JAMA Internal Medicine | Original Investigation | LESS IS MORE

Prevalence and Cost of Care Cascades After Low-Value Preoperative Electrocardiogram for Cataract Surgery in Fee-for-Service Medicare Beneficiaries

Ishani Ganguli, MD, MPH; Claire Lupo, BBA; Alexander J. Mainor, JD, MPH; Stephanie Raymond, BA; Qianfei Wang, MS; E. John Orav, PhD; Chiang-Hua Chang, PhD; Nancy E. Morden, MD, MPH; Meredith B. Rosenthal, PhD; Carrie H. Colla, PhD; Thomas D. Sequist, MD, MPH

IMPORTANCE Low-value care is prevalent in the United States, yet little is known about the downstream health care use triggered by low-value services. Measurement of such care cascades is essential to understanding the full consequences of low-value care.

OBJECTIVE To describe cascades (tests, treatments, visits, hospitalizations, and new diagnoses) after a common low-value service, preoperative electrocardiogram (EKG) for patients undergoing cataract surgery.

DESIGN, SETTING, AND PARTICIPANTS Observational cohort study using fee-for-service Medicare claims data from beneficiaries aged 66 years or older without known heart disease who were continuously enrolled between April 1, 2013, and September 30, 2015, and underwent cataract surgery between July 1, 2014 and June 30, 2015. Data were analyzed from March 12, 2018, to April 9, 2019.

EXPOSURES Receipt of a preoperative EKG. The comparison group included patients who underwent cataract surgery but did not receive a preoperative EKG.

MAIN OUTCOMES AND MEASURES Cascade event rates and associated spending in the 90 days after preoperative EKG, or in a matched timeframe for the comparison group. Secondary outcomes were patient, physician, and area-level characteristics associated with experiencing a potential cascade.

RESULTS Among 110 183 cataract surgery recipients, 12 408 (11.3%) received a preoperative EKG (65.6% of them were female); of those, 1978 (15.9%) had at least 1 potential cascade event. The comparison group included 97 775 participants (63.1% female). Those who received a preoperative EKG experienced between 5.11 (95% CI, 3.96-6.25) and 10.92 (95% CI, 9.76-12.08) additional events per 100 beneficiaries relative to the comparison group. This included between 2.18 (95% CI, 1.34-3.02) and 7.98 (95% CI, 7.12-8.84) tests, 0.33 (95% CI, 0.19-0.46) treatments, 1.40 (95% CI, 1.18-1.62) new patient cardiology visits, and 1.21 (95% CI, 0.62-1.79) new cardiac diagnoses. Spending for the additional services was up to $565 per Medicare beneficiary (95% CI, $342-$775), or an estimated $35 025 923 annually across all Medicare beneficiaries in addition to the $3 275 712 paid for the preoperative EKGs. Among preoperative EKG recipients, those who were older (adjusted odds ratio [aOR] for patients aged 75 to 84 years vs 66 to 74 years old, 1.42; 95% CI, 1.28-1.57), had more chronic conditions (aOR for each additional Elixhauser condition, 1.18; 95% CI, 1.14-1.22), lived in more cardiologist-dense areas (aOR, 1.05; 95% CI, 1.02-1.09), or had their preoperative EKG performed by a cardiac specialist rather than a primary care physician (aOR, 1.26; 95% CI, 1.10-1.43) were more likely to experience a potential cascade.

CONCLUSIONS AND RELEVANCE Care cascades after preoperative EKG for cataract surgery are infrequent but costly. Policy and practice interventions to reduce low-value services and the cascades that follow could yield substantial savings.

JAMA Intern Med. 2019;179(9):1211-1219. doi:10.1001/jamainternmed.2019.1739
Published online June 3, 2019.

Supplemental content

CME Quiz at jamanetwork.com/learning

Author Affiliations: Author affiliations are listed at the end of this article.

Corresponding Author: Ishani Ganguli, MD, MPH, Division of General Internal Medicine and Primary Care, Brigham and Women's Hospital, 1620 Tremont St, 3rd Floor, Boston, MA 02120 (iganguli@bwh.harvard.edu)

Low-value medical services may have sizable downstream consequences in the form of further tests, treatments, office visits, hospitalizations, and new diagnoses prompted by findings of the initial tests.[1-8] Regional studies and clinical experience suggest that these care cascades after low-value services can present patient, physician, and societal harms such as wasted resources and procedural complications.[9-12] Measuring these cascades would help quantify the full extent of low-value care and prioritize efforts to reduce it. But we know little about the national scope of care cascades triggered by low-value services.

Preoperative testing for cataract surgery provides an opportunity to evaluate cascades that may result from low-value services. Robust evidence, codified in multiple guidelines, makes clear that routine testing before this prevalent, low-risk, elective surgery does not improve outcomes or lower the risk of adverse events among Medicare beneficiaries.[13-17] But preoperative blood tests, electrocardiograms (EKGs), stress tests, and echocardiograms are still used often.[1,18-24] Preoperative EKGs, in particular, may be performed for more than one-fourth of patients undergoing cataract surgery in the United States[18] and could lead to a number of downstream tests, treatments, and diagnoses.[25-27] Medical record–based studies of healthy surgical patients have found that up to 43% of preoperative EKGs have seemingly abnormal findings that may prompt further services.[17,27,28]

To expand our understanding of care cascades associated with an initial low-value service, we evaluated preoperative EKGs for cataract surgery in a national sample of Medicare beneficiaries. We measured the prevalence and cost of cascade events after receipt of preoperative EKG, then explored patient, physician, and regional factors associated with these cascades.

Key Points

Question What are the prevalence and costs of care cascades after low-value preoperative electrocardiograms for cataract surgery?

Findings This cohort study of 110 183 fee-for-service Medicare beneficiaries found that 16% of those who received a preoperative electrocardiogram before cataract surgery experienced a potential cascade event; this was more likely among older, sicker individuals who lived in cardiologist-dense areas or had a cardiac specialist perform the electrocardiogram. There were 5 to 11 cascade events per 100 beneficiaries, costing up to $565 per beneficiary or $35 million nationally in addition to $3.3 million for the initial electrocardiograms.

Meaning Care cascades after low-value preoperative electrocardiograms are infrequent yet costly; policy and practice interventions to mitigate such cascades could yield substantial savings.

Methods

Data Source

This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline. We used a 20% random sample of fee-for-service (FFS) Medicare beneficiaries' inpatient and outpatient claims data from April 1, 2013, to September 30, 2015. This study was deemed exempt from review by the institutional review boards at Dartmouth College and the Harvard T.H. Chan School of Public Health.

