If you give a mouse an EKG: cascades after low-value care

Ishani Ganguli MD, MPH
Brigham and Women's Hospital
Harvard Medical School

October 17, 2019

…we'll feel compelled to get a stress test to go with it

Cascades after incidental findings: a physician survey

- National survey - 376 US internists, 45% response

Q. Your patient is a healthy 60yo man.
Routine preoperative chest x-ray → chest CT shows 5mm lung nodule
Radiology report: "repeat chest CT in 6-12 months"
Fleischner Society guidelines: "no further action"

What would you do next?

- ❑ Repeat chest CT in 6-12 months
- ❑ Consult with specialist

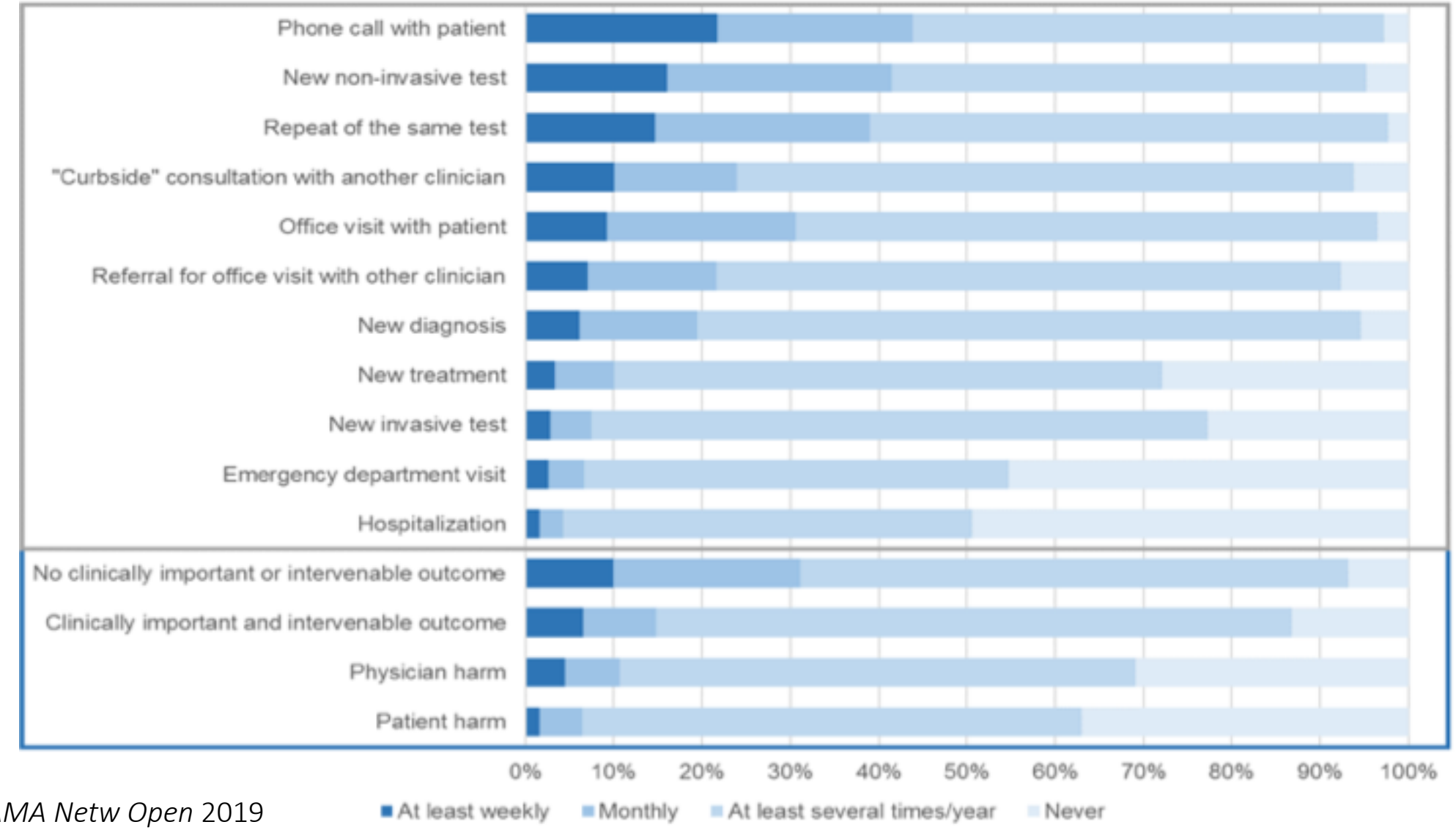
58%

- ❑ No further action per guidelines

42%

Ganguli et al, *JGIM* 2019

Cascades common, more often lead to “nothing”



