HSR Health Services Research

DOI: 10.1111/1475-6773.12600
BEST OF THE 2016 ACADEMYHEALTH ANNUAL RESEARCH MEETING

Are Two Heads Better Than One or Do Too Many Cooks Spoil the Broth? The Trade-Off between Physician Division of Labor and Patient Continuity of Care for Older Adults with Complex Chronic Conditions

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Objective. To examine the effects of physician division of labor and patient continuity of care (COC) on the care quality and outcomes of older adults with complex chronic conditions.

Data Sources/Study Setting. Seven years (2006–2012) of panel data from the Medicare Current Beneficiary Survey (MCBS).

Study Design. Regression models were used to estimate the effect of the specialty-type of physicians involved in annual patient evaluation and management, as well as patient COC, on simultaneous care processes and following year outcomes.

Data Collection/Extraction Methods. Multiyear cohorts of Medicare beneficiaries with diabetes and/or heart failure were retrospectively identified to create a panel of 15,389 person-year observations.

Principal Findings. Involvement of both primary care physicians and disease-relevant specialists is associated with better compliance with process-of-care guidelines, but patients seeing disease-relevant specialists also receive more repeat cardiac imaging ($p < .05$). Patient COC is associated with less repeat cardiac imaging and compliance with some recommended care processes ($p < .05$), but the effects are small. Receiving care from a disease-relevant specialist is associated with lower rates of following year functional impairment, institutionalization in long-term care, and ambulatory care sensitive hospitalization ($p < .05$).

Conclusions. Annual involvement of disease-relevant specialists in the care of beneficiaries with complex chronic conditions leads to more resource use but has a beneficial effect on outcomes.

Key Words. Patient continuity of care, specialty care, physician division of labor, older adults, chronic disease

One billion physician office visits are made annually in the United States. One quarter of these visits are by Medicare beneficiaries (Centers for Disease Control and Prevention 2010). Much of the delivery system reform agenda currently being implemented is closely tied to these quarter-of-a-billion office visits, including the Medicare Access and CHIP Reauthorization Act of 2015 (114th Congress 2015; Oberlander and Laugesen 2015).

Patient continuity of care (COC) is a key concept underpinning these policies. Because COC is largely built around primary care, these efforts also implicitly bring into question the role of specialty physicians' involvement in patient care. Despite this reliance on the role of COC from a conceptual standpoint, the empirical evidence supporting it is limited. Since 1984, there have been only 13 studies directly examining the effects of COC on process and outcome measures believed to reflect ambulatory health system performance among older adults (Wasson 1984; Weiss and Blustein 1996; Menec et al. 2006; Knight et al. 2009; Wolinsky et al. 2010, 2011a,b; Nyweide et al. 2013; Hussey et al. 2014; Romaire et al. 2014; Bayliss et al. 2015; Katz, McCoy, and Vaughan-Sarrazin 2015; Romano, Segal, and Pollack 2015). Few, if any, examine health outcomes and the underlying process mechanisms simultaneously in their study population. And though the plurality of outpatient visits are for patients with chronic conditions, who are a major source of cost growth (Thorpe 2013), only two of these studies focus on the role of COC in elderly patients with chronic conditions.

Our contribution is to provide a wholistic picture of the structure, processes, and outcomes of physician evaluation and management (E&M) of Medicare beneficiaries with complex chronic conditions. We conceptualize this relationship according to Donabedian's (2005) tripartite model. As depicted in Figure 1, the ambulatory care *structure* of physician E&M encounters with patients in a given time period is conceptualized as a trade-off between physician division of labor and patient COC. As more physicians of varying specialties get involved in the care of complex patients, physician division of labor increases but COC declines. We hypothesize that this physician involvement has an immediate effect on quality of care *processes* and a delayed effect on patient health *outcomes* and acute care use.

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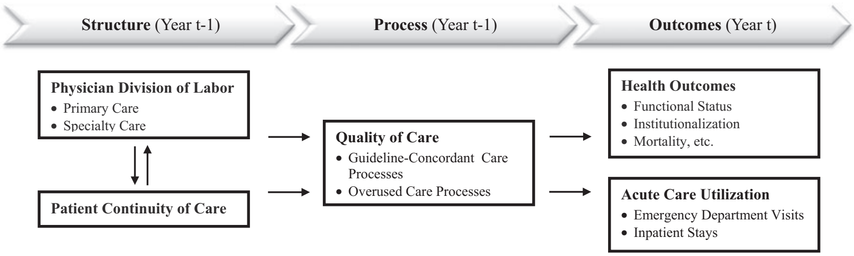
Figure 1: A Conceptual Model of Physician Evaluation and Management



Our conceptual model is the framework for this paper. We examine the effects of physician division of labor by specialty type and patient COC on (1) concurrent year process measures of care quality and (2) following year patient health outcomes and acute care use. We employ the Medicare Current Beneficiary Survey (MCBS) data, which include important information on patient functional status as well as on nonmedical characteristics and health behaviors not examined in most previous studies.

Background

Patient COC is a construct that describes how patient–physician encounters are connected over time (Shortell 1976; Haggerty et al. 2003; Jee and Cabana 2006). Patient COC is most frequently measured in health services research with the Bice–Boxerman Continuity of Care (BB) Index or the Usual Provider of Care (UPC) Index (Jee and Cabana 2006). Scores on these indices are interpreted as better COC when fewer physicians are seen (Jee and Cabana 2006; Nyweide 2014). A line of research stretching back to the 1980s finds beneficial associations between higher COC and lower probability of inpatient and/or emergency department (ED) utilization (van Walraven et al. 2010). However, more recently, a study of Medicare beneficiaries found increased incidence of ambulatory care–sensitive (ACS) hospitalization for those with higher COC (Romaire et al. 2014).

Only 4 of the 13 studies on COC in elderly populations examine health outcomes directly. Two studies focus on mortality. One finds higher COC is associated with lower mortality in Medicare beneficiaries (Wolinsky et al. 2010), and the other finds no effect (Nyweide et al. 2013). The other two studies focus on functional health and cognitive decline, and neither finds a significant association with COC (Wolinsky et al. 2011a,b).