Study Cohort

We identified Medicare beneficiaries aged 66 years or older as of April 1, 2014, residing in the 50 US states, and alive and continuously enrolled in fee-for-service Medicare between April 1, 2013, and September 30, 2015, who had cataract surgery between July 1, 2014, and June 30, 2015. We chose this enrollment window to allow for rolling 12-month look back periods, preoperative periods of 90 days or fewer, and 90-day cascade periods relative to cataract surgery. This window also permitted consistent use of *International Classification of Diseases, Ninth Edition* coding (before national conversion to the *Tenth Edition* coding system in October 2015)[29] (eFigure 1 in the Supplement shows the study timeline).

We identified beneficiaries' first routine cataract surgery between July 1, 2014, and June 30, 2015 using *Current Procedural Terminology* codes 66982-4 associated with an ophthalmology or ambulatory surgical center specialty, excluding those with an *International Classification of Diseases, Ninth Edition* code for "history of prior cataract surgery" or a claim for any type of cataract surgery in the 12 months preceding the index surgery.[22] We included in the study cohort only beneficiaries with a claim for ocular biometry (*Current Procedural Terminology* codes 76516, 76519, 92136) within the 90 days preceding cataract surgery. Biometry is the "necessary and final step" by which ophthalmologists prepare for cataract surgery and is used almost exclusively for this purpose.[22] We used biometry to define the start of the preoperative period, rather than assume that the preoperative period started 30 days before surgery. This allowed us to include postponed operations for which a preoperative EKG may have occurred more than 30 days before surgery, whether or not surgery was postponed because of abnormal preoperative EKG results.[22,27] We excluded beneficiaries with recorded diagnoses of heart disease in the 12 months before the start of the preoperative period (Choosing Wisely recommendations specify that preoperative EKG has low value in patients without heart disease) (eAppendix 1 and eTable 1 in the Supplement). Data analyses were performed from March 12, 2018, to April 9, 2019.

Preoperative EKG

We used the first ocular biometry claim to establish the start of the preoperative period. If this claim occurred within 30 days of the cataract surgery, we defaulted to a 30-day preoperative period (ie, 30 days before the cataract surgery) consistent with previous research.[22] We then defined a preoperative EKG as the first EKG that occurred during this preoperative period that both had a preoperative or cataract-related *ICD* diagnosis code and had no diagnosis code, such as chest pain, to suggest a nonpreoperative indication (eTable 2 in the Supplement).

EKG and Comparison Groups

We identified EKG (preoperative EKG) and comparison groups to estimate cascade-attributable event rates and spending relative to cataract surgery recipients who did not receive preoperative cardiac testing. The EKG group included 12 408 beneficiaries who received a preoperative EKG using the diagnosis code–based definition described above. Among the remaining 97 775 beneficiaries, a small subset had cardiac tests (EKG, stress test, or echocardiogram) in the preoperative period that may still have been intended as preoperative despite not meeting our diagnosis code–based definition (consistent with previous preoperative EKG rate estimates for cataract surgery).[18] Because we could not definitively classify these individuals with ambiguous indications for cardiac testing, we excluded them from our analysis. Our comparison group therefore included the remaining beneficiaries who had no EKG, stress test, or echocardiogram in the preoperative period (eFigure 2 and eAppendix 2 in the Supplement).

Cascade Events

We defined cascade events as follow-up tests, treatments, visits, hospitalizations, and new diagnoses that would follow plausibly from the initial service and could be captured reliably in claims data. Using earlier literature and clinical knowledge,[7,17,28,30,31] a team of 3 physician health services researchers (I.G., N.M., T.D.S.) and 2 consulting cardiologists defined cascade events within 3 clinical pathways that might arise from an EKG finding: ischemic heart disease, structural heart disease, and arrhythmia (eTables 3-7 in the Supplement).

In the EKG group, we examined incidence of cascade events in the 90 days after the preoperative EKG.[7] In the comparison group, with no EKG to define the start of the cascade period, we defined the start of this 90-day period as the mean time (13 days) from the preoperative EKG to cataract surgery in the EKG group. We recognized that EKGs, stress tests, and echocardiograms that fell within the cascade period but before cataract surgery could represent diagnostic or preoperative testing (some may be preoperative tests that were repeated to ensure that testing fell within 30 days of surgery if the initial preoperative tests were done "too early" [ie, more than 30 days before surgery]).[22] For this reason, we only counted EKGs, stress tests, and echocardiograms as cascade tests if they did not have a preoperative diagnosis code. In a sensitivity analysis to account for cases in which physicians intended these tests as preoperative but did not use a preoperative diagnosis code, we estimated event rates without counting any EKGs, stress tests, or echocardiograms occurring before cataract surgery as cascade tests. We used this sensitivity analysis to provide a lower bound on our cascade-attributable event and test rate estimates.

We estimated beneficiary-level spending using allowed charges on Medicare claims for both cascade events and total services during the 90-day follow-up period. Specifically, we summed the allowed amounts on the relevant claims, which reflect geographic and institution-specific components of reimbursement.

Patient and Physician Characteristics

To identify factors associated with potential cascades, we examined patient- and physician-level characteristics in the 12-month period preceding the start of the preoperative period. We used standard Medicare claims classifications to determine beneficiary characteristics including age, sex, race, disability,[32] end-stage renal disease,[32] and Medicaid enrollment. We used previous year claims to determine Elixhauser condition count.[33] We used zip codes to characterize beneficiaries' residential setting (eg, rural vs urban, based on rural-urban commuting area),[34] US region (based on US Census Bureau divisions), and 1 of 306 hospital referral regions to assess number of cardiologists per 10 000 residents.[2] We categorized the specialty of the performing physician linked to the preoperative EKG as primary care, cardiac specialty, or other using National Provider Identifier records (eTable 5 in the Supplement).

Statistical Analyses

We created unadjusted, beneficiary-level Poisson regression models to estimate cascade event rates and linear regression models to estimate Medicare spending.[35] We then created a series of multivariable regression models to determine event and spending rates adjusted for age, sex, race, Medicaid, Elixhauser condition count, and residential setting. We determined cascade-attributable event rates and spending by subtracting estimates in the comparison group, which represented baseline event rates and spending among cataract surgery recipients, from those in the EKG group.

Among patients who received the preoperative EKG, we performed *t* tests or χ^2 tests, as appropriate, to compare patient-, physician-, and area-level characteristics of patients who did or did not experience a potential cascade. We then created a multivariable logistic regression model with hospital referral region random effects to identify patient, physician, and geographic factors associated with the experience of a potential cascade. Reported *P* values were 2 sided and $P < .05$ represented statistical significance. The results shown were not adjusted for multiple testing; however, we confirmed that our conclusions did not change when we did so (ie, set a false discovery rate of 5% and calculated a new statistical significance threshold at $P < .009$).[36,37] We used SAS 9.4 statistical software (SAS Institute Inc) for the analyses.

