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Review

Health Insurance Coverage Disruptions and Cancer Care and Outcomes: Systematic Review of Published Research

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Abstract

Background: Lack of health insurance coverage is associated with poor access and receipt of cancer care and survival in the United States. Disruptions in coverage are common among low-income populations, but little is known about associations of disruptions with cancer care, including prevention, screening, and treatment, as well as outcomes of stage at diagnosis and survival. **Methods:** We conducted a systematic review of studies of health insurance coverage disruptions and cancer care and outcomes published between 1980 and 2019. We used the PubMed, EMBASE, Scopus, and CINAHL databases and identified 29 observational studies. Study characteristics and key findings were abstracted and synthesized qualitatively. **Results:** Studies evaluated associations between coverage disruptions and prevention or screening (31.0%), treatment (13.8%), end-of-life care (10.3%), stage at diagnosis (44.8%), and survival (20.7%). Coverage disruptions ranged from 4.3% to 32.8% of patients age-eligible for breast, cervical, or colorectal cancer screening. Between 22.1% and 59.5% of patients with Medicaid gained coverage only at or after cancer diagnosis. Coverage disruptions were consistently statistically significantly associated with lower receipt of prevention, screening, and treatment. Among patients with cancer, those with Medicaid disruptions were statistically significantly more likely to have advanced stage (odds ratios = 1.2-3.8) and worse survival (hazard ratios = 1.28-2.43) than patients without disruptions. **Conclusions:** Health insurance coverage disruptions are common and adversely associated with receipt of cancer care and survival. Improved data infrastructure and quasi-experimental study designs will be important for evaluating the associations of federal and state policies on coverage disruptions and care and outcomes.

Lack of health insurance coverage is one of the strongest predictors of poor cancer outcomes in the United States (1–4). The uninsured are less likely to receive evidence-based care throughout the cancer control continuum, including prevention and screening, diagnosis, treatment (ie, surgery, radiation therapy, and systemic therapies) and symptom management, survivorship, and end-of-life care than their counterparts with health insurance coverage (2,5). The uninsured are also more likely to have later stage of disease at diagnosis (6,7) and poorer survival (4,7). Because health insurance coverage can reduce health disparities in populations defined by race or ethnicity, poverty, and geography (2,8–13), expanding public and private health insurance coverage options has been the focus of many policy efforts.

Following the implementation of the Affordable Care Act (ACA), there were historic increases in the number of working-age Americans with health insurance coverage (14). Even so, some adults experience insurance coverage losses and/or gains within a single year (15,16). Coverage disruptions and health insurance coverage churn are especially common among the poor and those with Medicaid coverage (17). Research conducted in pediatric populations consistently shows that health insurance coverage disruptions are associated with reduced access to care (18). In the few studies of coverage disruptions conducted in adults, even a single loss of coverage of at least 1 month is associated with worse access to care (19), delaying or forgoing care (20), more emergency department use (15,21,22), and declines in

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overall health (15). Transitions between health plans can also disrupt access to usual source of care and provider networks. However, to date, most research on the health effects of insurance coverage has measured and evaluated coverage at only a single point in time (eg, at cancer diagnosis) (3,4,23–26), and synthesis of research addressing the effects of disruptions in insurance coverage on cancer care and outcomes across the cancer control continuum is needed. Understanding the associations of coverage disruptions with care is especially relevant given the rapidly changing health insurance landscape in the United States. In this study, we conducted a systematic review of published peer-reviewed research to assess the associations of health insurance coverage disruptions with care and outcomes, including cancer prevention, screening, and stage of disease at diagnosis, treatment, survival, and end-of-life care.

Methods

Literature Review

Because a standard definition of coverage disruptions does not exist, we defined health insurance coverage disruptions as gaps in coverage, losses or gains of public or private coverage, timing of coverage (eg, pre-, peri-, or postcancer diagnosis), or transitions between types of coverage (eg, public and private) or specific health insurance plans. We used the PubMed, EMBASE, Scopus, and CINAHL databases to identify studies assessing health insurance coverage disruptions and cancer care or outcomes in the United States and published in English between January 1, 1980, and July 31, 2019. We started the literature search in 1980 and ended with the most recent year to ensure we identified as many relevant studies as possible. In the PubMed database, our search strategy combined Medical Subject Heading and title and abstract terms for neoplasms, health insurance coverage, and health insurance enrollment (see Supplemental Methods, available online). This search strategy was replicated in the EMBASE, Scopus, and CINAHL databases, and the combined searches yielded 1523 unique articles. A single reviewer (J.Z.) assessed the abstracts of these articles for eligibility. Included studies were required to quantitatively assess insurance coverage at more than 1 time point to allow measurement of coverage disruptions (a period with insurance coverage and a period either without coverage or with a change in coverage) and examine the association between coverage disruption and cancer-related care (ie, prevention, screening, follow-up of abnormal findings, treatment, survivorship, or end-of-life care) or outcomes (ie, stage of disease at diagnosis, survival). We excluded studies conducted outside the United States or whose only source of health insurance coverage information was from cancer registry data, because registries only report coverage at a single time point consolidated after cancer diagnosis. We also excluded editorials, commentaries, and review articles. Questions about article eligibility were resolved by consensus. Following abstract review, 66 full articles were reviewed, and of these, 24 met the inclusion criteria. Reference lists of included articles were hand-searched, and an additional 5 articles were identified for a total of 29 articles (27–55). This systematic review was conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (http://prisma-statement.org/). Supplemental Table 1 (available online) describes the search terms used in the literature review, and Supplemental Figure 1 (available online) illustrates the search process.

Data Abstraction

Data were abstracted on study characteristics, including year of publication, data source(s), geographic setting (national, multiple states/cities, single state), and study design (cross-sectional, cohort, intervention). Component(s) of the cancer control continuum (prevention, screening, treatment, survivorship/survival, and end-of-life care) and outcome measures (receipt of care, stage at diagnosis, survival and/or mortality, spending) were also recorded. Although earlier stage of disease at diagnosis can reflect receipt of regular screening for breast, cervical, and colorectal cancers, screening tests are not recommended for other cancers. Additionally, early evaluation of signs and symptoms can play an important role in diagnosis. For these reasons, we abstracted and reported findings for stage at diagnosis separately from cancer screening.

Patient characteristics included sample size, age range or age distribution, and cancer diagnosis if the study was conducted in patients with cancer. The source of health insurance coverage measures included registry, self-report, and Medicaid enrollment. The type of insurance coverage disruption was abstracted as reported in underlying articles and later classified as a coverage gap, the measured duration of coverage or coverage gap, and timing of coverage (eg, pre-, peri-, or postcancer diagnosis). Similarly, data on comparison groups were classified by insurance type, continuously insured or previously insured, duration of coverage (eg, <12 months vs ≥ 12 months), and timing of coverage. Key findings abstracted from each article noted the prevalence and type of coverage disruption and the associations between coverage disruption and care and/or outcomes. A single author (J.Z.) abstracted data from the included studies, and another author (K.R.Y.) reviewed these data. Any inconsistencies were resolved by consensus. The heterogeneity of underlying study populations, coverage disruption measures, time periods, and component of the cancer control continuum precluded a quantitative data synthesis. We performed a qualitative synthesis of study findings by outcome examined.

Results

Study, Patient, and Insurance Coverage Characteristics

Most studies were conducted and published before 2014, conducted in a single state, and used cancer registry data linked to Medicaid enrollment data (Table 1). Studies were published after the passage of the ACA in 2010, but none evaluated the effects of the ACA on coverage disruptions or on the association of disruptions with care receipt or outcomes. Studies also used survey data or Medicaid enrollment and claims data only without registry linkage. Outcomes from claims, such as screening or treatment, are reported only during periods of continuous coverage. Studies evaluated associations between coverage disruptions and prevention or screening (31.0%), stage of disease at diagnosis (44.8%), treatment (13.8%), survivorship or survival (20.7%), and end-of-life care (10.3%). A single study evaluated health-care spending. Most were conducted in samples of at least 1000 patients, and among studies that evaluated patients after a cancer diagnosis, the most common types were breast, cervical, colorectal, and lung.