Ganguli et al, *JAMA Netw Open* 2019

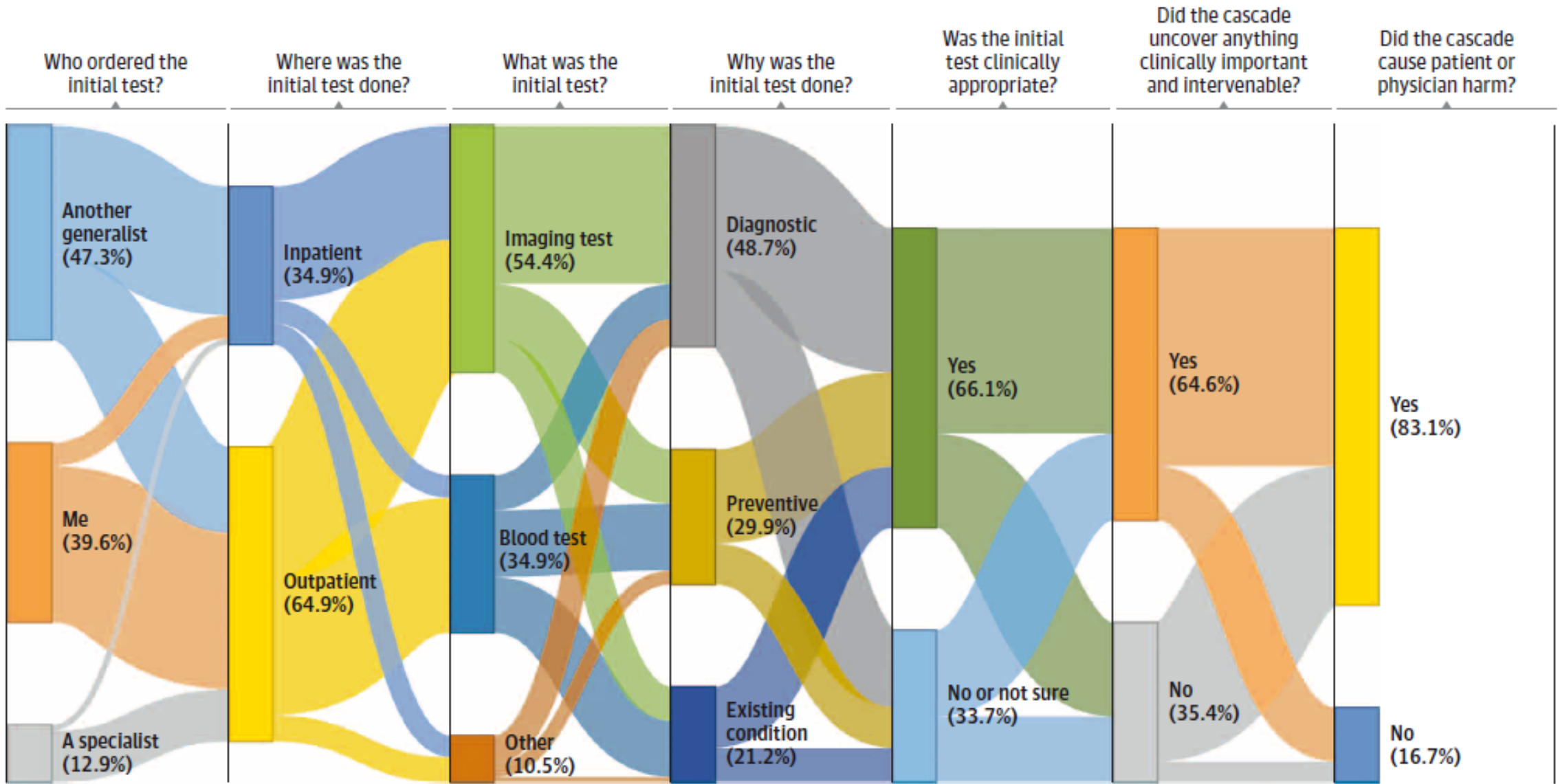
Rural setting, discomfort w/ uncertainty predicted self-reported physician harm

- Harms: anxiety, frustration, wasted time and effort

Physician characteristic		No Harm (N = 112)	Harm (N = 262)	Adjusted Odds Ratio (95% CI)
Age, y	≤39	31.5	68.5	Ref
	40-55	28.4	71.6	0.65 (0.26-1.63)
	≥56	32.8	67.2	0.40 (0.16-1.04)
Practice setting	Urban	35.6	64.4	Ref
	Suburban	30.2	69.8	1.28 (0.75-2.20)
	Rural	10.9	89.1	3.89 (1.38-10.97)
Prior malpractice lawsuit		27.3	72.7	1.44 (0.75-2.77)
Discomfort with uncertainty		3.6	3.8	1.23 (1.00-1.50)
Cost-consciousness		24.2	25.2	1.05 (1.00-1.10)