Results

Our study population included 4 485 118 Medicare beneficiaries. Within this group, 158 641 underwent cataract surgery preceded by biometry between July 1, 2014, and June 30, 2015. We excluded 42 573 beneficiaries with a previous diagnosis of heart disease and 5885 beneficiaries with ambiguous cardiac testing indications (ie, those who did not meet our inclusion criteria for preoperative EKG receipt but underwent an EKG, stress test, or echocardiogram during the preoperative period). Of the remaining 110 183 in our sample, 12 408 (11.3%) received a preoperative EKG (eFigure 2 in the Supplement).

Beneficiaries receiving preoperative EKGs were older, had more medical conditions on average, and were more often urban dwellers compared with those not receiving preoperative EKGs (**Table 1**).[38] We found that 1978 (15.9%) of beneficia-

Table 1. Characteristics of Fee-for-Service Medicare Beneficiaries Without Documented Heart Disease Undergoing Cataract Surgery by Receipt of Preoperative Electrocardiogram

Characteristic	Group, No. (%) EKG (n = 12 408)[a]	Comparison (n = 97 775)
Age, y		
66-74	6858 (55.3)	56 374 (57.7)
75-84	4653 (37.5)	35 430 (36.2)
≥85	897 (7.2)	5971 (6.1)
Female sex	8145 (65.6)	61 649 (63.1)
Race		
White	10 533 (84.9)	84 555 (86.5)
Black	696 (5.6)	5553 (5.7)
Hispanic	567 (4.6)	3876 (4.0)
Other	612 (4.9)	3791 (3.9)
Medicaid enrollment	720 (5.8)	5491 (5.6)
Elixhauser condition count, mean (SD)	1.10 (1.35)	1.06 (1.35)
Disability[b]	728 (5.9)	6852 (7.0)
ESRD[b]	43 (0.4)	339 (0.4)
Setting of residence		
Metropolitan	10 346 (83.4)	71 493 (73.1)
Micropolitan	1135 (9.2)	12 890 (13.2)
Suburban	524 (4.2)	7521 (7.7)
Rural	403 (3.3)	5871 (6.0)
Cardiologists per 10 000 residents in HRR, mean (SD)[c]	7.39 (2.05)	6.46 (1.75)

Abbreviations: EKG, electrocardiogram; ESRD, end-stage renal disease; HRR, hospital referral region.

[a] The EKG and comparison groups had statistically significant characteristic differences at $P < .05$ with the exception of Medicaid enrollment and ESRD.

[b] Disability and ESRD refer to initial reason for Medicare eligibility.

[c] Dartmouth Atlas, 2011.[38]

ries who received a preoperative EKG experienced at least 1 potential cascade event. Of these 1978 beneficiaries, 43.5% (861) experienced 1 potential cascade event, 421 (21.3%) had 2, 201 (10.2%) had 3, and 495 (25.0%) had 4 or more. The most common potential cascade event was a cardiac test (1673 [84.6% of those experiencing any potential cascade event), followed by cardiac specialist visit (950 [48.0%]), and cardiac treatment (40 [2.0%]). These categories were not mutually exclusive. Two hundred sixty-one (13.2%) EKG recipients with potential cascade had cardiac specialist visits alone, 1057 (53.4%) experienced further testing or treatment of an ischemic, structural, or arrhythmia issue, and 660 (33.4%) experienced further testing or treatment of multiple such issues (**Figure 1**).

When we compared event rates between the EKG and comparison groups, we found an adjusted cascade-attributable event rate of 10.92 (95% CI, 9.76-12.08) (**Table 2**). Relative to the comparison group, the EKG group incurred an additional $565 (95% CI, $348-$781) per beneficiary in cascade event-specific expenditures and an additional $1707 (95% CI, $1358-$2055) in all Medicare expenditures during the 90-day cascade period. Accounting for the 20% sample, this amounted to a rough estimate of cascade-associated spending of $35 025 923. In comparison, the estimated overall spending for the preoperative EKGs alone was $3 275 712, based on mean EKG charges of $50.80 in 2014 and $54.80 in 2015.

Cascade-attributable events—in particular, cascade tests and cardiac specialist visits—peaked within 2 weeks after the preoperative EKG but continued throughout the 90-day cascade period (**Figure 2**). The most common new diagnoses were identical in the EKG and comparison groups (eTable 9 in the Supplement). In multivariate analysis, beneficiaries who were older (adjusted odds ratio [aOR], for 75-84 vs 66 to 74 years, 1.42; 95% CI, 1.28-1.57), had more chronic conditions (aOR for each additional Elixhauser condition, 1.18; 95% CI, 1.14-1.22), or lived in higher cardiologist-density areas (aOR, 1.05; 95% CI, 1.02-1.09) were more likely to experience a potential cascade. In addition, a cardiac specialist performing the EKG, rather than a primary care physician, was associated with greater odds of potential cascade (aOR, 1.26; 95% CI, 1.10-1.43) (**Table 3**).

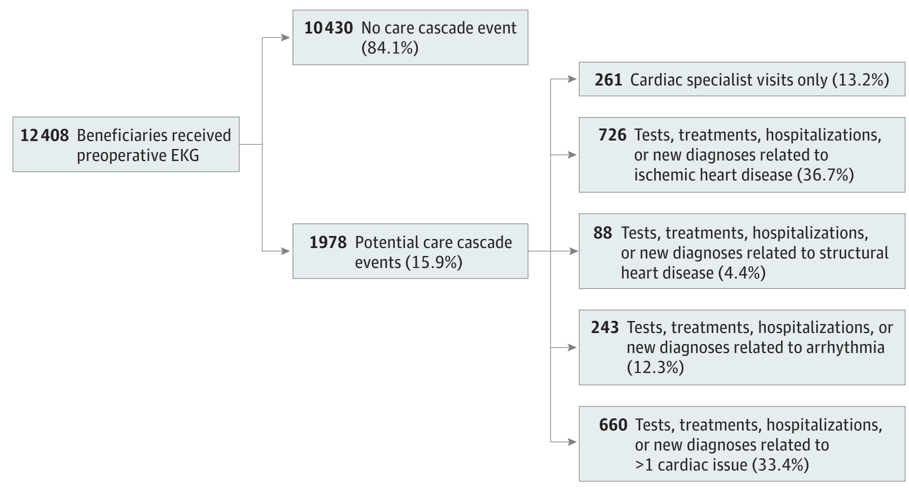
In the sensitivity analysis that assumed that all EKGs, stress tests, and echocardiograms done after the preoperative EKG but before surgery were intended as preoperative tests (and were therefore not cascade events), we estimated 14.7% of preoperative EKG recipients had a potential cascade event with 5.11 events per 100 beneficiaries (95% CI, 3.96-6.25) including 2.18 (95% CI, 1.34-3.02) tests per 100 beneficiaries. In this analysis, our spending estimates ($559 per beneficiary; 95% CI, $342-$775) and analysis of characteristics associated with cascades were nearly identical (eTables 10 and 11 in the Supplement).