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Table 1. Study, patient, and insurance coverage characteristics

Characteristics	No. of studies (%) (N = 29)
Study characteristics	
Publication year	
2000-2004	10 (34.5)
2005-2009	5 (17.2)
2010-2014	7 (24.1)
2015-2019	7 (24.1)
Geographic setting	
National	4 (13.8)
Multiple cities and/or states	2 (6.9)
Single state	23 (79.3)
Data source	
Cancer registry - Medicaid enrollment, ± claims	19 (65.5)
Medicaid enrollment, claims	4 (13.8)
Survey	6 (20.7)
Study design	
Cross-sectional	4 (13.8)
Cohort	25 (86.2)
Component of cancer control continuum[a]	
Prevention	1 (3.4)
Screening	8 (27.6)
Stage of diagnosis	13 (44.8)
Treatment	4 (13.8)
Survivorship/survival	6 (20.7)
End-of-life care	3 (10.3)
Study outcome(s)[a]	
Access to care or receipt of care	15 (51.7)
Stage of disease at diagnosis	13 (44.8)
Survival or mortality	7 (24.1)
Spending	1 (3.1)
Patient characteristics	
No. of patients	
<999	3 (10.3)
1000-9999	11 (37.9)
10 000+	15 (51.7)
Age group[a]	
<18	13 (44.8)
18-39	21 (72.4)
40-64	25 (82.8)
Cancer site(s)[a]	
Breast	8 (27.6)
Cervical	6 (20.7)
Colorectal	6 (20.7)
Lung	6 (20.7)
Other cancer sites	4 (13.8)
Multiple cancer types (eg, gynecologic, AYA)	3 (10.3)
All cancer sites	2 (6.9)
Without cancer	9 (31.0)
Insurance coverage	
Coverage disruption evaluated	
Medicaid only	22 (75.9)
Multiple types of coverage	7 (24.1)
Source of coverage measure	
Registry	1 (3.4)
Self-report	6 (20.7)
Enrollment and claims	21 (72.4)
Other	1 (3.4)
Coverage disruption measure(s)[a]	
Coverage gap	8 (27.6)
Duration of coverage gap	2 (6.9)
Duration of coverage	12 (41.4)
Timing of coverage (eg, pre- or postdiagnosis)	18 (62.1)
Comparison group[a]	
Continuously insured or continuously uninsured	11 (37.9)
Continuously insured and continuously uninsured	5 (17.2)
Prediagnosis coverage	9 (31.0)
Duration of coverage	4 (13.8)
Other	2 (6.9)

[a]Categories are not mutually exclusive, and studies were included in multiple categories. AYA = Adolescents and young adult.

Nearly three-quarters of studies used Medicaid enrollment and claims data as the source of health insurance coverage; self-report was less common. There was substantial heterogeneity across studies in the types of coverage disruptions evaluated. Studies evaluated coverage gaps (27.6%), timing of coverage, either pre- or postdiagnosis (62.1%), as well as the duration of coverage (41.4%) or coverage gap (6.9%). Many studies evaluated multiple types of disruptions. The type of coverage disruption varied by data source and outcome measured. For example, most studies evaluating stage of disease at diagnosis used measures about the timing of coverage pre-, peri-, and/or postdiagnosis. The number of months used to measure the timing of coverage varied widely.

All studies included a comparison group, although comparison groups varied, and included the continuously insured, without Medicaid coverage (both uninsured and insured), insured before diagnosis, and a combination of continuously insured and continuously uninsured. Although some studies included populations with all types of coverage, including private coverage, none of the studies evaluated coverage disruptions exclusively among those with private coverage or transitions between different private insurance plans. Heterogeneity of geographic region, patient population, measures, and outcomes in the underlying studies precluded the measurement of trends over time.

Cancer Prevention and Screening

For the studies evaluating cancer prevention and screening, details of study populations, settings, measures of coverage disruptions and outcomes, comparison groups, and key findings are listed in Table 2. One study evaluated associations between coverage disruptions and HPV vaccination in adolescent girls (39), and 8 studies examined associations between disruptions and cancer screening in age-eligible adults (27–32,37,38). Prevalence of coverage disruptions ranged from 4.3% to 32.8% in samples of adults without a cancer history and age-eligible for cancer screening in studies that reported this information (27,30). Coverage disruptions were statistically significantly associated with less frequent receipt of prevention or screening in 7 of 9 studies; associations were null in the remaining 2 studies. Coverage disruptions were statistically significantly associated with less use of mammography (27–29,32,37) and Pap testing (27–29) compared with continuously insured women or women

Table 2. Health insurance coverage disruptions and cancer screening[a]

Reference	Sample size, No.	Setting, data source, and year	Insurance coverage measures	Outcome measures	Key findings
Ayanian et al., 2000 (27)	223 128 adults aged 18-64 y	National; BRFSS, 1997-1998	Self-reported short-term uninsured (uninsured <1 y) with coverage gap <1 year vs currently insured (private and/or public)	Self-reported Pap test ≤3 y, mammography ≤2 y, fecal occult blood test ≤2 y, and sigmoidoscopy ≤5 y among eligible adults	4.3 % short-term uninsured Compared with currently insured, short-term uninsured were less likely to receive mammography (78.7% vs 89.0%, $P < .05$) or Pap test (89.5% vs 93.7%, $P < .05$) No differences observed for receipt of CRC screenings
Bednarek and Schone, 2003 (28)	11 755 women aged 21-64 y	National; MEPS, 1996	Self-reported duration of private or public coverage, measured as 1-6 mo, 7-11 mo vs all 12 mo	Self-reported use of mammography and Pap test ≤2 y among eligible women	Percentage short-term insured 1-6 and 7-11 mo not reported Compared with continuously insured for 12 mo, insured for 1-6 mo less likely to have Pap smears (79.9% vs 70.7%, $P < .05$) or mammograms (66.7% vs 53.6%, $P < .05$) Compared with insured 7-12 mo, insured 1-6 mo were less likely to have Pap smears (81.8% vs 70.7%, $P < .05$) or mammograms (67.0% vs 53.6%, $P < .05$). Continuously insured and insured 7-12 mo did not statistically significant differ
Broyles et al., 2002 (29)	1512 women aged ≥18 y	Oklahoma's BRFSS, 1993	Self-reported temporarily uninsured with coverage gap previous year vs continuously insured	Self-reported use of mammography (in the past 2 y) and Pap test screening (in the past 3 y) among eligible women	Percentage temporarily uninsured in previous year not reported Use of mammograms and Pap smears similar in temporarily uninsured and continuously insured (OR = 0.8 and OR = 0.9, respectively; both $P > .05$)
Freund et al., 2019 (30)	333 adults aged 40-74 y	Minority race/ethnicity or low SES participants recruited across 4 sites in 3 states: Chinese Americans in Boston, MA; Hispanic in Columbus, OH; Appalachian populations in OH's Appalachian region; and African American and Black populations in Philadelphia, PA. Patients recruited from community-based organizations, faith-based organizations, public housing, screening events, health fairs, and from existing research studies. Years of data collection not stated	Self-reported insurance instability in past 12 mo defined as uninsured, losing coverage, or changing insurance vs stable insurance status (insured, uninsured)	Self-reported use of screening and date of last test. Up to date for BC, cervical cancer, or CRC screening status calculated per USPSTF	32.8% reported insurance instability No statistically significant differences in BC (72.6% vs 80.6%, $P = .23$), cervical cancer (67.2% vs 73.4%, $P = .48$), and CRC (61.4% vs 70.1%, $P = .19$) screening between adults with insurance coverage instability compared with those with stable coverage
Jerant et al., 2013 (31)	92 809 adults aged ≥18 y	National; MEPS, 2000-2008; 2-y panels	Self-reported insurance loss during 2-y follow-up period vs no private and/or public coverage change (continuously insured	Self-reported use of CRC screening (fecal occult blood testing ≤2 y and/or endoscopy ≤5 y), Pap test ≤3 y, and mammography	3193 adults lost insurance. Those with insurance loss less likely to receive Pap (OR = 0.6, 95% CI = 0.5 to 0.8) and mammography (OR = 0.6, 95% CI = 0.4 to 0.8) than those without insurance change. Also less likely to receive CRC screenings, but association not statistically significant (OR = 0.7, 95% CI = 0.4 to 1.0)