Ganguli et al, *JAMA Netw Open* 2019

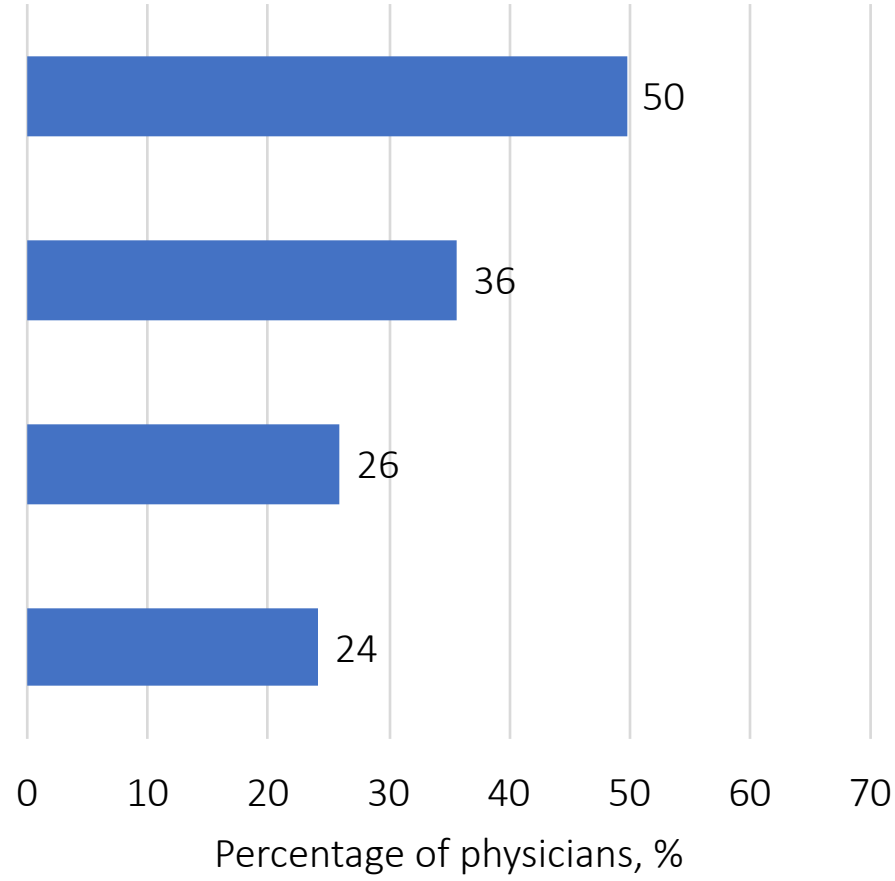
One-third of cascades stem from potentially inappropriate tests



Cascades often pursued for non-clinical reasons

Q. ***Why did you pursue testing (if not needed clinically – 41% of cascades)?***

- ❑ I was following the norms of my practice or medical community
- ❑ I was concerned about being sued if I missed something important
- ❑ Another doctor advised it
- ❑ The patient asked for it



Ganguli et al, *JGIM* 2019

To limit negative consequences of cascades, respondents favored point-of-care solutions

Approach	Respondents, weighted % (95% CI) N = 376
Evidence-based recommendations for next steps on radiology and laboratory result reports	66.5
Accessible guidelines on how to manage incidental findings	62.8
Clinician education on managing incidental findings during training or continuing medical education	54.7
Patient and clinician education on potential harms from unnecessary medical care	48.1
Shared decision-making tools to aid conversations with patients	44.6
Malpractice reform	42.0
Patient cost-sharing (i.e., insurance plan requires patient to pay a portion of medical costs out-of-pocket)	18.1
Value-based payment models (eg, Accountable Care Organizations)	16.2

Conclusions

- Cascades following incidental findings extremely common, including billed and non-billed services
- “Nothing” cascades more common than those with clinically meaningful outcomes
- Most led to patient, physician harms
- Pursuit of cascades driven by practice norms, fear of lawsuits
- To mitigate cascades, point-of-care >> payment solutions