Discussion

Among Medicare beneficiaries who received preoperative EKGs before cataract surgery, up to 16% experienced cascades of downstream care at sizeable cumulative expense—10 times that of the initial EKGs. We estimated between 5 and 11 cascade-attributable events per 100 beneficiaries, including cardiac catheterizations, cardiac specialist visits, and new diagnoses, in the 90 days after their preoperative EKGs. Our results build on a study showing that patients in Ontario, Canada, who received an EKG as part of a wellness visit were more likely to receive additional cardiac tests, visits, or procedures than those who did not.[7] This work also substantiates the concern described in a recent US Preventive Services Task Force statement that screening EKG in low-risk, asymptomatic patients can lead to harms including “unnecessary invasive procedures, overtreatment, and labeling.”[25]

We did not distinguish high- from low-value downstream services in this study. Although we purposefully chose an initial service whose low value at a population level is well established in the literature, in some individual cases, the test may have resulted in care that improved health.[39] But on average, such cascades are likely to come at a cost to patients, clinicians, and payers[9-12]: in addition to the financial cost, patients might experience anxiety, risks associated with treatment, inconvenience, and opportunity costs owing to time spent on office visits or procedures[9,11,40-42] or from the bur-

Figure 1. Potential Care Cascade Event Pathways Among Medicare Fee-for-Service Beneficiaries Receiving Preoperative Electrocardiogram (EKG) for Cataract Surgery[a]



[a] Mutually exclusive and comprehensively exhaustive outcomes experienced by beneficiaries who received a preoperative EKG.

Table 2. Care Cascade-Attributable Event Rates and Spending After Preoperative Electrocardiogram for Cataract Surgery

Event Rate per 100 Beneficiaries	Group, No. (%) EKG (n = 12 408)	Comparison (n = 97 775)	Cascade-Attributable Event Rate	Adjusted Cascade-Attributable Event Rate (95% CI)[a]
All				
Events	6259 (50.4)	36 173 (37.0)	13.4	10.92 (9.76-12.08)[b]
Tests	3654 (29.5)	19 488 (19.9)	9.6	7.98 (7.12-8.84)[b]
Treatments	74 (0.6)	368 (0.4)	0.22	0.33 (0.19-0.46)[b]
Tests and treatments				
Electrocardiogram	1697 (13.7)	10 471 (10.7)	3.0	1.81 (1.20-2.42)[b]
Stress test	503 (4.1)	1928 (2.0)	2.1	2.03 (1.74-2.32)[b]
Echocardiogram	859 (6.9)	3625 (3.7)	3.2	2.90 (2.51-3.28)[b]
Myocardial perfusion test	259 (2.1)	1065 (1.1)	1.0	0.94 (0.73-1.15)[b]
Event/Holter monitor	204 (1.6)	916 (0.9)	0.71	0.68 (0.49-0.88)[b]
Cardiac catheterization	28 (0.2)	121 (0.1)	0.10	0.15 (0.07-0.23)[b]
Visits and hospitalizations				
All cardiac specialist visits	1196 (9.6)	7060 (7.2)	2.4	1.27 (0.78-1.76)[b]
New patient cardiac specialist visit	336 (2.7)	1146 (1.2)	1.5	1.40 (1.18-1.62)[b]
Cardiac specialist visit for abnormal finding	122 (1.0)	262 (0.3)	0.72	0.57 (0.46-0.68)[b]
Cardiac hospitalization	49 (0.4)	284 (0.3)	0.10	0.15 (0.04-0.26)[b]
Diagnoses				
New cardiac diagnosis	1286 (10.4)	8973 (9.2)	1.2	1.21(0.62-1.79)[b]
Medicare spending per beneficiary, mean (SD), $				
Allowable charges related to cascade events in 90-d period	1789 (14 489)	1201 (10 999)	588	565 (348-781)[b]
Total Medicare allowable charges in 90-d period	11 666 (22 235)	9880 (18 021)	1786	1707 (1358-2055)[b]

Abbreviation: EKG, electrocardiogram.

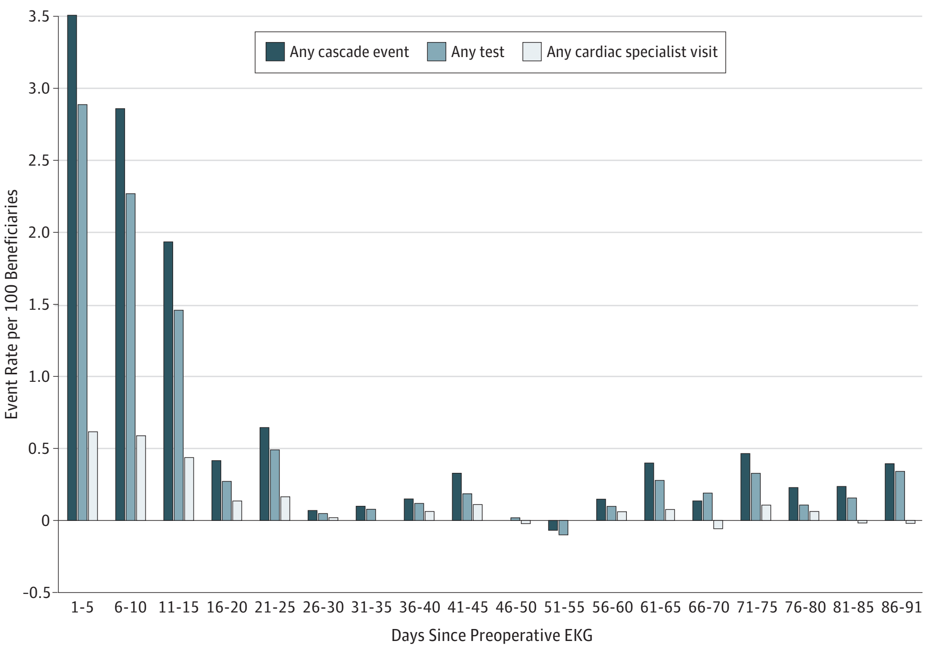
[a] The multivariable model included the following covariates: age, sex, race, Medicaid enrollment, Elixhauser condition count, disability (if reason for Medicare eligibility), end-stage renal disease (if reason for Medicare eligibility), and setting of residence.