(continued)

Table 2. (continued)

Reference	Sample size, No.	Setting, data source, and year	Insurance coverage measures	Outcome measures	Key findings
			and continuously uninsured)	≤2 y among eligible adults	
Koroukian, 2004 (32)	140 592 women aged 40-64 y	Ohio Medicaid claims and enrollment files, 1992-1999	Duration of coverage = length of enrollment in Medicaid (≤12, 13-24, 25-36 mo, etc [up to 8 y])	Receipt of annual and regular annual screening mammography from claims	40.7% enrolled ≤12 mo, 17.6% enrolled 13-24 mo, 41.7% enrolled >24 mo Proportion of women receiving screening mammography increased statistically significantly each additional year of Medicaid enrollment (AOR = 1.6, 95% CI = 1.6 to 1.6) Mean annual mammograms increased from 0.08 in women with enrollment ≤12 mo to 0.26 in women with enrollment ≥7 y
McWilliams et al., 2003 (37)	2036 adults aged 60-64 y in 1996; No. of women not stated	National; Health and Retirement Study, 1994, 1996	Self-reported coverage gap measured as intermittently insured (insured in either 1994 or 1996) vs privately and/or publicly insured in both 1994 and 1996 (continuously insured)	Self-reported mammography ≤2 y	216 were intermittently insured Compared with continuously insured, intermittently insured less likely to receive mammography (76.0% vs 57.7%, $P < .05$)
O'Leary et al., 2019 (38)	10 831 adults who turned 50 y during 2010-2013	Oregon Medicaid claims data, 2010-2014	New enrollment in Medicaid at 50 y vs prior enrollment before 50 y	CRC screening with colonoscopy, sigmoidoscopy, or stool testing from claims within 12 mo of age 50 y	Percentage newly enrolled not reported No differences in CRC screening newly enrolled in Medicaid and prior enrollment (RR = 1.0, 95% CI = 0.8 to 1.3, $P = .87$)
Staras et al., 2010 (39)	237 015 girls aged 9-17 y	Florida Medicaid enrollment and claims, June 2006 to Dec 2008	Coverage duration measured as no. of months enrolled in Medicaid (1–31)	At least 1 HPV vaccine claim	Percentages by duration of months enrolled in Medicaid not reported Longer length of Medicaid enrollment positively associated with receipt of at least 1 HPV vaccination. HPV vaccination rates were 3.5%, 12.8%, 19.0%, 22.2%, 28.4% for girls enrolled in Medicaid for 1-7, 8-13, 14-19, 20-25, 26-31 mo, respectively

[a]AOR = adjusted odds ratio; BC = breast cancer; BRFSS = Behavioral Risk Factor Surveillance Survey; CI = confidence interval; CRC = colorectal cancer; MEPS = Medical Expenditure Panel Survey; OR = odds ratio; RR = risk ratio; SES = socioeconomic status; USPSTF = United States Preventive Services Task Force.

with longer durations of insurance coverage. Shorter durations of insurance coverage were statistically significantly associated with less frequent receipt of HPV vaccination among adolescent girls (39). Several studies reported a dose-response relationship between coverage duration and greater receipt of prevention and screening (28,32,39).

Coverage disruption was not statistically significantly associated with receipt of screening in 1 study with a relatively small sample (n = 333) that included adults older than age 65 years (who are generally age-eligible for continuous Medicare coverage) (30). Associations between coverage disruptions and colorectal cancer screening (eg, fecal occult blood test, flexible sigmoidoscopy, or colonoscopy) in men and women were null (27,30,38). Two of the 4 studies did not include colonoscopy (27,38), currently the most common colorectal cancer screening modality.

Stage of Disease at Diagnosis

Among the 13 studies that examined coverage disruptions and stage of disease at diagnosis, details for study populations, settings, measures of coverage disruptions and outcomes, comparison groups, and key findings are listed in Table 3 (33,34,40,41,43–51). Each of these studies examined timing of Medicaid enrollment in a single state, including California, Michigan, New Jersey, North Carolina, Ohio, or Washington. Coverage disruption was measured as Medicaid enrollment timing in relation to diagnosis or as continuity of Medicaid coverage. The number of months used to define timing of coverage or coverage continuity varied widely. Information about insurance coverage before Medicaid enrollment was not available, and patients could have been previously enrolled in private health insurance plans or uninsured.

Among newly diagnosed patients with Medicaid coverage, between 22.1% and 59.5% enrolled in Medicaid at or after diagnosis in studies that reported this information. Coverage disruptions were associated with advanced stage in all 13 studies, with odds ratios ranging from 1.2 to 3.8. In studies that evaluated the effects of coverage disruptions by cancer site, disruptions were statistically significantly associated with advanced stage for breast, cervical, colorectal, thyroid, lung, melanoma, non-Hodgkin and Hodgkin lymphomas, and ovarian cancers.

None of the studies explicitly compared the magnitude of associations between coverage disruptions for those cancers with effective screening tests (ie, breast, cervical, colorectal) and those cancers without effective screening tests that are typically diagnosed at a later stage of disease. One study linked cancer registry, Medicaid enrollment, and the Breast and Cervical Cancer Early Detection Program (BCCEDP) data to assess one-time and repeat BCCEDP use and stage at breast cancer diagnosis (34) (previously uninsured women diagnosed with cancer as a result of screening through BCCEDP are automatically enrolled in Medicaid). Compared with prediagnosis Medicaid enrollees, one-time BCCEDP users were more likely to be diagnosed with advanced-stage breast cancer, but there was no statistically significant association with stage for repeat BCCEDP users.

Cancer Treatment and Survival

Four studies evaluated the effects of Medicaid coverage disruptions on receipt of treatment (44,51–53), and 7 studies evaluated the effects of disruptions on survival (34,35,40,42,44,45,51). Details of study populations, settings, measures of coverage disruptions and outcomes, comparison groups, and key findings are listed in Table 4. Studies were conducted in California, Georgia, Michigan, North Carolina, New Jersey, and Ohio. Among newly diagnosed patients with Medicaid coverage, between 22.1% and 59.5% enrolled in Medicaid at or after diagnosis. In 3 of 4 studies evaluating treatment, coverage disruptions were associated with treatment delay (51) and lower likelihood of receiving treatment (44,52). Treatment delay and lack of definitive surgery were reported for multiple cancer sites, including breast, colon, lung, and gastric cancers (44,51,52). Two relatively small studies reported null findings for the association between coverage disruption and receipt of treatment (52,53); however, they measured both coverage disruptions and treatment with Medicaid claims after diagnosis, limiting interpretation of findings because treatment could not be measured among those without Medicaid coverage.

All 7 studies reported that survival following diagnosis was statistically significantly worse for patients who gained Medicaid coverage at or after diagnosis. Worse survival was reported for multiple cancer types, including, breast, cervical, colon, lung, and gastric cancers, with odds ratios or hazard ratios ranging from 1.28 to 2.43 (40,42,51). Several studies reported that disparities in survival for those with coverage disruptions were mediated by differences in stage at diagnosis (40,45).