Four of the 13 studies examine some dimension of quality (Wasson 1984; Weiss and Blustein 1996; Hussey et al. 2014; Romano, Segal, and Pollack 2015). The most recent finds that higher COC is associated with lower odds of overuse on 9 of 16 care processes, and also higher odds of overuse for three such processes (Romano, Segal, and Pollack 2015). However, none look at the impact on guideline-concordant care processes, which are the factors directly within physician control, and for which there is some evidence that they affect outcomes (Institute of Medicine 1990).

Beyond concerns over a systematic examination of process and outcomes within a given cohort, there are other concerns with this literature. First, despite the growing recognition that there is a need to better integrate specialty care with primary care (Fisher 2008; Baron and Davis 2014), the trade-off between specialist involvement and COC has not been thoroughly examined. Many studies focus solely on care delivered by PCPs (Wasson 1984; Menec et al. 2006; Wolinsky et al. 2010; Katz, McCoy, and Vaughan-Sarrazin 2015), while those that allow for inclusion of specialists do not test for a separate effect (Weiss and Blustein 1996; Gill and Mainous 1998; Nyweide et al. 2013; Hussey et al. 2014; Romano, Segal, and Pollack 2015). Only 1 of the 13 identified studies tests for any separate specialist effect, and it finds that effect to be beneficial for reducing inpatient and ED utilization but it does not address health outcomes or distinguish between disease-relevant and other types of specialists (Romaire et al. 2014). The prior research on specialist involvement in chronic illness care is mixed. Most studies have found better quality of care or outcomes associated with outpatient specialist involvement (Smetana 2007), in particular for heart failure patients (Ansari et al. 2003; Ezekowitz et al. 2005). However, some studies have found no difference or worse outcomes (Smetana 2007), although patient case mix is an important confounder (Kravitz 1992; Frances et al. 1999).

Finally, patient–physician encounters over time are confounded with disease progression and other unobserved patient characteristics. Reverse causality is a problem in 9 of the 13 identified studies because COC is measured concurrently with the dependent variable (Weiss and Blustein 1996; Menec et al. 2006; Knight et al. 2009; Hussey et al. 2014) or continuously updated until the outcome occurs (Wolinsky et al. 2010, 2011a,b; Nyweide et al. 2013; Bayliss et al. 2015). The reported associations of higher COC with fewer hospital stays, for instance, may plausibly reflect a process, whereby sicker patients seek care from more physicians, yielding lower COC indices (Chen and Ayanian 2014). Omitted variables are also a problem because 8 of the 13 studies rely solely on administrative data (Wasson 1984; Knight et al.

2009; Nyweide et al. 2013; Hussey et al. 2014; Romaire et al. 2014; Bayliss et al. 2015; Katz, McCoy, and Vaughan-Sarrazin 2015; Romano, Segal, and Pollack 2015) and therefore lack control for important person-level covariates such as health behaviors, social support, income, and education. Given that disease severity is negatively correlated with COC and desirable health outcomes, it is possible that existing studies have overestimated the beneficial effect of COC.

METHODS

Data and Sample

We employ pooled data from the MCBS for the seven calendar years of 2006–2012, linking the Access to Care survey component to beneficiaries' FFS Medicare claims. The MCBS is an annual nationally representative survey of the FFS Medicare population with a 4-year rotating cohort design and conducted by CMS (Center for Medicare and Medicaid Services 2009). (More information on the MCBS and our study timeline is in Data S1.)

Our focus was on the older adult Medicare population with type 2 diabetes and/or heart failure. These are important individuals to examine from a clinical perspective, as patients with either of these conditions are known to be at increased risk of developing the other condition as well as adverse outcomes common to both conditions, such as impaired kidney function and cardiovascular events (Khan, Butler, and Gheorghiade 2014). We also focus on these conditions because their cost to Medicare is substantial, they are high prevalence and represent a large health burden to older adults, there is an established set of guidelines that can be measured in medical claims (Heidenreich and Fonarow 2007; Shekelle and Vijan 2007), and the conditions are medically complex enough to plausibly benefit from involvement of specialists in addition to PCPs.

We restrict the study population to MCBS respondents who are (1) ages 65 and over; (2) continuously enrolled in Medicare Part A and B for at least two consecutive years overlapping their participation in the survey (also included if deceased in second year); and (3) identified as having a diagnosis for type 2 diabetes and/or heart failure in their medical claims in the baseline year (using the ICD-9-CM codes listed in Data S2) or having self-reported the conditions. We exclude those beneficiaries whose reasons for eligibility (due to end-stage renal disease or disability), institutionalization in long-term care or hospice at baseline, or presence of type 1 diabetes make them quite different in age or clinical status from the average beneficiary with the conditions of interest. Because we are measuring COC, as well as other care processes and outcomes found in claims data, we further exclude individual observation years if there were less than 12 FFS enrollment months (unless deceased in the follow-up year). Lastly, because some of our focal variables are related to area-level factors included in our models, we exclude individuals who moved to a different county from the prior year (unless institutionalized in the follow-up year), or had no listed U.S. Zip code.

Application of our study inclusion and exclusion criteria generates a sample of 15,389 eligible person-year observations for testing the simultaneous year t effects of the exposure variable on the dependent variable quality of care. In addition, we have 9,807 observations for testing the lagged year $t-1$ effects on the following year t dependent variables health outcomes and acute care utilization. The reason for this smaller number is that the year $t-1$ exposure and year t dependent variable form a single analytic observation. For our analyses involving COC, we further limit our sample to the 90 percent of beneficiaries with two or more annual E&M visits. (Details on the sample selection process are in Figure S2.)

Dependent Variables

These include a broad set of measures of quality of care, acute care utilization, and health outcomes. Many of these measures are clinically appropriate for both heart failure and diabetes. Thus, we include both conditions in the measurement of the dependent variables and in our models where evidence-based guidelines are applicable to older adults with both conditions. However, we limit our analysis to the subpopulation with the appropriate condition where evidence-based guidelines are applicable only to that one condition, where noted below.