[b] Statistically significant at $P < .05$.

den of a new diagnosis.[43,44] Meanwhile, physicians may feel distress, decision-making conflict, or burden from the added work of following up the initial abnormality.[10,11,40,42]

We found that factors associated with cascades mirrored those associated with the low-value services themselves. Our results confirm findings from earlier work that preoperative testing for cataract surgery is more common among older, sicker individuals who live in urban areas and that there is greater use of low-value services in areas with more specialists and spending per capita.[1,18,19,23,24] In parallel, we show that older, sicker patients who lived in more cardiologist-dense areas or saw a cardiac specialist for their initial EKG had greater odds of experiencing the downstream cascades. Given these findings, mechanisms such as more aggressive care for patients who

Figure 2. Cascade-Attributable Event Rates After Preoperative Electrocardiogram (EKG) for Cataract Surgery



Cascade-attributable events (any test, treatment, cardiac specialist visit, or cardiac hospitalization) up to 91 days after preoperative EKG. New diagnoses were not included because they did not correspond to a single date. Event rates were determined by subtracting the rate in the comparison group from the rate in the EKG group for each 5-day increment.

appear (or who are) more medically complex and supply-induced demand may drive both the initial low-value services and their downstream cascades.[45-47] This builds on previous work suggesting that cascades after incidental findings may be driven by clinician desire to have more information, ensure patient safety, assuage medicolegal risk, or meet the perceived or real expectations of patients or other clinicians.[1,11,12,18,40-42,48-52]

Although we cannot pinpoint in this claims-based analysis which potential cascade events followed directly from the preoperative EKG (eg, the most prevalent new diagnoses were identical in our EKG and comparison groups, reflecting cardiac conditions common in the Medicare population), we note that recipients of preoperative EKGs had higher rates of cardiac specialist visits coded with primary diagnosis of an unspecified "abnormal finding." Similarly, a medical record review of ophthalmic preoperative examinations found that these examinations uncovered EKG abnormalities such as first-degree atrioventricular block and bradycardia,[27] diagnoses that can be of limited clinical importance yet have the potential to lead to further testing and treatment.

Finally, we found that although patients who received a preoperative EKG had additional cascade event-specific spending up to $565 per patient, their total Medicare spending per patient during the cascade period was substantially higher as well, even when controlling for observed patient characteristics. These differences may represent spillover of cascades from preoperative EKGs into unanticipated areas or greater unmeasured medical need among recipients of preoperative EKG.

Limitations

Our work has limitations similar to those of other low-value care studies using administrative claims. We did not have certain clinical information such as physical examination findings to confirm intentions behind billed services. To address this, we used conservative estimates whenever possible, biasing our results to the null. For example, we used a diagnosis code–based definition of preoperative EKG, which likely contributed to finding lower preoperative EKG rates than previously reported, and limited our analysis to the 90 days after the preoperative EKG, when related downstream events would most likely occur. We further limited our analysis to beneficiaries who underwent cataract surgery within 90 days of initial evaluation (biometry), thereby missing beneficiaries for whom a cascade after preoperative EKG may have caused postponement of the surgery beyond this time frame or outright cancellation.

Despite these precautions, some EKGs meeting our preoperative EKG definition (ie, those with a preoperative diagnosis code and no recorded diagnosis code for a relevant symptom or cardiovascular condition) may still have been intended as diagnostic EKGs. We further acknowledge that unmeasured confounders may contribute to our findings. For example, despite selecting for patients without existing cardiac conditions and controlling for patient comorbidities among other variables, patients with suspected but undocumented conditions may have been more likely both to receive a preoperative EKG from a cardiac specialist and to experience a potential cascade. Finally, we were unable to capture other elements of cascades, such as new prescriptions, complications from cascade events (eg, radiation exposure from imaging), or financial, physical, psychological, or social consequences for patients, all of which will be important to address in future work.[9,25,26]

This study highlights the importance of policy efforts to target both low-value services and the cascades that follow. Despite Choosing Wisely campaign efforts to publicize the low

Table 3. Characteristics Associated With Experience of Potential Care Cascade Among Fee-for-Service Medicare Beneficiaries Receiving Preoperative EKG for Cataract Surgery

Characteristic	Potential Cascade, No. (%) Experienced (n = 1978)	Potential Cascade, No. (%) Did Not Experience (n = 10 430)	Adjusted OR (95% CI)[a]
Age, y			
66-74	938 (47.4)	5920 (56.8)	1 [Reference]
75-84	859 (43.4)	3794 (36.4)	1.42 (1.28-1.57)[b]
≥85	181 (9.2)	716 (6.9)	1.54 (1.29-1.84)[b]
Female sex	1277 (64.6)	6868 (65.8)	0.93 (0.84-1.03)
Race			
White	1643 (83.1)	8890 (85.2)	1 [Reference]
Black	134 (6.8)	562 (5.4)	1.13 (0.92-1.39)
Hispanic	101 (5.5)	458 (4.4)	1.17 (0.93-1.47)
Other	92 (4.7)	520 (5.0)	0.91 (0.71-1.15)
Medicaid enrollment	145 (7.3)	575 (5.5)	1.19 (0.97-1.46)
Setting of residence			
Metropolitan	1672 (84.5)	8674 (83.2)	1 [Reference]
Micropolitan	157 (7.9)	978 (9.4)	0.91 (0.75-1.10)
Suburban	84 (4.2)	440 (3.2)	1.09 (0.85-1.39)
Rural	65 (3.3)	338 (3.2)	1.12 (0.85-1.48)
Elixhauser condition count, mean (SD)	1.39 (1.48)	1.04 (1.31)	1.18 (1.14-1.22)[b]
Physician ordering preoperative EKG			
Primary care physician	1364 (69.0)	7557 (72.5)	1 [Reference]
Cardiac specialist	374 (18.9)	1701 (16.3)	1.26 (1.10-1.43)[b]
Other	240 (12.1)	1172 (11.2)	1.14 (0.97-1.33)
Practice region			
Northeast	705 (35.6)	3379 (32.4)	0.98 (0.82-1.18)
South	634 (32.1)	3352 (32.1)	1.03 (0.87-1.22)
West	326 (16.5)	1877 (18.0)	1.00 (0.82-1.22)
Midwest	313 (15.8)	1822 (17.5)	1 [Reference]
Cardiologists per 10 000 residents in HRR, mean (SD)[c]	7.57 (2.1)	7.36 (2.0)	1.05 (1.02-1.09)[b]

Abbreviations: EKG, electrocardiogram; HRR, hospital referral region; OR, odds ratio.

[a] Among beneficiaries who received a preoperative EKG, we compared those who did or did not experience a potential cascade using univariate analyses and multivariable logistic regression in which the primary outcome was experience of the cascade and the covariates were all characteristics included in the table and HRR random effects.

[b] Statistically significant at $P < .05$.