Although studies did not explicitly compare the magnitude of associations between coverage disruptions for cancers with and without effective screening tests, 1 study of patients with breast cancer reported better cancer-specific and overall survival among previously uninsured one-time and repeat BCCEDP users compared with other Medicaid enrollees (34).

End-of-Life Care and Health-Care Spending

Two studies evaluated coverage disruptions and end-of-life care (54,55) and 1 evaluated spending among Medicaid enrollees who died of cancer. Details for each study are listed in Table 5 (36). Studies were conducted in California, New York, and Ohio. Disruptions were associated with statistically significantly less use of hospice before death among patients diagnosed with stage IV lung cancer compared with those with continuous Medicaid coverage in 2 states (54). Similarly, disruptions were associated with statistically significantly less hospice use among those diagnosed with any cancer as adolescent and young adults (55). Both studies reported a dose-response association, with lower odds of hospice use among those with greater coverage discontinuity between diagnosis and death (54,55). Discontinuous Medicaid coverage was also associated with less use of other types of care, including aggressive treatment, measured as chemotherapy within 14 days of death, emergency room visit, hospitalization, or intensive care unit stay within 30 days of death (55). Longer Medicaid enrollment was associated with higher per-person, per-month medical care spending among patient with any cancer indicated as the underlying cause of death (36), although no age restriction on the date of death was used and 61% were aged 65 years and older and age-eligible for Medicare coverage.

Discussion

In this study, we conducted a systematic review of the published literature to assess the role of health insurance coverage disruptions on receipt of cancer care and outcomes in the

Table 3. Health insurance coverage disruptions and stage of disease at cancer diagnosis[a]

Reference	Sample size, No.	Setting, data source, and year	Insurance coverage measures	Outcome measures	Key findings
Bradley et al., 2003a (41)	5852 women and men aged 25-64 y newly diagnosed with BC, CRC, or cervical or lung cancer	Michigan Cancer Registry - Medicaid enrollment, 1996-1997	Timing of coverage measured as Medicaid-enrolled after diagnosis vs Medicaid-enrolled for >1 mo at diagnosis	Early stage (in situ or localized) vs late stage (regional, distant, or invasive/unknown) from registry	36% enrolled in Medicaid after diagnosis Postdiagnosis Medicaid enrolled more likely to have late-stage diagnosis compared with previously enrolled for BC (1.328, 95% CI = 0.95 to 1.67), cervical cancer (2.96, 95% CI = 1.85 to 4.75), CRC (2.08, 95% CI = 1.30 to 3.33, and lung cancer (3.40, 95% CI = 2.13 to 5.43)
Bradley et al., 2003b (40)	598 women aged 29-64 y with newly diagnosed BC	Michigan Cancer Registry - Medicaid enrollment, 1996-1997	Timing of coverage measured as Medicaid-enrolled after diagnosis vs Medicaid-enrolled for >1 mo at diagnosis	Early stage (in situ or localized) vs late stage (regional, distant, or invasive/unknown) from registry	22.1% enrolled in Medicaid after diagnosis Lack of Medicaid coverage before diagnosis increased odds of late-stage diagnosis (HR = 1.71, 95% CI = 1.13 to 2.58, $P < .05$)
Bradley et al., 2004 (43)	1063 women aged <65 y with newly diagnosed cervical cancer	Michigan Cancer Registry - Medicaid enrollment, 1996-1997	Timing of coverage measured as Medicaid-enrolled after diagnosis vs Medicaid-enrolled for >1 mo at diagnosis	Early-stage (in situ or local) vs late stage (regional, distant, or invasive/unknown) from registry	Percentage enrolled in Medicaid after diagnosis not reported. Compared with those enrolled in Medicaid >1 mo before diagnosis, those enrolled after diagnosis more likely diagnosed at late stage (4% vs 8%, $P < .05$)
Dawes et al., 2014 (44)	96 220 women and men aged <65 y newly diagnosed with colon, esophageal, lung, ovarian, pancreatic, or gastric cancers	California Cancer Registry, California's Patient Discharge Database, and Medicaid enrollment files, 2002-2008	Discontinuous Medicaid enrollment (did not have consecutive 6 mo coverage prediagnosis) vs continuous Medicaid enrollment (>6 mo prediagnosis)	Early stage (localized and regional) vs advanced stage (remote) from registry	59.5% of patients with Medicaid discontinuously enrolled Compared with those continuously enrolled in Medicaid, those discontinuously enrolled more likely to have advanced stage of diagnosis for colon (29.8% vs 41.7%), esophageal (51.6% vs 58.5%), lung (67.8% vs 78.5%), ovarian (59.8% vs 69.4%), pancreatic (66.1% vs 69.5%), and gastric (52.6% vs 61.6%) cancers in unadjusted analyses
Doll et al., 2016 (45)	782 women aged <65 y newly diagnosed with cancers of cervix, uterus, ovary, and vulva or vagina	North Carolina Central Cancer Registry - Medicaid enrollment, 2003-2008. Follow-up through 2010	Timing of coverage measured as Medicaid enrollment after diagnosis vs Medicaid enrollment prediagnosis (≥1-6 mo before diagnosis)	Early stage (local) vs advanced stage (regional and distant) from registry	38.6% enrolled in Medicaid after diagnosis After propensity matching, postdiagnosis enrollment group more likely to have advanced stage (OR = 1.46, 95% CI = 1.03 to 2.05). When stratified by cancer site, effect greatest in uterine cancer (OR = 1.74, 95% CI = 0.87 to 3.47) and cervix (OR = 1.50, 95% CI = 0.91 to 2.49), but not statistically significant
Keegan et al., 2019 (46)	52 774 AYAs aged 15-39 y newly diagnosed with 9 common cancers, including BC, CRC, and thyroid, melanoma, testicular, non-Hodgkin lymphoma,	California Cancer Registry data (2005–2014), linked to Medicaid enrollment (2004-2014)	Timing of coverage and coverage gap measured as Medicaid peridiagnosis enrolled <1 mo, or discontinuous Medicaid vs continuous Medicaid (enrolled ≥5 mo before	AJCC stage I vs II-IV or AJCC stage I-II vs III-IV from registry	Of Medicaid patients, 34.2% peridiagnosis enrolled <1 mo and 15.7% discontinuously enrolled Compared with AYAs with private insurance, AYAs who gained Medicaid coverage at diagnosis 2.2-2.5 times more likely later stage (stage II-IV vs I: OR = 2.46, 95% CI = 2.26 to

(continued)

Table 3. (continued)