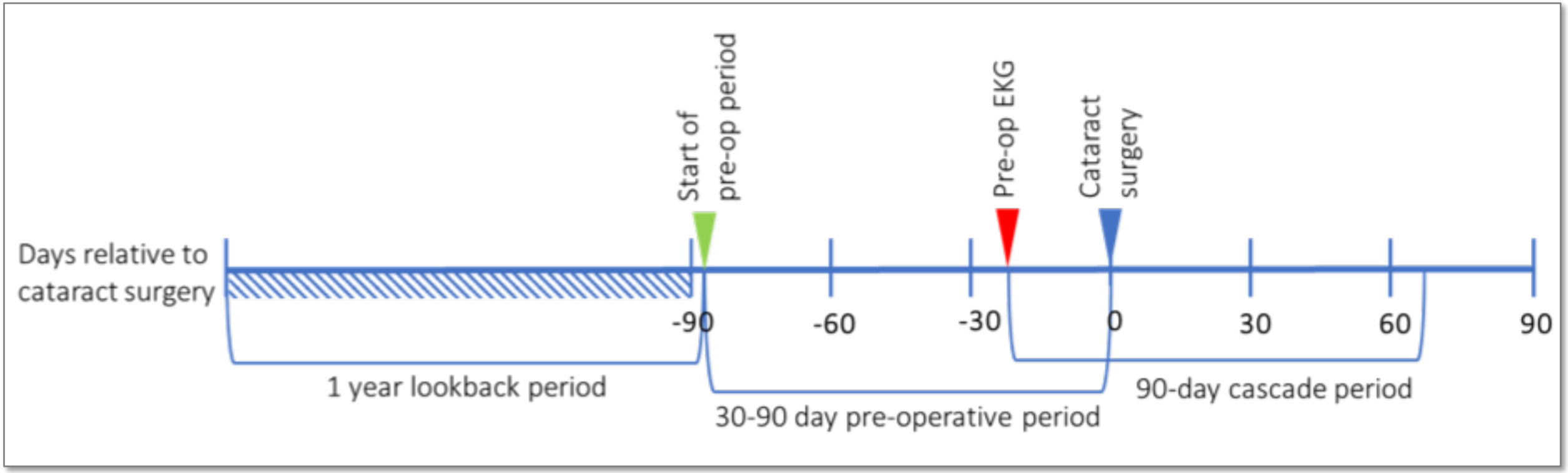
Cascades after low-value care: preoperative EKG for cataract surgery