[c] Dartmouth Atlas, 2011.[38]

value of preoperative EKGs for cataract surgery, these tests persist.[1,2,18,22] To reduce use of these services, payers could limit reimbursements or steer patients toward clinicians with lower rates of low-value ordering. Likewise, primary care clinicians could refrain from referring patients to ophthalmologists who require such testing. Given the role of institutional culture and physician preference in driving low-value testing, quality improvement efforts might target physician and institutional outliers for intervention using techniques such as peer comparison, clinical decision support, and physician notifications.[23,24,53,54]

To limit cascades, policymakers might consider including preoperative testing as part of surgical bundles to reduce incentives to order both the initial tests and the cascade services.[55] Malpractice tort reform may reduce physician need to order owing to perceived liability, although evidence on this is weak.[56-59] Specialist e-consultations could help generalists obtain timely, informed advice to expedite resolution of cascades.[60] Longer visits, shared-decision making aids, and other tools to facilitate needed patient-clinician conversations may encourage more conservative approaches to clinical uncertainty, for example, choosing active surveillance of a potentially harmless EKG abnormality rather than invasive testing.[48] We also need rigorous, multimodal research to understand if and how interventions might reduce low-value care and associated cascades, as well as unintended consequences of these interventions.[53,61]

Conclusions

Cascade events are relatively infrequent, but the cumulative cost of these events eclipses that of the initial low-value services. In future work, we should characterize cascades after other low-value services and determine whether they have similar incidence and cost. In addition, understanding how clinicians think about these cascades could inform interventions to mitigate their potential harm. For example, initial low-value services may be easier to limit than cascades that clinicians feel obligated to pursue. Our work demonstrates that low-value services that appear financially benign may have large downstream consequences; we should consider these cascades when measuring the consequences of low-value care and prioritizing efforts to reduce it.

ARTICLE INFORMATION

Accepted for Publication: April 13, 2019.

Published Online: June 3, 2019. doi:10.1001/jamainternmed.2019.1739

Author Affiliations: Department of Medicine, Harvard Medical School, Boston, Massachusetts (Ganguli, Sequist); Division of General Internal Medicine and Primary Care, Brigham and Women's Hospital, Boston, Massachusetts (Ganguli, Lupo, Orav, Sequist); Partners HealthCare, Boston, Massachusetts (Ganguli, Sequist); The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine at Dartmouth, Lebanon, New Hampshire (Mainor, Raymond, Wang, Morden, Colla); Department of Biostatistics, Harvard T. H. Chan School of Public Health, Boston, Massachusetts (Orav); Division of Geriatric and Palliative Medicine, Department of Internal Medicine, University of Michigan Medical School, Ann Arbor, Michigan (Chang); Department of Health Care Policy and Management, Harvard T. H. Chan School of Public Health, Boston, Massachusetts (Rosenthal); Norris Cotton Cancer Center, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire (Colla).

Author Contributions: Dr Colla, Dr Chang, Ms Wang, and Ms Raymond had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Concept and design: Ganguli, Mainor, Chang, Morden, Rosenthal, Colla, Sequist.
Acquisition, analysis, or interpretation of data: Ganguli, Lupo, Raymond, Wang, Orav, Chang, Morden, Rosenthal, Colla, Sequist.
Drafting of the manuscript: Ganguli, Lupo, Mainor, Morden, Sequist.
Critical revision of the manuscript for important intellectual content: Ganguli, Mainor, Raymond, Wang, Orav, Chang, Morden, Rosenthal, Colla, Sequist.
Statistical analysis: Raymond, Wang, Orav, Chang, Sequist.
Obtained funding: Rosenthal, Colla, Sequist.
Administrative, technical, or material support: Ganguli, Lupo, Mainor, Raymond, Colla.
Supervision: Ganguli, Mainor, Chang, Morden, Rosenthal, Colla, Sequist.

Conflict of Interest Disclosures: Dr Ganguli reported receiving consulting fees from Haven unrelated to this work. Dr Mainor reported receiving grants from the Agency for Healthcare Research and Quality (AHRQ) during the conduct of the study. Dr Morden reported receiving grants from NIH during the conduct of the study and is now an employee of Microsoft. Dr Rosenthal reported receiving grants from AHRQ during the conduct of the study. Dr Colla reported receiving grants from AHRQ during the conduct of the study. Dr Sequist reported receiving grants from AHRQ during the conduct of the study and personal fees from Aetna outside the submitted work. No other disclosures were reported.

Funding/Support: This work was supported by the Agency for Healthcare Research and Quality grant 1R01HS023812 (Dr Ganguli, Ms Lupo, Mr Mainor, Ms Raymond, Ms Wang, Dr Chang, Dr Rosenthal, Dr Colla, Dr Sequist.

Role of the Funder: The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Meeting Presentations: This work was presented in poster form at the 2019 Society of General Internal Medicine Annual Meeting; May 11, 2019; Washington, DC, and as an oral presentation at the 2019 Academy Health Annual Research Meeting, June 3, 2019; Washington, DC.

Additional Contributions: We thank Alice C. Lorch, MD, MPH, of the Massachusetts Eye and Ear Infirmary for her advice on the use of cataract surgery codes and Catherine L. Chen, MD, MPH, of the University of California, San Francisco, for her guidance on evaluation of preoperative testing in cataract surgery. We are grateful to Jason H. Wasfy, MD, MPhil, and Varsha Tanguturi, MD, of Massachusetts General Hospital for their review of cardiac cascade items. They were not compensated for their work on this study.

REFERENCES

1. Colla CH, Morden NE, Sequist TD, Schpero WL, Rosenthal MB. Choosing Wisely: prevalence and correlates of low-value health care services in the United States. *J Gen Intern Med*. 2015;30(2):221-228. doi:10.1007/s11606-014-3070-z

2. Colla CH, Sequist TD, Rosenthal MB, Schpero WL, Gottlieb DJ, Morden NE. Use of non-indicated cardiac testing in low-risk patients: Choosing Wisely. *BMJ Qual Saf*. 2015;24(2):149-153. doi:10.1136/bmjqs-2014-003087

3. Schwartz AL, Landon BE, Elshaug AG, Chernew ME, McWilliams JM. Measuring low-value care in Medicare. *JAMA Intern Med*. 2014;174(7): 1067-1076. doi:10.1001/jamainternmed.2014.1541

4. Schwartz AL, Chernew ME, Landon BE, McWilliams JM. Changes in low-value services in year 1 of the Medicare Pioneer Accountable Care Organization program. *JAMA Intern Med*. 2015;175 (11):1815-1825. doi:10.1001/jamainternmed.2015.4525

5. Schwartz AL, Zaslavsky AM, Landon BE, Chernew ME, McWilliams JM. Low-value service use in provider organizations. *Health Serv Res*. 2018;53(1):87-119. doi:10.1111/1475-6773.12597

6. Rothberg MB. The $50 000 physical[A Piece of My Mind]. *JAMA*. 2014;311(21):2175-2176. doi:10.1001/jama.2014.3415

7. Bhatia RS, Bouck Z, Ivers NM, et al. Electrocardiograms in low-risk patients undergoing an annual health examination. *JAMA Intern Med*. 2017;177(9):1326-1333. doi:10.1001/jamainternmed.2017.2649

8. EKGs and exercise stress tests: when you need them—and when you don't. http://www.choosingwisely.org/patient-resources/ekgs-and-exercise-stress-tests/. Accessed November 5, 2018.

