.0-6.2)	1.12 (0.96-1.31)	1.11 (0.95-1.31)	1.02 (0.80-1.30)
Care from external providers	5.8 (5.0-6.7)	6.3 (5.6-7.1)	1.17 (0.98-1.40)	1.09 (0.91-1.31)	Reference
Preeclampsia					
Care from internal providers	4.00 (3.51-4.64)	3.48 (3.09-3.99)	0.91 (0.76-1.09)	0.87 (0.72-1.05)	0.95 (0.71-1.26)
Care from external providers	4.66 (4.00-5.55)	4.29 (3.74-5.00)	1.01 (0.82-1.25)	0.92 (0.74-1.14)	Reference
Number of days in which an ultrasound was received in the third trimester (per 100 deliveries)‖					
Care from internal providers	85.2 (81.5-89.1)	87.0 (83.6-90.6)	1.03 (0.97-1.09)	1.02 (0.96-1.08)	1.00 (0.92-1.10)
Care from external providers	119.6 (111.1-127.9)	121.7 (116.3-127.8)	1.05 (0.98-1.12)	1.02 (0.95-1.09)	Reference
Number of days in which a nonstress test was received (per 100 deliveries)‖					
Care from internal providers	134.6 (128.7-141.0)	157.0 (150.6-164.1)	**1.19 (1.12-1.27)**	**1.17 (1.10-1.24)**	**1.12 (1.02-1.24)**
Care from external providers	166.6 (156.6-177.8)	173.16 (164.5-182.6)	**1.09 (1.01-1.19)**	1.04 (0.96-1.13)	Reference
Preterm birth					
Care from internal providers	5.4 (4.8-6.1)	5.1 (4.7-5.8)	0.97 (0.83-1.13)	0.96 (0.82-1.12)	0.94 (0.74-1.20)
Care from external providers	6.0 (5.2-7.0)	6.1 (5.4-6.9)	1.03 (0.87-1.23)	1.01 (0.84-1.22)	Reference
Shoulder dystocia					
Care from internal providers	1.7 (1.3-2.1)	1.6 (1.3-2.0)	0.98 (0.73-1.31)	0.96 (0.71-1.29)	0.86 (0.54-1.25)
Care from external providers	2.3 (1.8-2.9)	2.6 (2.2-1.6)	1.13 (0.85-1.49)	1.16 (0.87-1.55)	Reference
Any Cesarean delivery (primary or repeat)					
Care from internal providers	27.5 (26.2-28.8)	25.7 (24.7-26.8)	0.97 (0.91-1.03)	0.94 (0.88-0.99)	1.00 (0.91-1.07)
Care from external providers	32.7 (31.1-34.5)	30.8 (29.4-32.3)	0.97 (0.91-1.03)	0.94 (0.88-1.01)	Reference
NTSV cesarean delivery					
Care from internal providers	24.1 (22.4-26.0)	21.5 (20.1-23.1)	0.94 (0.85-1.04)	**0.89 (0.81-0.99)**	1.01 (0.86-1.18)
Care from external providers	28.7 (26.2-31.7)	25.5 (23.5-27.8)	0.92 (0.81-1.04)	0.89 (0.78-1.01)	Reference
Vaginal delivery among women with a prior cesarean delivery					

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Care from internal providers	16.3 (13.9-19.8)	20.0 (17.6-28.4)	1.18 (0.95-1.47)	1.23 (0.98-1.53)	0.96 (0.67-1.38)
Care from external providers	11.6 (9.4-14.8)	14.8 (12.5-18.1)	1.16 (0.89-1.52)	1.27 (0.96-1.69)	Reference
Operative vaginal delivery					
Care from internal providers	5.1 (4.6-5.8)	5.2 (4.7-5.8)	1.03 (0.88-1.20)	1.01 (0.86-1.18)	1.06 (0.83-1.35)
Care from external providers	6.7 (5.8-7.7)	6.4 (5.7-7.2)	0.95 (0.80-1.14)	0.95 (0.79-1.15)	Reference
Severe perineal tear among vaginal deliveries					
Care from internal providers	5.5 (4.8-6.3)	4.7 (1.2-5.3)	0.92 (0.77-1.10)	0.85 (0.71-1.01)	1.03 (0.76-1.40)
Care from external providers	5.9 (5.0-7.1)	4.9 (4.1-5.8)	0.84 (0.66-1.06)	0.82 (0.64-1.05)	Reference
Neonatal jaundice					
Care from internal providers	31.0 (29.7-32.6)	33.1 (31.9-34.3)	**1.10 (1.04-1.16)**	**1.07 (1.01-1.13)**	1.07 (0.98-1.16)
Care from external providers	34.0 (32.4-35.8)	34.1 (32.7-35.6)	1.00 (0.94-1.07)	1.00 (0.94-1.07)	Reference
Birth injury					
Care from internal providers	3.2 (2.8-3.8)	3.5 (3.1-4.0)	1.12 (0.92-1.37)	1.09 (0.89-1.34)	1.09 (0.79-1.49)
Care from external providers	3.7 (3.1-4.5)	3.7 (3.2-4.4)	1.00 (0.79-1.26)	1.00 (0.79-1.28)	Reference
Neonatal intensive care unit admission level (2-4)¶					
Care from internal providers	11.2 (10.4-12.2)	11.6 (10.9-12.5)	1.03 (0.93-1.14)	1.03 (0.93-1.15)	0.84 (0.70-1.01)
Care from external providers	8.9 (7.9-10.0)	10.9 (10.0-12.0)	**1.23 (1.07-1.41)**	**1.23 (1.06-1.42)**	Reference
Infant mortality					
Care from internal providers	0.32 (0.20-0.52)	0.33 (0.22-0.51)	1.03 (0.54-1.97)	#	#
Care from external providers	0.21 (0.10-0.43)	0.34 (0.20-0.56)	1.63 (0.67-3.99)	#	#

CI = Confidence interval; NTSV = Nulliparous term singleton vertex. Relative risks are bolded if they are statistically significantly different (p<0.05) from 1.00.