We assess quality on 12 measures. Of these, seven are process indicators of guideline-concordant E&M care defined using medical claims data: (1) E&M visit follow-up within 30 days of inpatient stay; (2) annual hemoglobin A1c (HbA1c) screening for those with diabetes; (3) biannual HbA1c screening for those with diabetes; (4) annual low-density level (LDL) cholesterol screening; (5) annual nephropathy screening or treatment for kidney disease for those with diabetes; (6) annual serum creatinine screening; and (7) annual left ventricular function assessment for those with heart failure. These seven indicators represent care processes that should be performed for older adults with diabetes and/or heart failure to prevent future complications and decline in health status (McGlynn et al. 2003; Heidenreich and Fonarow 2007; Shekelle and Vijan 2007; National Committee for Quality Assurance [NCQA] 2008; Bonow et al. 2012; Yancy et al. 2013). Two of the other measures are self-reported receipt of guideline-concordant care with an established evidence base (McGlynn et al. 2003) including (1) influenza vaccination in the past winter and (2) pneumonia vaccination ever. The remaining three indicators are of care processes thought to represent overuse of cardiac imaging, defined as two or more of the following: (1) cardiac stress tests; (2) echocardiograms; and (3) chest X-rays. The indicators are adapted from “low value” service lists outlined by the American Board of Internal Medicine (2013) and operationalized for Medicare claims (Schwartz et al. 2014). However, we count all repeat cardiac imaging—and not only preoperative imaging—to assess the effect in an ambulatory care setting.

We examine 10 measures of acute care utilization, which include the count of (1) ACS inpatient stays; (2) diabetes-related ACS inpatient stays for those with diabetes; (3) heart failure–related ACS inpatient stays for those with heart failure; (4) all diabetes-related inpatient stays for those with diabetes; (5) all heart failure–related inpatient stays for those with heart failure; (6) all inpatient stays; (7) ACS ED visits; (8) diabetes-related ED visits for those with diabetes; (9) heart failure–related ED visits for those with heart failure; and (10) all ED visits.

We then examine six measures of health outcomes, which include (1) mortality; (2) institutionalization in long-term care; (3) incident diagnosis of heart failure for those with diabetes and no baseline heart failure; (4) low self-rated health; (5) count of activities of daily living (ADLs) done with difficulty and/or unable to do; and (6) count of instrumental activities of daily living (IADLs) done with difficulty and/or unable to do. (Details on measurement of dependent variables are in Data S3.)

Independent Variables

The focal variables are patient COC and physician division of labor for annual patient E&M. We identify such E&M visits using the Berenson-Eggers Type of Service codes in Medicare Part B physician claims as face-to-face office visits for new and established patients, home visits, specialist visits, and consultations. We further limit E&M visits by physician specialty type to PCPs and medical specialists who provide regular E&M care (e.g., cardiology and dermatology), excluding visits to specialty types deemed inappropriate for regular E&M (e.g., critical care and radiology). (Details on our E&M visit definition and the codes used are in Data S4.)

We measure patient COC using the BB index calculated on all E&M visits defined above. The BB index mathematically characterizes the dispersion of unique physicians seen by individuals across the total count of their E&M visits (Bice and Boxerman 1977; Jee and Cabana 2006) (details are in Data S5). Our goal was to reflect the breadth of patient experience of ambulatory physician E&M. Medicare beneficiaries see multiple physicians and specialty-types each year for ambulatory care, especially those with chronic conditions (Pham et al. 2007). Thus, as in prior research, we include a broad array of PCPs and specialists in assessing COC (Nyweide et al. 2013; Romano, Segal, and Pollack 2015).

We define physician division of labor as the specialty type of the physician(s) encountered by beneficiaries for their E&M visits during the year. Specifically, we use two binary indicators of any involvement by (1) PCPs; (2) disease-relevant specialists (cardiologist for those with heart failure or diabetes with a heart disease comorbidity, and endocrinologist or nephrologist for those with diabetes). We also control for other medical specialists providing E&M care. (Details on physician specialty are in Data S4.)

By integrating participants' surveys with their medical claims, we have a rich set of controls. We define health status broadly to include control variables for the Charlson/Quan comorbidity index (Quan et al. 2005) and the CMS hierarchical condition categories (HCC) risk score (Ash et al. 2000). We also individually control for diabetes, heart failure, and ischemic heart disease because not all individuals in our sample have the same combination of these conditions, and they directly affect the care of beneficiaries by disease-relevant specialists. We further control for depression and Alzheimer's/dementia as measures of cognitive health status, and we use the VES-13 scoring system to assess functional health (Saliba et al. 2001).

We include controls for health care utilization, including count of E&M visits, ED visits, inpatient stays, and SNF stays. (We use ED visit and inpatient stays as control variables in the *baseline* year, that is, not the same measurement year as when the same variables are measured as outcomes.) We further use Medicare enrollment records to capture beneficiaries' age, gender, race, Medicare Part D drug insurance, and dual enrollment in Medicaid.

We use the survey responses in the MCBS to control for a host of characteristics not addressed in previous studies. Controls for negative health behaviors include obesity and current tobacco use. Controls for patient socioeconomic status and social support include self-reported annual income, highest level of education attained, marital status, whether a beneficiary has children, and whether a beneficiary lives alone. We also control for insurance statuses that might influence the quantity of care consumed including whether the individual has private Medicare supplemental insurance and veteran status.

Finally, we control for local area-level market factors that are likely related to access to different types of care. These include the supply of acute care hospital beds per 100,000 HSA residents (Center for the Evaluative Clinical Sciences at Dartmouth 2009) and county of residence measures of (1) level of urbanicity (metropolitan, micropolitan, rural); (2) percent of adult residents uninsured; (3) percent of all residents at or below poverty; (4) percent of residents unemployed; and (5) percent of residents enrolled in Medicare for the aged (Health Resources and Services Administration 2014).

Analytic Approach

We hypothesize that physician E&M of patients has a simultaneous effect on quality of care processes but a delayed effect on patient acute care use and health outcomes. Thus, we begin with care processes and estimate a model assessing the concurrent year effects of patient COC and physician division of labor on the 12 binary quality indicators:

$$Q_{igt} = \beta_0 + \beta_1 P_{igt} + \beta_2 D_{igt} + \beta_3 C_{igt} + \beta_4 E_{igt} + \beta_5 X_{igt} + \beta_6 A_{gt} + Y_t + \varepsilon_{igt} \quad (1)$$

Equation (1) is estimated with logistic regression for patient i in local area g in year t on the 12 quality indicators (Q) at the same year t. We are interested in the effect of physician division of labor by specialty-type—with binary indicators for PCP (P) and disease-relevant specialist involvement (D)—together with patient COC (C), while adjusting for E&M visit count (E). X and A represent the individual patient characteristics and area-level factors we control for detailed above.