- National Medicare claims analysis

Ganguli et al. *JAMA IM* 2019

Cascades after low-value care: preoperative EKG for cataract surgery

- National Medicare claims analysis



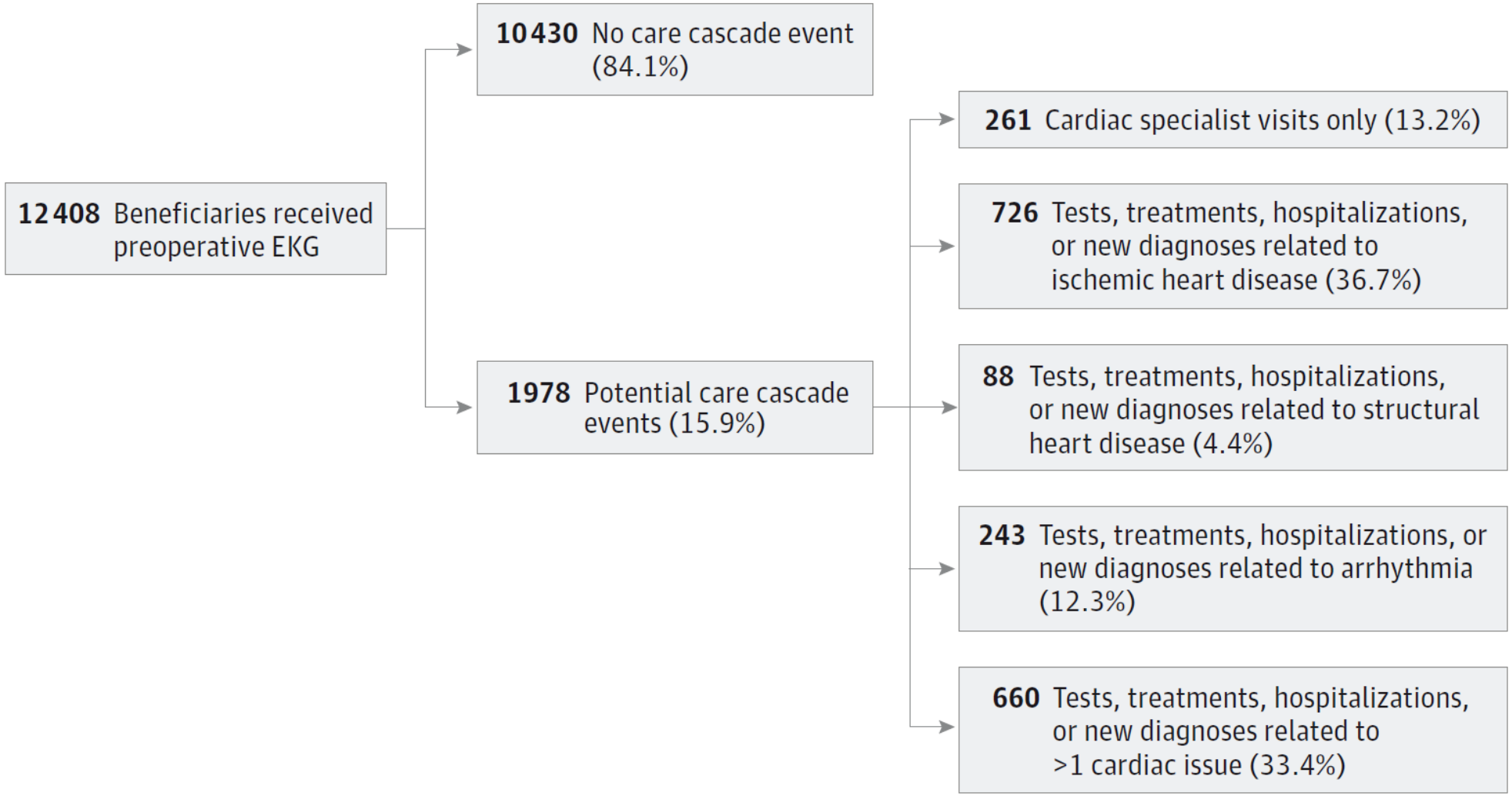
Ganguli I, et al. *JAMA IM* 2019

Of 110,000 cataract surgery recipients, 11% received a pre-operative EKG

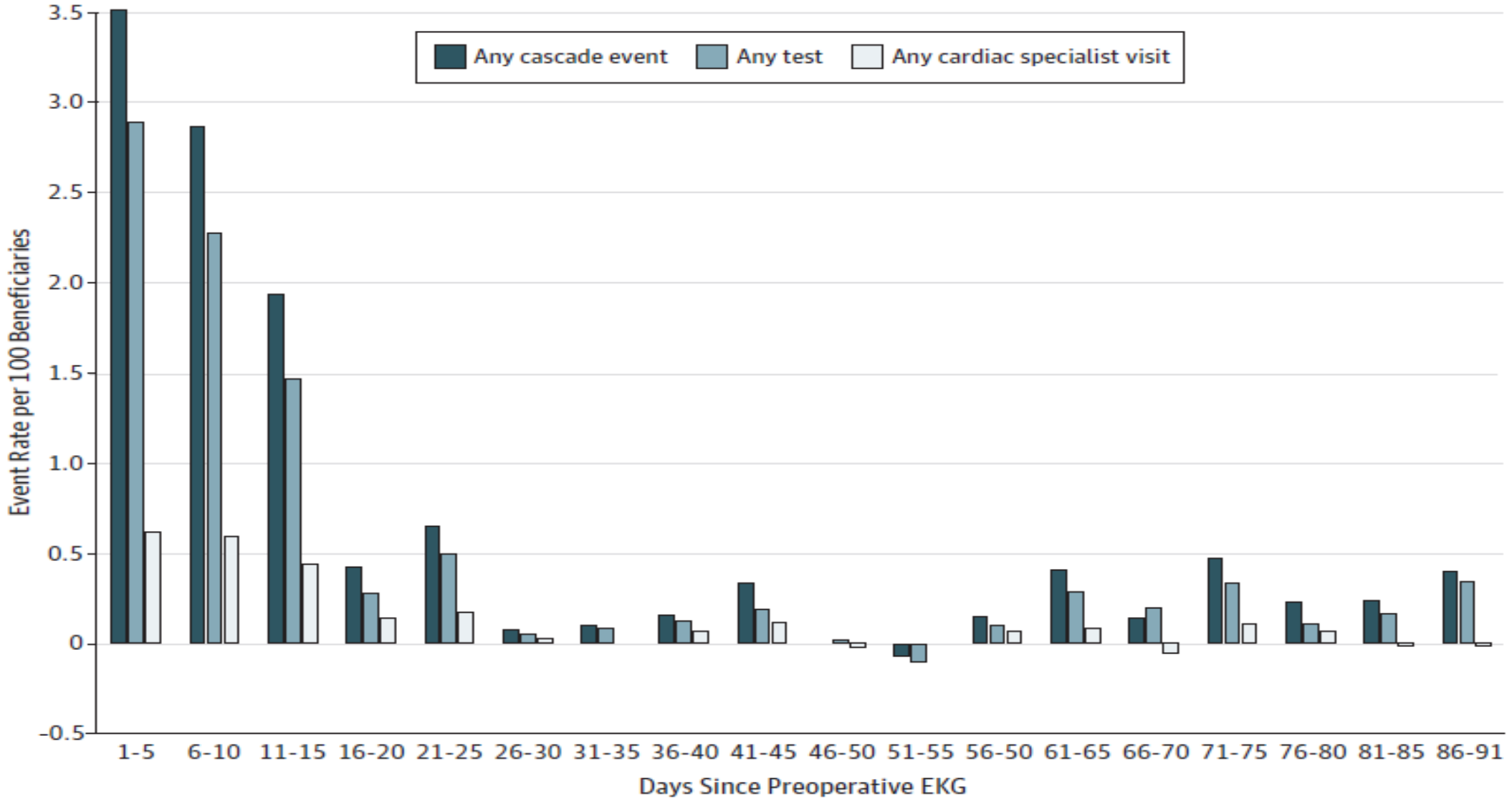
Characteristic		Preop EKG, no. (%) N = 12,408	Comparison, no. (%) N = 97,775
Age, y	66-74	6,858 (55.3)	56,374 (57.7)
	75-84	4,653 (37.5)	35,430 (36.2)
	≥85	897 (7.2)	5,971 (6.1)
Female sex		8,145 (65.6)	61,649 (63.1)
Elixhauser condition count, mean (SD)		1.10 (1.35)	1.06 (1.35)
Setting	Metropolitan	10,346 (83.4)	71,493 (73.1)
	Micropolitan	1,135 (9.2)	12,890 (13.2)
	Suburban	524 (4.2)	7,521 (7.7)
	Rural	403 (3.3)	5,871 (6.0)
Cardiologists per 10,000 residents in HRR, mean (SD)		7.39 (2.05)	6.46 (1.75)