Reference	Sample size, No.	Setting, data source, and year	Insurance coverage measures	Outcome measures	Key findings
	Hodgkin lymphoma, cervical, and ovarian		diagnosis) and private or military coverage		2.69; III-IV vs I-II: OR = 2.16, 95% CI = 2.00 to 2.33) and AYAs with discontinuous Medicaid 1.7-1.9 times more likely later stage (stage II-IV vs I: OR = 1.93, 95% CI = 1.70 to 2.18; III-IV vs I-II: OR = 1.74, 95% CI = 1.56 to 1.95) in adjusted analyses. Findings statistically significant for all 9 cancers. In analyses limited to AYAs with Medicaid, continuous coverage improved odds of earlier stage diagnosis compared with both peridiagnosis enrollment or discontinuous enrollment
Koroukian, 2003 (33)	2576 women aged ≥15 y, newly diagnosed with BC or cervical cancer	Ohio Cancer Registry; Medicaid Enrollment data, 1996-1998	Medicaid vs non-Medicaid coverage, and timing of Medicaid enrollment: prediagnosis (enrolled >3 mo preceding diagnosis), peridiagnosis (2 mo preceding diagnosis), and postdiagnosis (enrolled ≥3 mo after diagnosis)	Early stage (in situ or localized) vs advanced stage (regional or distant) from registry	Of patients with Medicaid, 70.8% enrolled prediagnosis, 25.2% peridiagnosis, and 4.0% postdiagnosis Compared with prediagnosis enrollment, peridiagnosis group had increased risk of advanced cancer overall (AOR = 3.8, 95% CI = 2.8 to 5.0) and for BC (AOR = 3.8, 95% CI = 2.8 to 5.2) and cervical cancers (AOR = 3.6, 95% CI = 1.8 to 7.3) Postdiagnosis enrollment increased risk of advanced cancer compared with prediagnosis group (AOR = 2.2, 95% CI = 1.2 to 4.0). By cancer site, advanced disease higher for BC (AOR = 3.8, 95% CI = 2.8 to 5.2; AOR = 2.1, 95% CI = 1.1 to 4.1) and cervical cancers (AOR = 3.6, 95% CI = 1.8 to 7.3; AOR = 2.8, 95% CI = 0.5 to 14.2) for peri- and postdiagnosis groups compared with prediagnosis group, respectively
Koroukian et al., 2017 (34)	26 426 women aged 40-64 y newly diagnosed with invasive BC	Ohio Cancer Registry, Medicaid enrollment data, and BCCEDP database (diagnoses 2002-2008, deaths 2002-2010)	Timing of Medicaid coverage peridiagnosis, (enrolled at diagnosis or <3 mo of diagnosis), BCCEDP repeat user vs enrolled ≥3 mo before diagnosis	Localized vs advanced-stage (regional or distant) from registry	31.6% of patients in peri- or postdiagnosis group Peridiagnosis group more likely to be diagnosed with advanced-stage disease (AOR = 2.20; 95% CI = 1.83 to 2.66) Compared with Medicaid prediagnosis, BCCEDP 1-time users more likely to be diagnosed late stage (AOR = 1.48, 95% CI = 1.17 to 1.87) but repeat users similar stage at diagnosis (AOR = 0.83, 95% CI = 0.59 to 1.18)

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Table 3. (continued)

Reference	Sample size, No.	Setting, data source, and year	Insurance coverage measures	Outcome measures	Key findings
O'Malley et al., 2006 (47)	4682 women aged <65 y newly diagnosed with invasive cervical cancer	California Cancer Registry-Medicaid enrollment; 1996-1999	Timing of Medicaid coverage measured as prediagnosis: 1) first enrolled in month of diagnosis; 2) enrolled at time of diagnosis and for 1-11 mo in year before diagnosis (intermittently enrolled); 3) enrolled 12 mo before diagnosis, including at diagnosis; and 4) not enrolled at diagnosis	Early stage (localized) vs late stage (regional and remote) from registry	16.0% enrolled in Medicaid during month of diagnosis, 23.6% 1-11 mo before diagnosis, and 60.4% continuously enrolled ≥1 y before diagnosis Compared with non-Medicaid coverage (uninsured and insured), adjusted odds ratios for late- or unknown-stage diagnosis were: 2.8 (95% CI = 1.9 to 4.2) for those enrolled at diagnosis, 1.34 (95% CI = 1.00 to 1.80) for those enrolled 1-11 mo before diagnosis, and 1.08 (95% CI = 0.89 to 1.33) for those continuously enrolled in Medicaid for ≥1 y
Perkins et al., 2000 (48)	10 016 women aged 30-64 y, newly diagnosed with BC	California Cancer Registry, and linked Medi-Cal enrollment files, 1992-1993	Timing of prediagnosis Medicaid enrollment: 1) entire 12 mo before diagnosis; 2) part of 12 mo before diagnosis; and 3) not covered by Medicaid in any of 12 mo before diagnosis	Early stage (in situ and localized) vs late stage (any extension beyond the breast, including regional lymph nodes) from registry	18.0% enrolled in Medicaid at time of diagnosis Compared with non-Medicaid (uninsured/privately insured combined), odds ratio for late-stage disease among all women on Medi-Cal was 1.67 (95% CI = 1.41 to 1.97) but was reduced by 42% to 1.39 (95% CI = 1.15 to 1.67) when women without benefits before diagnosis excluded
Pollitt et al., 2008 (49)	4558 women and men aged 15-64 y, newly diagnosed with melanoma	California Cancer Registry and linked Medicaid enrollment files, 1998-1999	Medicaid enrollment at diagnosis (yes/no); timing of enrollment: 1) first enrolled at month of diagnosis, 2) enrolled during month of diagnosis and 1-11 mo before diagnosis, 3) enrolled during month of diagnosis and ≥12 mo before diagnosis, and 4) not enrolled at diagnosis	Localized and advanced-stage (regional or distant) from registry	Among Medicaid-insured, 13.7% first enrolled month of diagnosis; 31.6% enrolled for 1 -11 mo (continuously or noncontinuously) before diagnosis; and 54.7% enrolled entire past year. Compared with non-Medicaid coverage (uninsured and insured combined), adjusted odds ratios for late-stage diagnosis were: 13.64 (95% CI = 4.43 to 41.98) for those enrolled at diagnosis, 2.77 (95% CI = 1.28 to 5.99) for those enrolled 1-11 mo before diagnosis, and 1.30 (95% CI = 0.64 to 2.64) for those continuously enrolled in Medicaid ≥1
Ramsey et al., 2008 (50)	5009 women and men aged <65 y with newly diagnosed BC, CRC, or cervical, lung, or prostate cancer	Washington State Cancer Registry and Medicaid enrollment 1997-2002	Timing of Medicaid enrollment measured as previously enrolled (≥3 mo before diagnosis) vs enrolled at diagnosis (<3 mo before diagnosis to 6 mo after diagnosis)	In situ, localized, regional, and distant from registry	57.2% of Medicaid patients enrolled <3 mo before diagnosis Those enrolled in Medicaid at diagnosis more likely to have regional and distant stage disease at diagnosis than previously enrolled ($P < .001$) and more likely to disenroll at 12 mo (76.4% vs 23.6%)

(continued)

Table 3. (continued)

Reference	Sample size, No.	Setting, data source, and year	Insurance coverage measures	Outcome measures	Key findings
Tsui et al., 2018 (51)	19 209 women aged 21-64 y newly diagnosed with BC, CRC, or cervical cancer	New Jersey Cancer Registry and New Jersey Medicaid Management Information System, 2012-2014	Timing of coverage measured as longer term/established Medicaid (enrolled ≥6 mo at diagnosis) or newly enrolled Length of Medicaid enrollment (≥11, 6 to <11, 1 to <6, <1 mo) Continuous enrollment status (defined as no gaps >30 d in prior year)	Early stage (in situ or localized) or late (regional or distant) from registry	25.3% with Medicaid newly enrolled at diagnosis For all cancer sites, statistically significantly higher proportions of Medicaid patients and especially newly enrolled Medicaid patients diagnosed with late-stage cancer compared with non-Medicaid patients (BC, 20% and 23% vs 11%, $P < .001$; CRC, 46% and 56% vs 42%, $P = .025$; ICC, 41% and 38% vs 30%, $P < .001$) For all cancers combined, shorter enrollment length was associated with higher likelihood of late-stage diagnosis (57.5%, 48.1%, 39.9%, and 41.5 for <1, 1 to <6, 6 to <11, and ≥11 mo, respectively. $P < .001$) No statistically significant differences in stage at diagnosis observed comparing those continuously covered and with coverage disruptions (46.3% vs 45.2%, $P = .86$)

[a]AJCC = American Joint Committee on Cancer; AOR = Adjusted odds ratio; AYA = Adolescents and young adult; BC = breast cancer; BCCEDP = Breast and Cervical Cancer Early Detection Program; CI = confidence interval; CRC = colorectal cancer; HR = hazard ratio; ICC = invasive cervical cancer; OR = odds ratio; RR = risk ratio.