Next, we focus on acute care use as the dependent variable and model the delayed effect of involvement by the two physician specialty types along with patient COC on 10 following year utilization counts:

$$\begin{aligned} U_{igt} = {} & \beta_0 + \beta_1 P_{igt-1} + \beta_2 D_{igt-1} + \beta_3 C_{igt-1} + \beta_4 E_{igt-1} \\ & + \beta_5 X_{igt-1} + \beta_6 A_{gt-1} + Y_t + \varepsilon_{igt} \end{aligned} \quad (2)$$

Equation (2) is estimated with negative binomial regression for patient i in local area g in the prior year $t-1$ on acute care utilization (U) at the next year t. We use the same focal variables and controls as in 1, except that they are measured at the prior year $t-1$.

Last, we focus on health outcomes and model the delayed effect of involvement by the two physician specialty-types along with patient COC on six following year health outcomes:

$$H_{igt} = \beta_0 + \beta_1 P_{igt-1} + \beta_2 D_{igt-1} + \beta_3 C_{igt-1} + \beta_4 E_{igt-1} + \beta_5 X_{igt-1} + \beta_6 A_{gt-1} + Y_t + \varepsilon_{igt} \quad (3)$$

Equation (3) is estimated with negative binomial regression in the case of count outcomes or logistic regression in the case of binary outcomes for patient i in local area g in the prior year $t-1$ on health outcomes (H) at the next year t. We use the same focal variables and controls as in equation (2).

We include both patient COC and physician specialty-type involvement in the same models as indicated in equations (1)–(3). By including a measure of disease-relevant specialist involvement, we are distinguishing lower continuity that may be clinically appropriate from cases where patients are just seeing a lot of different physicians. Conceptually, we are particularly interested in knowing the effects of disease-relevant specialist and PCP involvement holding COC constant, and vice-versa.

We include year fixed effects (Y_t) to account for secular trends in technology and health care delivery system change. Standard errors are clustered at the individual beneficiary level to account for within-person correlation. We report our regression results as marginal effects, that is, modeling the response in the dependent variable to a 1-unit change in the independent variable at the population mean.

Because our approach raises the issue of multiple outcome comparisons, we adjust our p-values using the Holm–Bonferonni correction, making it more difficult to reject the null hypothesis at $p < .05$. Specifically, we adjust our p-values for the number of comparisons in each conceptual domain—12 comparisons for the quality of care processes, 10 comparisons for the acute care utilization measures, and 6 comparisons for the health outcome indicators.

RESULTS

Description of Patient Population and Their Quality of Care, Health, and Utilization

Descriptive statistics on our study population are in Table 1. We stratify results by whether beneficiaries have annual involvement of a disease-relevant specialist. There is a strong negative relationship ($p < .05$) between such specialist involvement and patient COC. In addition, there is notable risk sorting by

Table 1: Descriptive Statistics on Medicare Current Beneficiary Survey Study Sample at Baseline[†]

	Source: Claims (C) Survey (S)[‡]	Health Outcomes Sample	Quality of Care Sample	Health Outcomes Sample at Baseline by Involvement of Disease-Relevant Specialist	
				Specialist	*No Specialist*
Sample (unique member-years)		9,807	15,389	3,781	6,026
Sample with ≥2 E&M visits		8,797	13,798	3,728	5,069
Independent variables[§]					
Bice–Boxerman Index(≥2 E&M visits), Mean	C	0.39	0.39	0.29	0.47*
≥1 E&M visit PCP, %	C	83	83	86	82*
≥1 E&M visit disease-relevant specialist, %	C	39	39	100	0*
Dependent variables—quality of care processes					
SR influenza vaccine in past winter, %	S	–	79	81	77*
SR pneumonia vaccination ever, %	S	–	81	83	76*
30-day E&M visit follow-up, %	C	–	73	81	65*
Annual HbA1C (diabetes only), %	C	–	73	80	72*
Biannual HbA1C (diabetes only), %	C	–	45	53	43*
LDL cholesterol screen, %	C	–	74	81	71*
Nephropathy screen (diabetes only), %	C	–	32	45	26*
Serum creatinine screen, %	C	–	88	95	85*
LVEF screen (heart failure only), %	C	–	52	69	34*
≥2 stress tests, %	C	–	8	15	4*
≥2 echocardiograms, %	C	–	10	18	5*
≥2 chest X-rays, %	C	–	32	45	25*
Dependent variables—health outcomes		Following Year		Baseline Year	
Mortality, %	S	1.0	–	0.0	0.0
Institutionalized in long-term care, %	S	1.9	–	0.0	0.0
Low self-rated health, %	S	28	–	31	24*

Continued

Table 1. *Continued*

	Source: Claims (C) Survey (S)‡	Health Outcomes Sample	Quality of Care Sample	Health Outcomes Sample at Baseline by Involvement of Disease-Relevant Specialist: Specialist	No Specialist
Incident heart failure diagnosis, %	C	6.8	–	n/a	n/a
Count of ADLs with difficulty, mean	S	1.0	–	0.83	0.81
Count of IADLs with difficulty, mean	S	1.2	–	1.05	1.03
Dependent variables—acute care use		Following Year		Baseline Year	
ACS hospital stays, per 100	C	10.7	–	12.8	7.0*
Diabetes ACS hospital stays, per 100	C	0.7	–	1.0	0.5*
Heart failure ACS hospital stays, per 100	C	8.0	–	8.3	5.3*
All-cause hospital stays, per 100	C	43.7	–	62.8	29.7*
Diabetes-related hospital stays, per 100	C	22.9	–	34.6	14.5*
Heart failure-related hospital stays, per 100	C	29.2	–	33.7	22.8*
ACS ED visits, per 100	C	14.6	–	17.2	9.5*
All-cause ED visits, per 100	C	67.1	–	86.2	49.4*
Diabetes-related ED visits, per 100	C	30.1	–	41.6	19.2*
Heart failure–related ED visits, per 100	C	28.6	–	31.8	21.0*
Control variables—sociodemographics					
Percent male	C	46	46	50	43*
Mean age on January 1	C	77.3	77.7	77.8	76.9*
White %	C	87	87	90	86*
Black %	C	8	8	7	10*
Other race/ethnicity %	C	4	4	4	5*
High school/some college education %	S	55	55	57	54*
College/graduate school education %	S	17	17	18	16*
No high school or college education %	S	28	28	25	30*