9. Korenstein D, Chimonas S, Barrow B, Keyhani S, Troy A, Lipitz-Snyderman A. Development of a conceptual map of negative consequences for patients of overuse of medical tests and treatments. *JAMA Intern Med*. 2018;178(10):1401-1407. doi:10.1001/jamainternmed.2018.3573

10. Booth TC, Boyd-Ellison JM. The current impact of incidental findings found during neuroimaging on neurologists' workloads. *PLoS One*. 2015;10(2): e0118155. doi:10.1371/journal.pone.0118155

11. Berland LL, Silverman SG, Gore RM, et al. Managing incidental findings on abdominal CT: white paper of the ACR incidental findings committee. *J Am Coll Radiol*. 2010;7(10):754-773. doi:10.1016/j.jacr.2010.06.013

12. Rao VM, Levin DC. The overuse of diagnostic imaging and the Choosing Wisely initiative. *Ann Intern Med*. 2012;157(8):574-576. doi:10.7326/0003-4819-157-8-201210160-00535

13. Schein OD, Katz J, Bass EB, et al;. The value of routine preoperative medical testing before cataract surgery. Study of Medical Testing for Cataract Surgery. *N Engl J Med*. 2000;342(3):168-175. doi:10.1056/NEJM200001203420304

14. Keay L, Lindsley K, Tielsch J, Katz J, Schein O. Routine preoperative medical testing for cataract surgery. *Cochrane Database Syst Rev*. 2012;3(3): CD007293. doi:10.1002/14651858.CD007293.pub3

15. Cavallini GM, Saccarola P, D'Amico R, Gasparin A, Campi L. Impact of preoperative testing on ophthalmologic and systemic outcomes in cataract surgery. *Eur J Ophthalmol*. 2004;14(5): 369-374. https://www.ncbi.nlm.nih.gov/pubmed/15506597. Accessed May 23, 2018. doi:10.1177/112067210401400502

16. Nascimento MA, Lira RP, Soares PH, Spessatto N, Kara-José N, Arieta CE. Are routine preoperative medical tests needed with cataract surgery? study of visual acuity outcome. *Curr Eye Res*. 2004;28(4):285-290. https://www.ncbi.nlm.nih.gov/pubmed/15259298. doi:10.1076/ceyr.28.4.285.27832

17. Gold BS, Young ML, Kinman JL, Kitz DS, Berlin J, Schwartz JS. The utility of preoperative electrocardiograms in the ambulatory surgical patient. *Arch Intern Med*. 1992;152(2):301-305. doi:10.1001/archinte.1992.00400140055013

18. Chen CL, Lin GA, Bardach NS, et al. Preoperative medical testing in Medicare patients undergoing cataract surgery. *N Engl J Med*. 2015; 372(16):1530-1538. doi:10.1056/NEJMsa1410846

19. Thilen SR, Treggiari MM, Lange JM, Lowy E, Weaver EM, Wijeysundera DN. Preoperative consultations for medicare patients undergoing cataract surgery. *JAMA Intern Med*. 2014;174(3): 380-388. doi:10.1001/jamainternmed.2013.13426

20. Rosenberg A, Agiro A, Gottlieb M, et al. Early trends among seven recommendations from the Choosing Wisely campaign. *JAMA Intern Med*. 2015;175(12):1913-1920. doi:10.1001/jamainternmed.2015.5441

21. Sigmund AE, Stevens ER, Blitz JD, Ladapo JA. Use of preoperative testing and physicians' response to professional society guidance. *JAMA Intern Med*. 2015;175(8):1352-1359. doi:10.1001/jamainternmed.2015.2081

22. Chen CL, Clay TH, McLeod S, Chang HP, Gelb AW, Dudley RA. A revised estimate of costs associated with routine preoperative testing in Medicare cataract patients with a procedure-specific indicator. *JAMA Ophthalmol*. 2018;136(3):231-238. doi:10.1001/jamaophthalmol.2017.6372

23. Kirkham KR, Wijeysundera DN, Pendrith C, et al. Preoperative testing before low-risk surgical procedures. *CMAJ*. 2015;187(11):E349-E358. doi:10.1503/cmaj.150174

24. Kirkham KR, Wijeysundera DN, Pendrith C, et al; Preoperative Laboratory Investigations. Preoperative laboratory investigations: rates and variability prior to low-risk surgical procedures. *Anesthesiology*. 2016;124(4):804-814. doi:10.1097/ALN.0000000000001013

25. Curry SJ, Krist AH, Owens DK, et al; US Preventive Services Task Force. Screening for cardiovascular disease risk with electrocardiography: US Preventive Services Task Force Recommendation Statement. *JAMA*. 2018; 319(22):2308-2314. doi:10.1001/jama.2018.6848

26. Jonas DE, Reddy S, Middleton JC, et al. Screening for cardiovascular disease risk with resting or exercise electrocardiography: evidence report and systematic review for the US Preventive Services Task Force. *JAMA*. 2018;319(22):2315-2328. doi:10.1001/jama.2018.6897

27. Phillips MB, Bendel RE, Crook JE, Diehl NN. Global health implications of preanesthesia medical examination for ophthalmic surgery. *Anesthesiology*. 2013;118(5):1038-1045. doi:10.1097/ALN.0b013e31828ea5b2

28. Noordzij PG, Boersma E, Bax JJ, et al. Prognostic value of routine preoperative electrocardiography in patients undergoing noncardiac surgery. *Am J Cardiol*. 2006;97(7):1103-1106. doi:10.1016/j.amjcard.2005.10.058

29. Khera R, Dorsey KB, Krumholz HM. Transition to the ICD-10 in the United States: an emerging data chasm. *JAMA*. 2018;320(2):133-134. doi:10.1001/jama.2018.6823

30. Amsterdam EA, Kirk JD, Diercks DB, Lewis WR, Turnipseed SD. Immediate exercise testing to evaluate low-risk patients presenting to the emergency department with chest pain. *J Am Coll Cardiol*. 2002;40(2):251-256. doi:10.1016/S0735-1097(02)01968-X

31. Laslett LJ, Amsterdam EA. Management of the asymptomatic patient with an abnormal exercise ECG. *JAMA*. 1984;252(13):1744-1746. doi:10.1001/jama.1984.03350130058036

32. Data Documentation—Master Beneficiary Summary File (MBSF) Base | ResDAC. Research Data Assistance Center. https://www.resdac.org/cms-data/files/mbsf-base/data-documentation. Accessed March 5, 2019.