Table 4. Health insurance coverage disruptions and treatment and mortality[a]

Reference	Sample size, No.	Setting, data source, and year	Insurance coverage measures	Outcome measures	Key findings
Adams et al., 2012 (52)	2048 women aged 19-63 y with newly diagnosed BC	Georgia Cancer Registry -Medicaid enrollment and BCCEDP data 2002–2004 with 2-y follow-up	Timing of coverage measured as Medicaid-enrolled before diagnosis vs Medicaid-enrolled after diagnosis and Medicaid-enrolled as part of BCCEDP Prevention and Treatment Act, disabled, and other Medicaid	Receipt of lumpectomy, mastectomy, any drug regimen (hormonal or chemotherapy), radiation, and any treatment from diagnosis to end of follow-up. Receipt of treatment measured by claims	51.7% enrolled after diagnosis and 48.9% continuously enrolled Compared with women enrolled in Medicaid after cancer diagnosis, those previously enrolled more likely to receive any treatment (OR = 2.41, 95% CI = 1.28 to 4.56) or any definitive surgery (OR = 7.66, 95% CI = 5.06 to 11.59) in adjusted analyses Compared with "other" and disabled Medicaid enrollment, BCCEDP enrolled more likely to receive any treatment (OR = 4.71, 95% CI = 2.48 to 8.96), any drug regimen (OR = 3.58, 95% CI = 2.32 to 5.51), and any definitive surgery (OR = 2.52, 95% CI = 1.74 to 3.66) in adjusted analyses
Bradley et al., 2003b (40)	598 women aged 29-64 y with newly diagnosed BC	Michigan Cancer Registry - Medicaid enrollment, 1996-1997. Follow-up until 1998	Timing of coverage measured as Medicaid-enrolled for >1 mo at diagnosis, Medicaid-enrolled after diagnosis	All-cause mortality Vital status from registry	22.1% enrolled in Medicaid after diagnosis Among those aged <65 y, mortality risk was higher for those without Medicaid coverage at diagnosis (HR = 1.67, 95% CI = 1.09 to 2.56, $P < .05$). Overall, late stage was strongest predictor of increased risk of mortality (HR = 4.40, 95% CI = 2.8 to 6.9, $P < .05$). When late-stage disease added to model, effects of Medicaid insurance no longer statistically significant
Bradley et al., 2005 (42)	13 740 women and men aged <65 y newly diagnosed with BC, CRC, or lung cancer	Michigan Cancer Registry - Medicaid enrollment, 1996-1997 and follow-up through 2003	Timing of coverage measured as Medicaid-enrolled for >1 mo at diagnosis, Medicaid-enrolled after diagnosis, or non-Medicaid (including uninsured or privately insured)	All-cause mortality Vital status from registry	42% enrolled in Medicaid after diagnosis Median survival in postdiagnosis enrollment group was 19 mo (95% CI = 17 to 22 mo) compared with 38 mo (95% CI = 32 to 44 mo) in prediagnosis enrollment group. When assessed by cancer site and stage, HR for Medicaid enrolled after diagnosis vs non-Medicaid generally higher for women with early-stage BC (HR = 3.10, 95% CI = 2.35 to 4.10), CRC (HR = 2.78, 95% CI = 1.87 to 4.14), and lung cancer (HR = 1.64, 95% CI = 1.19 to 2.26) than late-stage BC (HR = 2.43, 95% CI = 1.94 to 3.04), CRC (HR = 2.18, 95% CI = 1.59 to 2.98), and lung cancer (HR = 1.28, 95% CI = 1.08 to 1.52)

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Table 4. (continued)

Reference	Sample size, No.	Setting, data source, and year	Insurance coverage measures	Outcome measures	Key findings
Dawes et al., 2014 (44)	96 220 women and men aged <65 y newly diagnosed with colon, esophageal, lung, ovarian, pancreatic, or gastric cancers	California Cancer Registry, California's Patient Discharge Database, and Medicaid enrollment 2002-2008	Continuous Medicaid enrollment (>6 mo prediagnosis) vs discontinuous Medicaid enrollment (did not have 6 consecutive mo coverage prediagnosis)	Receipt of definitive operation status from hospital discharge, death within 1 y of diagnosis Vital status from registry	59.5% of patients with Medicaid discontinuously enrolled Compared with those continuously enrolled in Medicaid, discontinuously enrolled patients less likely to receive definitive surgery for colon (70.5% vs 61.9%, $P < .001$), lung (17.7% vs 15.3%, $P = .012$), and gastric (37.2% vs 31.0%, $P = .015$) cancers. Adjusted models not reported for esophagus, ovary, and pancreas cancers. Statistically significant 1-y mortality benefit in patients with continuous (vs discontinuous) Medicaid coverage in 3 cancer types: colon (23.0% vs 19.1%, $P = .001$), lung (66.7 vs 62.4%, $P = .002$), and gastric (57.8 vs 49.0%, $P = .001$) cancers. No statistically significant mortality differences were observed for esophagus (66.6% vs 70.4%, $P = .33$), ovary (21.5% vs 22.1% $P = .80$), and pancreas (76.1% vs 75.7%, $P = .87$) cancers in adjusted analyses
Doll et al., 2016 (45)	782 women aged <65 y newly diagnosed with cancers of cervix, uterus, ovary, and vulva/vagina	North Carolina Central Cancer Registry - Medicaid enrollment, 2003-2008. Follow-up through 2010	Timing of coverage measured as Medicaid enrollment before diagnosis (≥1 mo of coverage in 6 mo before diagnosis) vs Medicaid enrollment after diagnosis	All-cause mortality (median follow-up = 22 mo) Vital status from registry	38.6% enrolled in Medicaid after diagnosis Lack of prediagnosis Medicaid coverage had mortality HR of 1.28 (95% CI = 0.99 to 1.65) when stage not included and mortality HR of 1.19 (95% CI = 0.92 to 1.53) when adjusted for stage
Koroukian et al., 2012 (35)	12 703 women and men aged 15-54 y newly diagnosed with bladder, colon, lung, and testicular cancers, melanoma, pediatric malignancies, or Hodgkin	Ohio Cancer Registry; Ohio Medicaid Enrollment data, 1996-2002. Follow-up through 2007	Timing of coverage measured as Medicaid prediagnosis (≥3 mo coverage before diagnosis) vs Medicaid peri-/postdiagnosis (enrollment during <3-mo window before or after diagnosis)	Survival and 5-y mortality Vital status from registry	43.9% of Medicaid enrollees peri-/postdiagnosis. Adjusted AORs for 5-y disease-specific mortality were 1.58 for prediagnosis Medicaid enrollees (95% CI = 1.25 to 1.99) and 2.43 for peri-/postdiagnosis Medicaid enrollees (95% CI = 1.94 to 3.04) compared with non-Medicaid population with either private coverage or uninsured (for both, $P < .001$). Effects of coverage disruptions not reported by cancer site

(continued)

Table 4. (continued)