Continued

Table 1. *Continued*

	Source: Claims (C) Survey (S)‡	Health Outcomes Sample	Quality of Care Sample	Health Outcomes Sample at Baseline by Involvement of Disease-Relevant Specialist	
				Specialist	No Specialist
Annual income <$25,000/unknown, %	S	51	50	47	53*
Annual income ≥$25,000, %	S	35	35	37	35
Annual income ≥$50,000, %	S	14	16	16	13*
Married, %	S	50	50	53	48*
Have children, %	S	93	93	93	93
Live alone, %	S	34	34	33	35*
Veteran, %	S	29	29	33	27*
Private/supplemental insurance, %	S	71	72	75	69*
Part D Medicare drug benefit, %	C	49	50	48	50*
Medicaid coverage, %	C	14	14	12	15*
Control variables—health care utilization					
E&M visits§, mean	C	9.2	9.3	12.8	7.0
Missing ≥1 NPIs on E&M visits, %	C	4.1	3.2	4.4	4.0
≥1 E&M visit other specialist, %	C	71	71	80	65
Inpatient stays, per 100	C	42.4	43.3	62.8	29.7
Emergency department visits, per 100	C	63.6	64.8	86.2	49.4
Skilled nursing facility stays, per 100	C	6.9	7.2	8.4	6.0
Control variables—health status					
Diabetes, %	C & S	74	73	62	81*
Heart failure, %	C & S	43	45	64	30*
Ischemic heart disease, %	C & S	52	55	82	33*
Charlson index, mean	C	2.6	2.6	3.4	2.0*
HCC risk score, mean	C	1.3	1.3	1.7	1.1*

Continued

Table 1. *Continued*

	Source: Claims (C) Survey (S)[‡]	Health Outcomes Sample	Quality of Care Sample	Health Outcomes Sample at Baseline by Involvement of Disease-Relevant Specialist	
				Specialist	No Specialist
High risk on VES-13, %	S	51	52	55	49*
Alzheimer's/dementia, %	C & S	9	10	8	9
Depression, %	C & S	16	17	16	17
Current tobacco user, %	S	8	7	6	9*
Obese (BMI ≥30), %	S	32	31	29	34*
Control variables—local area factors					
Hospital beds, per 100,000 in HSA	C	255	255	251	258*
Medicare beneficiaries, county %	C	13	14	13	14*
Uninsured adults, county %	C	20	20	20	20
Adults below poverty, county %	C	15	15	14	15*
Unemployed adults, county %	C	7	8	7	7
Metropolitan %	C	71	71	76	68*
Micropolitan %	C	18	18	16	19*
Rural %	C	11	11	9	12*

[†]Taken from baseline year for all variables except where noted.
[‡]Claims, eligibility records, and medical claims as well as local area factors by Zip code; Survey, MCBS fall survey round.
[§]Variables are restricted to E&M visits with national provider identifiers (NPIs) listed on the medical claims.
*Statistically significant difference ($p < .05$) in means (ANOVA) or proportions (chi-squared) for specialist involvement.
ACS, ambulatory care sensitive; ADL, count of activities of daily living with difficulty or unable to do [range: 0,6]; ED, emergency department; E&M, evaluation and management; HbA1c, hemoglobin A1c; HCC, Hierarchical Condition Categories; HSA, Hospital Service Area; IADL, count of instrumental activities of daily living with difficulty or unable to do [range: 0,6]; LDL, low density lipoprotein cholesterol; kidney screen includes evidence of treatment for nephropathy; LVEF, left ventricular ejection fraction; NPI, national provider identifier; PCP, primary care provider; SR, self-reported; 30-day follow-up refers to E&M visit follow-up within 30 days of acute care hospitalization; VES-13, Vulnerable Elders Survey.

disease-relevant specialist involvement. There is statistically significant covariation ($p < .05$) on whether beneficiaries have such involvement for 23 of 28 dependent variables and 28 of 34 control variables.

Quality: Concurrent Year Effects of Patient COC and Physician Division of Labor on Care Processes

The results for our models estimating the effect of patient COC and physician division of labor on the 12 quality of care process indicators in the same year are in Table 2. When we examine the involvement of each of the two broad physician specialty types, we find higher concordance with guideline indicators for involvement of both PCPs (five of nine, $p < .05$) and disease-relevant specialists (five of nine, $p < .05$). In addition, disease-relevant specialist involvement is associated with a large effect on repeat imaging for stress testing and echocardiograms (two of three indicators, $p < .05$). We also find that higher patient COC (a 0.10 unit increase in the BB index) is associated with modestly higher rates of guideline-concordant care processes on two of nine indicators, but less repeat cardiac imaging on one of three measures ($p < .05$). The effect sizes for physician division of labor—and especially disease-relevant specialist involvement—are much larger than for patient COC.

Acute Care Utilization: Delayed Effects of Patient COC and Physician Division of Labor on Following Year Hospital and ED Use

Table 3 shows our results for models estimating the effects of patient COC and physician division of labor in year $t - 1$ on the 10 acute care utilization counts in the following year t. We find that disease-relevant specialist involvement is associated with 21.3 percent *lower* incidence of ACS hospitalization ($p < .05$). However, we do not find any other statistically significant effects for physician specialty type or for patient COC.

Health Outcomes: Delayed Effects of Patient COC and Physician Division of Labor on Following Year Health Outcomes

When we examine the effects of patient COC and physician division of labor in year $t - 1$ on the six health outcomes in the following year t, we find a large benefit for task-relevant specialized physician capital on patient functional health outcomes (Table 4). Disease-relevant specialist involvement is associated ($p < .05$) with 9.7 percent and 8.6 percent *lower* incidence of ADLs and

Table 2: Effects of Patient Continuity of Care and Physician Specialty-Type Involvement on Concurrent Year Quality of Care Measures