33. Mehta HB, Dimou F, Adhikari D, et al. Comparison of comorbidity scores in predicting surgical outcomes. *Med Care*. 2016;54(2):180-187. doi:10.1097/MLR.0000000000000465

34. Hart LG, Larson EH, Lishner DM. Rural definitions for health policy and research. *Am J Public Health*. 2005;95(7):1149-1155. doi:10.2105/AJPH.2004.042432

35. Buntin MB, Zaslavsky AM. Too much ado about two-part models and transformation? comparing methods of modeling Medicare expenditures. *J Health Econ*. 2004;23(3):525-542. doi:10.1016/j.jhealeco.2003.10.005

36. Benjamini Y, Hochberg Y. Controlling the false discovery rate: a practical and powerful approach to multiple testing. *J R Stat Soc B*. 1995;57(1):289-300.

37. Althouse AD. Adjust for multiple comparisons? it's not that simple. *Ann Thorac Surg*. 2016;101(5):1644-1645. doi:10.1016/j.athoracsur.2015.11.024

38. The Dartmouth Atlas of Healthcare. http://www.dartmouthatlas.org. Accessed December 1, 2018.

39. Rosenbaum L. The less-is-more crusade—are we overmedicalizing or oversimplifying? *N Engl J Med*. 2017;377(24):2392-2397. https://www.nejm.org/doi/pdf/10.1056/NEJMms1713248. Accessed June 29, 2018. doi:10.1056/NEJMms1713248

40. Jones K. Incidental findings: expect to find the unexpected. *CMAJ*. 2014;186(3):E105-E106. doi:10.1503/cmaj.109-4695

41. Bautista AB, Burgos A, Nickel BJ, Yoon JJ, Tilara AA, Amorosa JK; American College of Radiology Appropriateness. Do clinicians use the American College of Radiology Appropriateness criteria in the management of their patients? *AJR Am J Roentgenol*. 2009;192(6):1581-1585. doi:10.2214/AJR.08.1622

42. Wiener RS, Schwartz LM, Woloshin S. When a test is too good: how CT pulmonary angiograms find pulmonary emboli that do not need to be found. *BMJ*. 2013;347:f3368. doi:10.1136/bmj.f3368

43. de Ridder D, Geenen R, Kuijer R, van Middendorp H. Psychological adjustment to chronic disease. *Lancet*. 2008;372(9634):246-255. doi:10.1016/S0140-6736(08)61078-8

44. Cotter AR, Vuong K, Mustelin L, et al. Do psychological harms result from being labelled with an unexpected diagnosis of abdominal aortic aneurysm or prostate cancer through screening? A systematic review. *BMJ Open*. 2017;7(12):e017565. doi:10.1136/bmjopen-2017-017565

45. Wennberg DE, Kellett MA, Dickens JD, Malenka DJ, Keilson LM, Keller RB. The association between local diagnostic testing intensity and invasive cardiac procedures. *JAMA*. 1996;275(15):1161-1164. doi:10.1001/jama.1996.03530390027029

46. Lucas FL, Siewers AE, Malenka DJ, Wennberg DE. Diagnostic-therapeutic cascade revisited: coronary angiography, coronary artery bypass graft surgery, and percutaneous coronary intervention in the modern era. *Circulation*. 2008; 118(25):2797-2802. doi:10.1161/CIRCULATIONAHA.108.789446

47. Mudrick DW, Cowper PA, Shah BR, et al. Downstream procedures and outcomes after stress testing for chest pain without known coronary artery disease in the United States. *Am Heart J*. 2012;163(3):454-461. doi:10.1016/j.ahj.2011.11.022

48. PerryUndem Research/Communication. Unnecessary Tests and Procedures In the Health Care System: What Physicians Say About The Problem, The Causes, and the Solutions. Results from a National Survey of Physicians. http://www.choosingwisely.org/wp-content/uploads/2015/04/Final-Choosing-Wisely-Survey-Report.pdf. Accessed December 1, 2018.

49. Silverstein W, Lass E, Born K, Morinville A, Levinson W, Tannenbaum C. A survey of primary care patients' readiness to engage in the de-adoption practices recommended by Choosing Wisely Canada. *BMC Res Notes*. 2016;9(1):301. doi:10.1186/s13104-016-2103-6

50. Grover M, Abraham N, Chang Y-H, Tilburt J. Physician cost consciousness and use of low-value clinical services. *J Am Board Fam Med*. 2016;29(6):785-792. doi:10.3122/jabfm.2016.06.160176

51. Deyo RA. Cascade effects of medical technology. *Annu Rev Public Health*. 2002;23:23-44. doi:10.1146/annurev.publhealth.23.092101.134534

52. Zafar HM, Bugos EK, Langlotz CP, Frasso R. "Chasing a ghost": factors that influence primary care physicians to follow up on incidental imaging findings. *Radiology*. 2016;281(2):567-573. doi:10.1148/radiol.2016152188

53. Colla CH, Mainor AJ, Hargreaves C, Sequist T, Morden N. Interventions aimed at reducing use of low-value health services: a systematic review. *Med Care Res Rev*. 2017;74(5):507-550. doi:10.1177/1077558716656970

54. Doctor JN, Nguyen A, Lev R, et al. Opioid prescribing decreases after learning of a patient's fatal overdose. *Science*. 2018;361(6402):588-590. doi:10.1126/science.aat4595

55. Cutler DM, Ghosh K. The potential for cost savings through bundled episode payments. *N Engl J Med*. 2012;366(12):1075-1077. doi:10.1056/NEJMp1113361

56. Mello MM, Studdert DM, Kachalia A. The medical liability climate and prospects for reform. *JAMA*. 2014;312(20):2146-2155. doi:10.1001/jama.2014.10705

57. Waxman DA, Greenberg MD, Ridgely MS, Kellermann AL, Heaton P. The effect of malpractice reform on emergency department care. *N Engl J Med*. 2014;371(16):1518-1525. doi:10.1056/NEJMsa1313308

58. Sloan FA, Shadle JH. Is there empirical evidence for "defensive medicine"? a reassessment. *J Health Econ*. 2009;28(2):481-491. doi:10.1016/j.jhealeco.2008.12.006

59. Baicker K, Fisher ES, Chandra A. Malpractice liability costs and the practice of medicine in the Medicare program. *Health Aff (Millwood)*. 2007;26(3):841-852. doi:10.1377/hlthaff.26.3.841

60. Wasfy JH, Rao SK, Kalwani N, et al. Longer-term impact of cardiology e-consults. *Am Heart J*. 2016;173:86-93. doi:10.1016/j.ahj.2015.11.019

61. Kerr EA, Kullgren JT, Saini SD. Choosing Wisely: how to fulfill the promise in the next 5 years. *Health Aff (Millwood)*. 2017;36(11):2012-2018. doi:10.1377/hlthaff.2017.0953