Ganguli I, et al. *JAMA IM* 2019

16% of pre-operative EKG recipients experienced a potential cascade event



For every 100 EKG recipients, 5-11 cascades events in 90 days



Pre-op EKG recipients had extra stress tests, catheterizations, visits, new diagnoses

Event Rate Per 100 Beneficiaries	Preop EKG, no. (%) N = 12,408	Comparison, no. (%) N = 97,775	Adjusted Cascade-Attributable Event Rate (95%CI)
All events	6,259 (50.4)	36,173 (37.0)	10.92 (9.76-12.08)
Tests and treatments	3,728 (30.1)	19,856 (20.3)	8.31 (7.31-9.30)
Electrocardiogram	1,697 (13.7)	10,471 (10.7)	1.81 (1.20-2.42)
Stress test	503 (4.1)	1,928 (2.0)	2.03 (1.74-2.32)
Echocardiogram	859 (6.9)	3,625 (3.7)	2.90 (2.51-3.28)
Event/Holter monitor	204 (1.6)	916 (0.9)	0.68 (0.49-0.88)
Catheterization	28 (0.2)	121 (0.1)	0.15 (0.07-0.23)
New cardiac specialist visits	336 (2.7)	1,146 (1.2)	1.40 (1.18-1.62)
Hospitalizations	49 (0.4)	284 (0.3)	0.15 (0.04-0.26)
New diagnoses	1,286 (10.4)	8,973 (9.2)	1.21 (0.62-1.79)
Cascade $ per bene, mean (SD)	1,789 (14,489)	1,201 (10,999)	565 (348-781)

Older, sicker beneficiaries more likely to experience potential cascades

Characteristic		Experienced Potential Cascade, no. (%), N = 1,978	Did Not Experience Potential Cascade, no. (%), N = 10,430	Adjusted OR (95% CI)
Age, y	**66-74**	938 (47.4)	5,920 (56.8)	1 [Ref]
	75-84	859 (43.4)	3,794 (36.4)	1.42 (1.28-1.57)
	≥85	181 (9.2)	716 (6.9)	1.54 (1.29-1.84)
Elixhauser count, mean (SD)		1.39 (1.48)	1.04 (1.31)	1.18 (1.14-1.22)
Pre-op EKG ordering physician	**PCP**	1,364 (69.0)	7,557 (72.5)	1 [Ref]
	Cardiac specialist	374 (18.9)	1,701 (16.3)	1.26 (1.10-1.43)
	Other	240 (12.1)	1,172 (11.2)	1.14 (0.97-1.33)
Cardiologists per 10,000 residents in HRR, mean (SD)		7.57 (2.1)	7.36 (2.0)	1.05 (1.02-1.09)

Conclusions

- Cascades after low-value preoperative EKGs infrequent yet costly
- Across US – **$35 million** for cascades + **$3 million** for initial EKGs
- Perceived patient complexity and supply-induced demand may drive both low-value events and cascades
- Next steps: quantify Rx, complications; expand to other low-value services

Don’t go chasing waterfalls

- What we can do about them
  - Avoid initial tests when possible (Choosing Wisely, policy changes, quality improvement initiatives)

Original Investigation | Less Is More

March 25, 2019

Evaluation of an Intervention to Reduce Low-Value Preoperative Care for Patients Undergoing Cataract Surgery at a Safety-Net Health System

John N. Mafi, MD, MPH[1,2]; Patricia Godoy-Travieso, MSN, MHA, RN[3]; Eric Wei, MD[3]; et al

Don’t go chasing waterfalls

- What we can do about them
  - Avoid initial tests when possible (Choosing Wisely, policy changes, quality improvement initiatives)
  - Mitigate downstream effects (point of care guidelines, peer support)

Thank you! Questions?