	Guideline-Concordant Care Processes†									*Repeat Cardiac Imaging*†		
	1 Flu Shot	*2 Pneumonia Vaccine*	*3 30-Day Follow-Up*	*4 HbA1c Annual*	*5 HbA1c Biannual*	*6 LDL Screen*	*7 Kidney Screen*	*8 Serum Creatinine*	*9 LV Function Screen*	*10 ≥2 Stress Tests*	*11 ≥2 Echo-Cardiograms*	*12 ≥2 Chest X-Rays*
Dependent variable sample mean	79%	81%	73%	73%	45%	74%	32%	88%	52%	8%	10%	32%
Disease-relevant specialist§	−0.012	0.019	0.033	0.043*	0.093*	0.052*	0.200*	0.013	0.267*	0.049*	0.038*	0.023
Standard error	0.011	0.011	0.015	0.013	0.017	0.010	0.017	0.005	0.017	0.006	0.006	0.014
% Effect on dependent variable	−1.5	2.3	4.5	5.9	20.9	7.0	61.7	1.4	51.3	62.2	36.0	7.2
Primary care physician‡	0.015	0.008	0.069*	0.091*	0.077*	0.098*	−0.008	0.034*	−0.020	0.008	−0.004	0.013
Standard error	0.015	0.015	0.024	0.021	0.023	0.017	0.022	0.008	0.025	0.006	0.008	0.019
% Effect on dependent variable	1.8	1.0	9.4	12.5	17.2	13.3	−2.5	3.9	−3.8	10.4	−3.7	4.1
Patient COC (0.10 unit increase)‡	−0.002	0.002	0.008*	0.006	0.018*	0.000	−0.002	−0.001	−0.005	−0.003*	−0.003	−0.005
Standard error	0.002	0.002	0.003	0.002	0.003	0.002	0.003	0.001	0.004	0.001	0.001	0.002
% Effect on dependent variable	−0.2	0.2	1.0	0.8	4.0	0.0	−0.7	−0.1	−1.0	−4.2	−2.9	−1.6

Continued

Table 2. *Continued*

	Guideline-Concordant Care Processes[†]									*Repeat Cardiac Imaging*[†]		
	1 Flu Shot	*2 Pneumonia Vaccine*	*3 30-Day Follow-Up*	*4 HbA1c Annual*	*5 HbA1c Biannual*	*6 LDL Screen*	*7 Kidney Screen*	*8 Serum Creatinine*	*9 LV Function Screen*	*10 ≥2 Stress Tests*	*11 ≥2 Echo-Cardiograms*	*12 ≥2 Chest X-Rays*
Model chi-squared statistic	394.0	425.0	575.0	365.0	427.0	654.0	676.0	517.0	895.0	773.0	1,170.0	2,310.0
Model pseudo-R^2	0.06	0.07	0.16	0.06	0.05	0.07	0.10	0.10	0.17	0.11	0.16	0.28
N (member-years)	13,798	13,798	3,726	10,004	10,004	13,798	10,004	13,798	6,453	13,798	13,798	13,798

Notes. Patient COC measured with the Bice–Boxerman continuity of care index. Models are restricted to individuals with ≥2 E&M visits; model 3 is further restricted to individuals with one or more hospitalization; models 4, 5, 7 to individuals with type 2 diabetes; and model 9 to individuals with heart failure. Models control for the control variables shown in Table 1 (sociodemographics, health care utilization, health status, local area factors) in year *t*, as well as year fixed effects. 30-day follow-up refers to E&M visit follow-up within 30 days of hospitalization.

[†]We estimated logistic regression models for outcomes 1–12.

[‡]We report marginal effects as the response in the outcome variable (probability) to a 1-unit change in the independent variables at the population mean.

*$p < .05$, robust clustered standard errors reported, and *p*-values used for hypotheses testing were Holm–Bonferroni corrected for the 12 models.

COC, continuity of care; DM, type 2 diabetes; E&M, evaluation and management; HbA1c, hemoglobin A1c; HF, heart failure; LDL, low-density lipoprotein cholesterol; kidney screen includes evidence of treatment for nephropathy; LV, left ventricular.

Table 3: Effects of Patient Continuity of Care and Physician Specialty-Type Involvement on Acute Care Use in the Subsequent Year

	Acute Care Utilization (Counts)[†]									
	1 ACS Hospital Stay	*2 DM ACS Hospital Stay*	*3 HF ACS Hospital Stay*	*4 All-Cause Hospital Stay*	*5 DM Hospital Stay*	*6 HF Hospital Stay*	*7 ACS ED Visit*	*8 All-Cause ED Visit*	*9 DM ED Visit*	*10 HF ED Visit*
Dependent variable sample mean	0.11	0.01	0.08	0.44	0.23	0.29	0.15	0.67	0.30	0.29
Disease-relevant specialist[‡]	−0.023*	−0.002	−0.013	−0.029	−0.012	−0.026	−0.024	−0.041	−0.009	−0.015
Standard error	0.007	0.001	0.009	0.020	0.017	0.025	0.009	0.026	0.022	0.024
% Effect on dependent variable	−21.3	−24.3	−16.4	−6.7	−5.4	−8.9	−16.1	−6.2	−3.0	−5.2
Primary care physician[‡]	0.001	0.001	−0.004	0.007	−0.015	0.008	0.008	0.037	0.011	0.006
Standard error	0.011	0.001	0.013	0.029	0.024	0.032	0.014	0.034	0.025	0.034
% Effect on dependent variable	0.7	20.0	−5.5	1.6	−6.6	2.8	5.6	5.5	3.8	2.2
Patient COC (0.10 unit increase)[‡]	0.002	0.0005	0.002	0.004	0.008	0.006	0.000	−0.003	0.006	0.005
Standard error	0.001	0.0002	0.002	0.004	0.003	0.005	0.002	0.005	0.004	0.005
% Effect on dependent variable	1.9	7.7	2.7	1.0	3.5	2.1	0.0	−0.5	1.9	1.7

Continued

Table 3. *Continued*

	Acute Care Utilization (Counts)[†]									
	1 ACS Hospital Stay	*2 DM ACS Hospital Stay*	*3 HF ACS Hospital Stay*	*4 All-Cause Hospital Stay*	*5 DM Hospital Stay*	*6 HF Hospital Stay*	*7 ACS ED Visit*	*8 All-Cause ED Visit*	*9 DM ED Visit*	*10 HF ED Visit*
Model chi-squared statistic	682.0	680.0	219.0	1,102.0	519.0	350.0	823.0	1,598.0	708.0	347.0
Model pseudo-R^2	0.09	0.12	0.08	0.06	0.05	0.06	0.09	0.07	0.06	0.06
N (member-years)	8,797	6,427	3,925	8,797	6,427	3,925	8,797	8,797	6,427	3,925

Notes. Patient COC measured with the Bice–Boxerman continuity of care index. Models are restricted to individuals with ≥2 E&M visits in prior year; models 2, 5, 9 are further restricted to individuals with type 2 diabetes, and models 3, 6, 10 to individuals with heart failure. Models control for the control variables shown in Table 1 (sociodemographics, health care utilization, health status, local area factors) in prior year, as well as year fixed effects. ACS, ambulatory care sensitive as defined by the Agency for Healthcare Research and Quality; COC, continuity of care; DM, with diagnosis codes for type 2 diabetes; E&M, evaluation and management; HF, with diagnosis codes for heart failure.