Reference	Sample size, No.	Setting, data source, and year	Insurance coverage measures	Outcome measures	Key findings
	and non-Hodgkin lymphoma				
Koroukian et al., 2017 (34)	26 426 women aged 40-64 y newly diagnosed with invasive BC	Ohio Cancer Registry, Medicaid enrollment data, and BCCEDP data. Patients diagnosed 2002-2008; deaths through 2010	Timing of coverage measured as Medicaid status (enrolled ≥3 mo before diagnosis or peridiagnosis, [enrolled at diagnosis or <3 mo of diagnosis]), BCCEDP repeat user	Overall and cancer-specific survival Vital status from registry	31.6% enrolled peri-/postdiagnosis. Peridiagnosis Medicaid worse overall and cancer-specific survival compared with non-Medicaid ($P < .05$). Peridiagnosis Medicaid similar overall (HR = 0.87, 95% CI = 0.74 to 1.02) and cancer-specific (HR = 0.92, 95% CI = 0.76 to 1.11) survival compared with prediagnosis Medicaid. Compared with Medicaid prediagnosis, BCCEDP 1 time and repeat users better overall (AHR = 0.60, 95% CI = 0.45 to 0.80 and AHR = 0.27, 95% CI = 0.13 to 0.54, respectively) and cancer-specific survival (AHR = 0.77, 95% CI = 0.57 to 1.06 and AHR = 0.36, 95% CI = 0.16 to 0.80, respectively)
Subramanian and Chen, 2013 (53)	Adults aged 18-64 y from California (N = 691) and Georgia (N = 225) newly diagnosed with head and neck cancer and alive ≥12 mo after diagnosis	California and Georgia State Cancer Registry - California and Georgia Medicaid Claims, 2002-2006. Follow-up time not stated	Continuous Medicaid from diagnosis to 12 mo postdiagnosis: vs not continuously enrolled (gaps in coverage of ≥2 mo) vs continuously Medicaid enrolled (no gaps in coverage or gaps in coverage for <2 mo)	Receipt of first course of treatment (surgery, radiation, and chemotherapy) from cancer diagnosis to end of follow-up from claims	9.3% and 31.5% patients alive 12 mo after diagnosis not continuously enrolled in Medicaid after diagnosis in California and Georgia, respectively Compared with continuously enrolled, no statistically significant differences for receipt of surgery (OR = 1.05, 95% CI = 0.72 to 1.56), radiation (OR = 0.93, 95% CI = 0.63 to 1.37), and chemotherapy (OR = 1.49, 95% CI = 1.00 to 2.27) with those not continuously insured
Tsui et al., 2018 (51)	19 209 women newly diagnosed with BC, CRC, or cervical cancer	New Jersey Cancer Registry and New Jersey Medicaid Management Information System, 2012-2014; survival through 2016	Timing of coverage measured as longer term/established Medicaid patients (enrolled ≥6 mo at diagnosis), newly enrolled Medicaid patients (<6 mo). Duration of coverage measured as length of Medicaid enrollment (≥11, 6 to <11, 1 to <6, <1 mo) vs continuous enrollment status (no gaps >30 d in prior year).	Treatment delay (>90 d after diagnosis) from claims, and 2-y survival Vital status from registry	25.3% with Medicaid newly enrolled at diagnosis Newly enrolled patients higher likelihood of treatment delay for BC (OR = 8.79, 95% CI = 5.91 to 13.10), cervical cancer (OR = 2.47, 95% CI = 1.00 to 6.15), and CRC (OR = 3.02, 95% CI = 1.94 to 4.71) cancers Shorter enrollment time associated with treatment delay (76.3%, 41.6%, 46.5%, and 51.9 for <1 mo, 1 to <6 mo, 6 to <11 mo, and ≥11 mo, respectively; $P < .001$) No statistically significant differences in treatment delay between continuously covered and coverage disruptions (46.9% vs 51.3%, $P = .45$) Newly enrolled in Medicaid had lowest 2-y survival compared with established Medicaid and patients without Medicaid coverage (private insurance and uninsured; $P < .001$)

[a]BC = breast cancer; BCCEDP = Breast and Cervical Cancer Early Detection Program; CI = confidence interval; CRC = colorectal cancer; HR = hazard ratio; OR = odds ratio; AOR = adjusted odds ratio.

Table 5. Health insurance coverage disruptions and other health services use and health-care spending[a]

Reference	Sample size, No.	Setting, data source, and year	Insurance coverage measures	Outcome measures	Key findings
Koroukian et al., 2006 (36)	44 509 decedents with cancer as underlying cause of death (no age restriction)	Ohio Medicaid Enrollment and claims data: death certificate, 1992-2002	Duration of coverage measured as Medicaid enrollment months prior death (enrolled at month of death, or 1-3, 4-6, 7-9, 10-12, or >12 mo prior death)	Per person per month enrolled total medical expenditures from claims	2.5%, 12.7%, 7.8%, 5.3%, 4.7%, and 67.0% of decedents enrolled in Medicaid at month of death, 1-3, 4-6, 7-9, 10-12, or >12 mo prior death, respectively. Overall, longer time of Medicaid enrollment was associated with higher monthly total expenditures. Monthly expenditures were $770, $1105, $1674, $1941, $1987, and $1905 for those enrolled at month of death, 1-3, 4-6, 7-9, 10-12, or >12 mo before death, respectively. Year of dollars not stated
Mack et al., 2013 (54)	4797 California patients and 4001 New York patients aged 21-64 y with newly diagnosed stage IV lung cancer	California and New York State Cancer Registry - California and New York Medicaid Enrollment, 2002-2006. Follow-up through 2017	Medicaid enrollment between month of diagnosis and month of death or censoring (continuous, enrolled more than 50% of the time but not continuously, enrolled <50% of time)	Hospice use from claims	69%, 21%, and 10% patients continuously enrolled in Medicaid, enrolled >50% of time but not continuously, enrolled <50% of time in California, respectively; 64%, 24%, and 12% patients continuously enrolled in Medicaid, enrolled >50% of time but not continuously, enrolled <50% of time in New York, respectively. In both states, compared with continuously enrolled, patients enrolled >50% of time but not continuously (OR = 0.82, 95% CI = 0.69 to 0.98) or enrolled <50% of time (OR = 0.45, 95% CI = 0.35 to 0.57) had lower hospice use
Mack et al., 2015 (55)	705 decedents previously diagnosed with cancer between ages of 15 and 29 y	New York State Cancer Registry - Medicaid Enrollment, 2004-2011. Deaths by Dec. 31, 2011	Timing of coverage measured as 1) enrolled in Medicaid before diagnosis or around time of diagnosis (duration of enrollment before diagnosis not stated); 2) Medicaid enrollment between month of diagnosis and month of death (continuous, enrolled >50% of the time but not continuously, enrolled <50% of time)	1) Hospice use; 2) EOL intensity measured by chemotherapy use within 14 d of death, care in ICU within 30 d of death, more than 1 ER visit within 30 d of death, hospitalization within 30 d of death from claims	15.4% of patients enrolled in Medicaid at or after cancer diagnosis. 65.5%, 28.5%, and 6.0% patients continuously enrolled in Medicaid, enrolled >50% of time but not continuously, enrolled <50% of time, respectively. Compared with patients enrolled before cancer diagnosis, those enrolled at or after diagnosis had lower hospice use (OR = 0.26, 95% CI = 0.08 to 0.83). Compared with continuously enrolled, patients who enrolled >50% of time but not continuously (OR = 0.36, 95% CI = 0.23 to 0.56) or enrolled <50% of time (OR = 0.22, 95% CI = 0.10 to 0.51) were less likely to have intensive EOL care

[a]CI = confidence interval; EOL = end-of-life; ER = emergency room; ICU = intensive care unit; OR = odds ratio.

United States. We identified 29 observational published studies and found that coverage disruptions were common and despite heterogeneity in populations and measures, disruptions were consistently statistically significantly associated with less frequent receipt of cancer care and poorer cancer outcomes. Specifically, those with coverage disruptions were less likely to receive cancer prevention or screening (27–29,32,37,39), and if diagnosed with cancer, they were more likely to have advanced disease (33,34,40,41,43–51), be less likely to receive treatment (44,52,54,55), and have worse survival (34,35,40,42,44,45,51) than their counterparts without coverage disruptions. Findings were consistent across multiple cancer sites. Additionally, several studies reported a dose-response relationship between coverage duration and receipt of prevention (39), screening (28,32), earlier stage (51), and timeliness of treatment (51). The consistency of these findings across the cancer control continuum highlight the importance of minimizing health insurance coverage disruptions in addressing cancer disparities and promoting health equity.