This analysis is limited to women who were eligible to experience the outcome, e.g. women with chronic hypertension were excluded from gestational hypertension analyses because by definition they could not develop gestational hypertension. Counts of deliveries in the numerators and denominators are in Appendix 4.

*Before the guideline change, 01/2009-03/2011; after the change, 04/2012-12/2014.

†Incidence and relative risks were adjusted for maternal age, race-ethnicity, education, marital status, parity, pre-pregnancy BMI, chronic hypertension, smoking during pregnancy, and Medicaid insurance coverage; and infant sex.

‡For each prenatal care setting, the reference group was deliveries occurring before the guideline change (01/2009-03/2011).

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§The "Difference-in-Difference" Relative Risk compares the relative risk of the outcome After versus Before the guideline change among those cared for by internal providers to the comparable estimate among those cared for by external providers; that is, the denominator is the Relative Risk After versus Before in those cared for by external providers (e.g. RR=1.09 for gestational hypertension).

‖For continuous variables (i.e., number of days of receipt of an ultrasound during the third trimester and number of days of receipt of a nonstress test during pregnancy) the adjusted mean per 100 deliveries was reported instead of the incidence.

¶Level 2-4 includes continuing care (e.g. low birth weight neonates who are not sick), intermediate care, and intensive care.

#Adjusted estimate was not computed due to the small number of events. Unadjusted difference-in-difference relative risk = 0.63 (95% CI: 0.21-1.91)

Appendix 4. Numerator and Denominator for Each Perinatal Outcome for Table 3 (Primary Maternal and Neonatal Outcomes) and Appendix 3 (Secondary Maternal and Neonatal Outcomes) Before and After Kaiser Permanente Washington's Gestational Diabetes Guideline Change, According to Prenatal Care Setting*†

Outcomes	Before Number of Deliveries		After Number of Deliveries	
	Numerator	Denominator	Numerator	Denominator
Primary				
Gestational diabetes				
Cared for by internal providers	357	4,977	761	6,337
Cared for by external providers	305	3,386	483	4,454
Induction of labor				
Cared for by internal providers	1,226	4,977	1,797	6,337
Cared for by external providers	1,035	3,386	1,332	4,454
Primary cesarean				
Cared for by internal providers	826	4,317	1,029	5,504
Cared for by external providers	582	2,846	744	3,754
Macrosomia (≥4,500 g)				
Cared for by internal providers	118	4,977	127	6,337
Cared for by external providers	58	3,386	79	4,454
Large-for-gestational age				
Cared for by internal providers	486	4,977	581	6,337
Cared for by external providers	341	3,386	416	4,454
Small-for-gestational age				
Cared for by internal providers	361	4,977	467	6,337
Cared for by external providers	212	3,386	270	4,454
Neonatal intensive care unit admission (levels 3-4)				
Cared for by internal providers	267	4,977	330	6,337
Cared for by external providers	226	3,386	340	4,454
Secondary				
Gestational Hypertension				
Cared for by internal providers	240	4,862	340	6,150
Cared for by external providers	184	3,292	280	4,286
Preeclampsia				
Cared for by internal providers	204	4,977	237	6,337
Cared for by external providers	148	3,386	197	4,454
Preterm birth				
Cared for by internal providers	285	4,977	352	6,337
Cared for by external providers	204	3,386	277	4,454
Shoulder dystocia				
Cared for by internal providers	78	4,977	97	6,337
Cared for by external providers	79	3,386	117	4,454
Any cesarean delivery (primary or repeat)				
Cared for by internal providers	1,378	4,977	1,701	6,337
Cared for by external providers	1,051	3,386	1,337	4,454
NTSV cesarean delivery				
Cared for by internal providers	512	2,111	635	2,793
Cared for by external providers	323	1,208	403	1,639
Vaginal delivery among women with a prior cesarean				
Cared for by internal providers	108	660	161	833

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Cared for by external providers	71	540	107	700
Operative vaginal delivery				
Cared for by internal providers	268	4,977	350	6,337
Cared for by external providers	203	3,386	255	4,454
Severe perineal tear among vaginal deliveries				
Cared for by internal providers	202	3,599	239	4,636
Cared for by external providers	121	2,335	135	3,117
Neonatal jaundice				
Cared for by internal providers	1,539	4,977	2,149	6,337
Cared for by external providers	1,119	3,386	1,479	4,454
Birth injury				
Cared for by internal providers	162	4,977	232	6,337
Cared for by external providers	120	3,386	158	4,454
Neonatal intensive care unit admission (levels 2-4)				
Cared for by internal providers	593	4,977	777	6,337
Cared for by external providers	291	3,386	471	4,454
Infant mortality				
Cared for by internal providers	16	4,977	21	6,337
Cared for by external providers	7	3,386	15	4,454

NTSV = nulliparous term singleton vertex.

*Before the guideline change, 01/2009-03/2011; after the change, 04/2012-12/2014.

†Deliveries are restricted to those eligible to experience the outcome, e.g. women with chronic hypertension were excluded from gestational hypertension because by definition they could not develop gestational hypertension.

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