[†]We estimated negative binomial regression models for outcomes 1–10.

[‡]We report marginal effects as the response in the outcome variable (count) to a 1-unit change in the independent variables at the population mean.

*$p < .05$, robust clustered standard errors reported, and p-values used for hypotheses testing were Holm–Bonferroni corrected for the 10 models.

Table 4: Effects of Patient Continuity of Care and Physician Specialty-Type Involvement on Health Outcomes in the Subsequent Year

	Health Outcomes†					
	1 *Mortality*	*2* *Low Self-Rated Health*	*3* *Incident Heart Failure*	*4* *Institutionalized*	*5* *ADL Count Difficult*	*6* *IADL Count Difficult*
Dependent variable sample mean	1.0%	28%	6.8%	1.9%	1.0	1.2
Disease-relevant specialist‡	−0.001	−0.022	0.008	−0.005*	−0.092*	−0.102*
Standard error	0.002	0.014	0.008	0.001	0.025	0.029
% Effect on dependent variable	−5.2	−7.7	11.1	−26.3	−9.7	−8.6
Primary care physician‡	−0.003	−0.035	0.006	0.001	0.011	−0.018
Standard error	0.003	0.021	0.010	0.002	0.037	0.043
% Effect on dependent variable	−35.1	−12.4	9.2	5.8	1.1	−1.5
Patient COC (0.10 unit increase)‡	0.001	0.001	0.002	0.000	0.002	0.010
Standard error	0.000	0.002	0.001	0.000	0.005	0.005
% Effect on dependent variable	6.4	0.3	2.2	0.4	0.2	0.8
Model chi-squared statistic	167.0	1,036.0	234.0	498.0	2,552.0	3,714.0
Model pseudo-R^2	0.10	0.14	0.09	0.26	0.13	0.14
N (member-years)	8,797	8,797	4,872	8,797	8,797	8,797

Notes. Patient COC measured with the Bice–Boxerman continuity of care index. Models are restricted to individuals with ≥2 E&M visits in prior year; model 3 is further restricted to individuals without heart failure in prior year. Models control for the control variables shown in Table 1 (sociodemographics, health care utilization, health status, local area factors) in prior year, as well as year fixed effects. ADL, count of activities of daily living with difficulty or unable to do [range: 0,6]; COC, continuity of care; E&M, evaluation and management; IADL, count of instrumental activities of daily living with difficulty or unable to do [range: 0,6].

†We estimated logistic regression models for outcomes 1–4 and negative binomial regression models for 5–6.

‡We report marginal effects as the response in the outcome variable (probability for models 1–4 and count for models 5–6) to a 1-unit change in the independent variables at the population mean.

*$p < .05$, robust clustered standard errors reported, and p-values used for hypotheses testing were Holm–Bonferroni corrected for the six models.

IADLs done with difficulty, as well as 26.3 percent *reduced* probability of institutionalization in long-term care. We do not find any other significant effects.

Sensitivity Analyses

We test the effects of PCP and disease-relevant specialist involvement without COC included in our models and find no substantive differences (see Tables S1, S4, and S7). We also estimate separate models to assess whether our results for non-disease-specific outcomes are different for the subpopulations with diabetes and heart failure. We find similar results as in our main models in the direction of our coefficients, if not always in significance and magnitude (see Tables S2, S3, S5, S6, S8, and S9).

DISCUSSION

A core goal of a value-based delivery system is to improve patients' health. Beyond survival, patients themselves value most their functional health (Porter, Larsson, and Lee 2016). We find a large benefit on functional health outcomes from annual involvement of disease-relevant specialists after controlling for involvement of other physician specialty types and patient COC. Such involvement appears to keep older adults with complex chronic conditions in their own homes longer and with fewer decrements in their ability to engage in daily activities. In agreement with recent prior research, we also find that such specialist involvement is associated with avoidance of ACS hospitalization (Romaire et al. 2014). Given that 39 percent of patients in our sample had annual involvement of a disease-relevant specialist (34 percent for those with diabetes and 58 percent for those with heart failure), there appears to be a compelling rationale for increasing access to such specialists for beneficiaries with complex chronic conditions.

We find that patient COC appears to attenuate repeat cardiac imaging. This is in agreement with a recent study of Medicare FFS beneficiaries (Romano, Segal, and Pollack 2015). We also find patient COC is associated with modestly greater 30-day follow-up after hospitalization and biannual HbA1c screening, but we caution that the effect sizes are small. We find the largest effects on patient care processes for physician division of labor. Having both PCP and disease-relevant specialist involvement on a beneficiary's annual E&M care team appears to effect an increase in guideline-concordant care processes. However, this effect is greatest for involvement of disease-relevant specialists, and it extends to all care processes—both those that are guideline-concordant as well as repeat cardiac imaging that may represent overuse. Furthermore, the varying patterns of effects correspond to the tasks we would expect are most relevant to the particular specialty types involved. For instance, disease-relevant specialist involvement has the largest effect on those processes of care most tied to disease complexity—screenings for kidney disease, left ventricular function, and stress testing.

Our results highlight a potential trade-off for physician division of labor. The same disease-relevant specialist involvement that is associated with delivery of guideline-concordant care and improved patient outcomes also increases resource use for care processes typically performed in an office-based setting. This relationship between better patient health outcomes and resource use has been found elsewhere—most recently for heart attack patients due to more intensive physician care (Currie, MacLeod, and Van Parys 2016) and for older adults with diabetes due to greater use of recommended care processes (Han et al. 2015). Although it is plausible that an increase in prior year care processes due to specialist involvement could lead to higher incidence of following year hospital and ED use due to more frequent interaction with the health care system, it is also plausible that an increase in prior year care processes could lead to prevention of disease complications and reduced likelihood of following year acute events. We find no evidence that specialist involvement leads to an increase in following year inpatient and ED utilization; conversely, we do find a reduction in ACS hospitalization.