- Research team: Arabella Simpkin, Claire Lupo, Alex Mainor, Stephanie Raymond, Qianfei Wang, E. John Orav, Chiang-Hua Chang, Nancy Morden, Meredith Rosenthal, Carrie Colla, Tom Sequist
- Funded by Agency for Healthcare Research and Quality grant 1R01HS023812

Appendix

Table 1

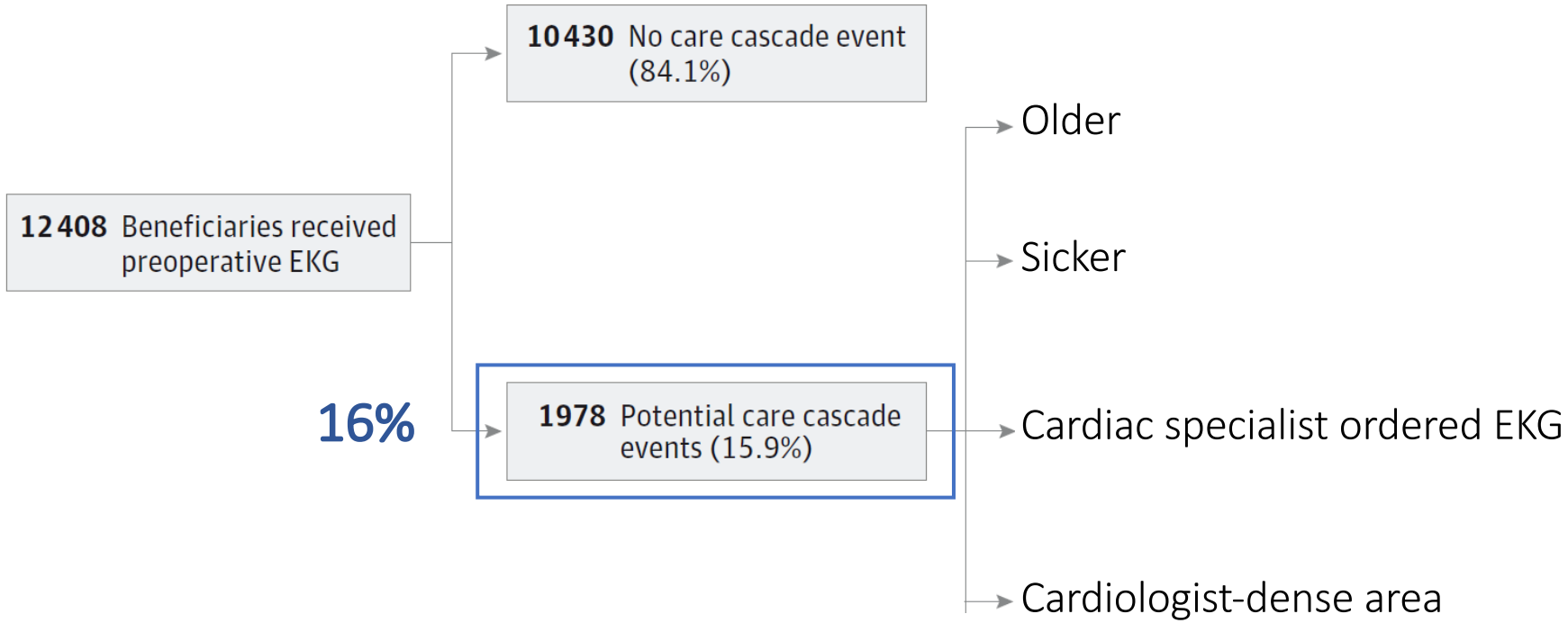
Characteristic		**Respondents, % N = 376**
Age, mean (SE)		43.4 (0.7)
Age categories, % (n)	≤39	148 (53.2)
	40-55	99 (23.2)
	≥56	129 (23.7)
Sex, % (n)[a]	Female	144 (39.6)
	Male	221 (60.4)
Race, % (n)	White	212 (51.3)
	Asian/Pacific Islander	89 (27.2)
	Black, mixed, other	31 (9.1)
	Prefer not to answer	44 (12.4)
Hispanic, % (n)	Yes	7 (4.9)
	No/prefer not to answer	359 (95.1)
Training, % (n)	US medical graduate	277 (69.5)
	Foreign medical graduate	99 (30.5)
Status, % (n)	Resident	93 (40.9)
	Fellow	22 (5.8)
	Attending	261 (53.3)