Policies and trends that exacerbate coverage disruptions may increase disparities. The recent emergence of work requirements for some state Medicaid programs might increase the prevalence of coverage disruptions. Research conducted in Arkansas suggests that Medicaid work requirements are associated with disenrollment of eligible residents without increases in employment (56). Broader employment trends, such as the increased prevalence of "gig" workers (eg, Uber, Lyft, TaskRabbit) (57) and associated income fluctuations, may increase disruptions in coverage among the nongroup self-insured facing frequent changes in eligibility for subsidies and coverage affordability. Despite the importance of private health insurance coverage for the working age population in the United States, we did not identify any studies specifically addressing the effects of private health insurance coverage disruptions on cancer care and outcomes. Preliminary research suggests that for cancer survivors, the magnitude of association between disruptions in private health insurance and worse access to and receipt of care is similar to that for disruptions in public insurance (58); additional research is warranted in both public and private coverage settings.

Conversely, policies that facilitate health insurance coverage continuity may minimize disparities. Increased availability of health insurance coverage options through the ACA, including individual purchase through the ACA Marketplace, availability of subsidies to reduce premium costs, expansion of dependent coverage on parents' private plans for young adults until age 26 years, and Medicaid eligibility in some states, might minimize disruptions and facilitate continuous health insurance coverage. State policies, such as the proposed New York Medicaid waiver to allow prisoners with health conditions to receive Medicaid coverage before and following their release from jail, may also help minimize disruptions and maintain care and provider network continuity. To date, most research evaluating the effects of the ACA has focused on coverage gains, and none assessed the effects of the ACA on reducing the prevalence or frequency of coverage disruptions and effects on cancer care and outcomes. A recent study found Medicaid expansion was associated with reductions in coverage disruptions in the low-income general population living in expansion compared with nonexpansion states (59). Given the rapidly changing health insurance landscape in the United States and the maturation of data post-ACA, evaluating the effects of specific provisions of the ACA, especially Medicaid expansions, on coverage disruptions and health outcomes will be important for future research using quasi-experimental designs.

We did not identify any published studies of effective interventions at the patient, provider, employer, health system, policy, or regulatory levels that help patients maintain continuous health insurance coverage throughout the cancer control continuum. Several studies testing interventions to improve coverage continuity are in progress (60,61), however. For example, within federally qualified health centers in multiple states, the introduction of electronic health record tools for identifying patients in advance of their Medicaid recertification to ensure continuity of coverage is being evaluated for potential improvements in receipt of cancer prevention and screening (60). Another ongoing intervention study involves a multi-employer Taft-Hartley Trust Fund that provides health benefits to hourly, low-wage employees who would otherwise not have health insurance coverage. This ongoing study is testing provision of continuous health benefits coverage for low-wage employees after a cancer diagnosis and incentives for the use of high-quality cancer care providers through travel benefits and narrow networks (61). Further development and testing of interventions to improve coverage continuity in public and private settings using experimental designs, especially for patients at risk of coverage disruptions, will be important.

Most studies in this review were conducted in single states and used cancer registry–Medicaid enrollment and claims linkages to evaluate the effects of coverage disruptions. Although the prevalence of coverage disruptions varied, among those with Medicaid coverage, up to 59.5% of newly diagnosed patients enrolled only at or after their cancer diagnosis (42,50). Findings that peri- and postdiagnosis enrollment were consistently associated with worse outcomes suggest that at least some of the worse survival associated with Medicaid compared with private insurance coverage observed elsewhere (4,7) may be attributable to the impact of coverage disruptions.

Coverage disruptions were consistently associated with advanced stage and worse survival for cancers with effective screening tests—namely, breast, cervical, and colorectal cancers (33,34,40–43,46–48,50,51). Two studies included in this review evaluated the effects of breast and cervical cancer screening through BCCEDP before Medicaid enrollment in 2 states (34,52), but they could not fully disentangle the potentially positive effects of screen detection vs the potentially negative effects of limited access to usual source of care or symptom evaluation associated with lack of insurance coverage before diagnosis. A large body of research has consistently found that in addition to health insurance coverage, having a usual source of health care is strongly associated with receipt of breast and cervical cancer screening (5), but neither study reported this information. Medicaid patients with coverage disruptions have also been reported to be more likely to disenroll in the year after their cancer diagnosis (50), which may adversely affect completion of recommended treatment(s) and access to and receipt of high-quality survivorship care. Care received after Medicaid disenrollment, including assessment for recurrence, surveillance for new cancers, symptom management, or end-of-life care, is unknown. Among adults with private insurance coverage, a cancer diagnosis and its treatment(s) can lead to time away from work, job loss, and loss of employer-sponsored health insurance coverage. The longitudinal effects of coverage disruptions across the cancer control continuum are not easily addressed with current data infrastructure, however.

Improvements in cancer registry and health insurance data infrastructure resulting in comprehensive longitudinal data can help to quantify the effects of coverage disruptions and differences in state-level policies, such as Medicaid generosity,

physician reimbursement, managed care penetration, and timing of Medicaid eligibility recertification, on receipt of cancer care and outcomes. Current individual state-level linkages, such as the ones identified in this review, cannot be used to evaluate the effects of differences between states in state-level policies. Centralized data linkages across multiple states, such as SEER-Medicaid, could transform the ability to evaluate Medicaid policies, especially as the updated version of the national Medicaid data, Transformed Medicaid Statistical Information System, becomes available (62). Currently, more than 15 states have legislation requiring aggregation of all-payer claims data (APCD); as these data become increasingly available and research-ready, state-level cancer registry–APCD linkages may be especially useful for evaluating the effects of private coverage disruptions and cancer outcomes and potentially, differences in state policies. As APCD data become standardized across states, centralized cancer registry data linkages across multiple states with APCD could further these efforts.

We identified many limitations in existing studies, including inconsistency of coverage disruption measures and lack of information about prior coverage (private or uninsured) or reasons for prior uninsurance or coverage change among those newly enrolled in Medicaid at or after cancer diagnosis. Because previous private insurance coverage would be expected to convey better access to care, any misclassification of previously uninsured patients suggests that the effect of gaining coverage only after diagnosis is understated. Similarly, some studies compared patients gaining Medicaid coverage at diagnosis to all non-Medicaid-covered patients, including privately insured and uninsured, which would underestimate the magnitude of associations between disruptions and more advanced stage or survival following diagnosis. Generalizability of findings of the adverse effects of coverage disruptions in populations of Medicaid enrollees to populations with private health insurance coverage may be limited.

All studies included in this systematic review were observational, and we cannot infer causality between health insurance coverage disruptions and worse care receipt and outcomes. However, all studies included comparison groups and despite the heterogeneity of measures of coverage disruptions, findings were consistent across studies and the magnitude of many associations was large. Nonetheless, studies with experimental designs are needed to infer causality of coverage disruptions and intervention effects to minimize disruptions and receipt of cancer care and health outcomes. In addition, evaluation of trends and comparisons of findings from specific states at different time points are limited by differences in state-level policies (eg, Medicaid eligibility threshold, recertification timing), socioeconomic characteristics, cancer sites, and heterogeneity of definitions of coverage disruptions.

An important strength of this systematic review is that we used multiple scientific publication databases to identify articles in our efforts to comprehensively assess the effects of health insurance coverage disruptions on care and cancer outcomes. We included many years of published studies in our search, starting in 1980. We also hand-searched the reference lists of each included article for any additional published studies that were not initially captured in the electronic search process. It is possible we missed some relevant studies, however. In addition, although we used standardized data abstraction measures, there still may be some unavoidable subjectivity in some of the measures we abstracted and reported. Finally, because of the heterogeneity of measures, study populations, and cancer sites, we could not conduct quantitative meta-analyses. Nonetheless, we were able to qualitatively synthesize a large body of research and identify research gaps and opportunities for data infrastructure improvements.

In summary, we found that health insurance coverage disruptions were consistently adversely associated with receipt of cancer prevention and screening and among those diagnosed with cancer, later stage of disease, delayed treatment if any, and poorer survival. Future research identifying modifiable factors at the patient, employer, state, and federal policy levels to minimize coverage disruptions may also reduce cancer disparities. Improved data infrastructure and quasi-experimental and experimental study designs will be important for evaluating the associations of federal and state policies on coverage disruptions and care and outcomes.

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