However, we find considerable patient risk sorting on level of physician involvement by specialty type in annual patient E&M. The direction of the risk sorting supports our belief that sicker beneficiaries are more likely to receive care from disease-relevant specialists and have worse clinical prognoses at baseline. This is in agreement with prior research (Kravitz 1992). However, the direction of the risk sorting also shows that beneficiaries who do not see such specialists are socially disadvantaged in numerous ways: they have less education, lower incomes, less private supplemental insurance, more tobacco use, and are more likely to live in rural areas. To the extent prior research on patient COC or specialist involvement has not controlled for such patient factors, it is likely to have produced biased results.

Our findings raise the question of the nature of the benefit that physician specialization exerts on patient outcomes. Is the observed benefit due solely to greater adherence to guideline-concordant care processes, or is it in other unmeasured components of the E&M visit with specialists such as diagnostic expertise? Ryan and Doran (2012) found that 29.6 percent of the improvement in health outcome for adults with diabetes can be attributed to guideline-concordant care processes, and 25.6 percent of the improvement in health outcomes detected for coronary heart disease can similarly be attributed to such processes. Such annual disease-relevant screenings provide clinical information to physicians about patients in order to guide treatment and signal that physicians are actively managing patients. Thus, it is important to consider whether the repeat cardiac imaging observed in this study represents overuse. It is possible that this repeat testing represents waste and duplication, but it is also possible that the repeat testing was needed to provide additional diagnostic information on patients whose conditions were changing during the course of the year. Thus, although we can point out that such use leads to more resource use for repeat imaging, we cannot conclude that it is inappropriate per se and would caution against policy makers drawing that conclusion without additional information.

It is thought that MACRA will speed the trend toward physicians joining multispecialty group practices (Aaron 2015). To the extent this trend leads to the shared E&M of Medicare beneficiaries with complex chronic conditions by PCPs and disease-relevant specialists, the result predicted by this study is improved guideline-concordant patient care and better health outcomes. In addition, the common management and information structure that are characteristic of such practice arrangements may help attenuate coordination problems that lead to overuse of resources.

Several limitations should be noted. First, our sample is limited to the over-65 Medicare FFS population on whom both medical claims and MCBS data are available. This excludes the 25 percent of the Medicare population enrolled in managed care during this period (Medicare Payment Advisory Commission 2013). Second, we are unable to measure certain disease-specific clinical outcomes—such as ejection fraction for heart failure patients. However, we do find significant results for disease-specific process-of-care measures—such as annual left ventricular function assessment. Finally, despite our inclusion of control variables not included in many previous studies of COC, we acknowledge the likely presence of unobserved patient factors, in particular clinical heterogeneity in disease progression. To the extent that we have not fully captured baseline disease severity or opportunity to access specialists at baseline, among other unobserved factors, our estimates could be biased. However, our descriptive analysis shows that patients who visit disease-relevant specialists at baseline are of higher severity and are more likely to have worse baseline prognoses. Thus, we believe it is most plausible that our estimates on the beneficial effects of disease-relevant specialist involvement are biased toward zero and therefore conservative. In addition, we allowed for a 1-year lag between our independent variables and the 6 health outcome and 10 acute care utilization variables, enabling us to establish temporal precedence of potential cause and effect.

Conclusion

We find a benefit to physician division of labor for delivery of guideline-concordant care processes and for prevention of adverse health outcomes in a nationally representative population of Medicare FFS beneficiaries with complex chronic conditions. This benefit is most evident for specialized physician capital that is most task-relevant to patient conditions, and it appears to persist despite the mechanical trade-off we observe between specialist involvement and reduced COC.

Acknowledgments

Joint Acknowledgment/Disclosure Statement: The authors gratefully acknowledge Kimberly J. Rask, M.D., Ph.D., and David H. Howard, Ph.D., for their contribution to the study design and conceptualization of this research as well as their review of early versions of the manuscript. This study was deemed exempt from review by Emory University's Institutional Review Board (letter on file).

Disclosures: None.

Disclaimers: None.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Data S1: Explanation of the Medicare Current Beneficiary Survey Panels and Our Study Population and Study Timeline for Measurement of Variables.

Data S2: CMS Chronic Condition Warehouse ICD-9-CM Codes Used.

Data S3: Additional Detail on the Dependent Variables.

Data S4: Definition of the Patient–Physician E&M Visit.

Data S5: Measuring Patient Continuity of Care with the Bice–Boxerman Index.

Figure S1. Medicare Current Beneficiary Survey Panels and Our Study Timeline.

Figure S2. Study Sample Selection Flowchart.

Figure S3. The Bice–Boxerman and Usual Provider of Care (UPC) Indices.

Table S1. Effects of Physician Specialty-Type Involvement on Concurrent Year Quality of Care Measures.

Table S2. Effects of Patient Continuity of Care and Physician Specialty-Type Involvement on Concurrent Year Quality of Care Measures. Limited to Sample with *Diabetes* for Nondisease-Specific Quality of Care Indicators.

Table S3. Effects of Patient Continuity of Care and Physician Specialty-Type Involvement on Concurrent Year Quality of Care Measures. Limited to Sample with *Heart Failure* for Non-Disease-Specific Quality of Care Indicators.

Table S4. Effects of Specialty-Type Involvement on Acute Care Use in the Subsequent Year.

Table S5. Effects of Patient Continuity of Care and Physician Specialty-Type Involvement on Acute Care Use in the Subsequent Year. Limited to Sample with *Diabetes* for Non-Disease-Specific Acute Care Utilization Counts.

Table S6. Effects of Patient Continuity of Care and Physician Specialty-Type Involvement on Acute Care Use in the Subsequent Year. Limited to

Sample with *Heart Failure* for Non-Disease-Specific Acute Care Utilization Counts.

Table S7. Effects of Physician Specialty-Type Involvement on Health Outcomes in the Subsequent Year.

Table S8. Effects of Patient Continuity of Care and Physician Specialty-Type Involvement on Health Outcomes in the Subsequent Year. Limited to Sample with *Diabetes* for Non-Disease-Specific Health Outcomes.

Table S9. Effects of Patient Continuity of Care and Physician Specialty-Type Involvement on Health Outcomes in the Subsequent Year. Limited to Sample with *Heart Failure* for Non-Disease-Specific Health Outcomes.