Table 1 con’t

Characteristic		**Respondents, % N = 376**
Practice site, % (n)	Solo	39 (7.7)
	Group private practice	122 (26.2)
	Academic medical center	136 (45.2)
	Community/government practice	62 (16.9)
	Other (including staff model HMO)	17 (4.0)
Practice setting, % (n)	Urban	172 (49.8)
	Suburban	165 (40.3)
	Rural	39 (9.9)
Geographic region, % (n)[b]	Northeast	94 (25.2)
	Midwest	86 (24.0)
	South	107 (29.7)
	West	83 (21.2)
Area-level education, % with high school education (SE)[c]		88.0 (0.72)
Area-level income[c]	Median income <200% below federal poverty line 2017	117 (35.3)
	Median income ≥200% above federal poverty line 2017	241 (64.7)
Time in direct patient care, % (n)	<49%	49 (13.6)
	50-74%	52 (15.8)
	≥75%	275 (70.7)
Prior medical malpractice lawsuit, % (n)	Never	274 (80.3)
	Once	57 (11.1)
	More than once	45 (8.6)
Discomfort with uncertainty scale,[d] 95% CI		3.8 (3.6, 3.9)
Cost consciousness scale,[e] 95% CI		24.9 (24.3, 25.5)

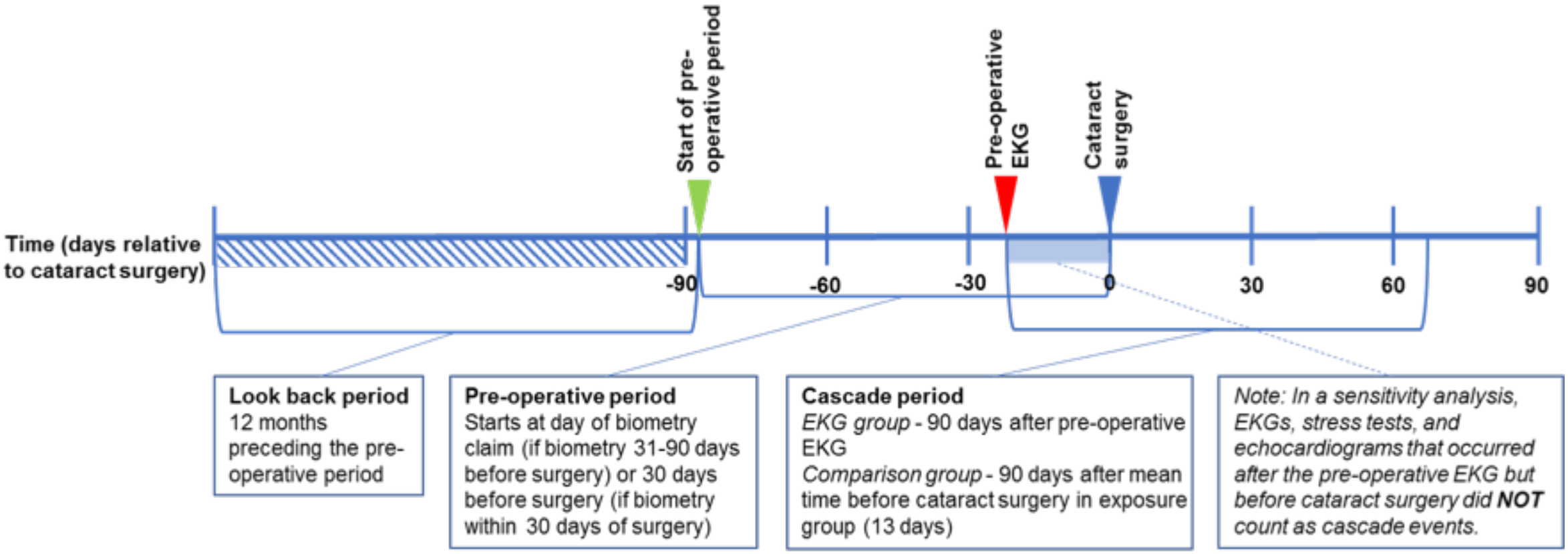
Cascades from low-value care: preop EKG for cataract surgery

- National Medicare claims analysis
- Of 110,000 cataract surgery recipients, **11%** had preoperative EKG

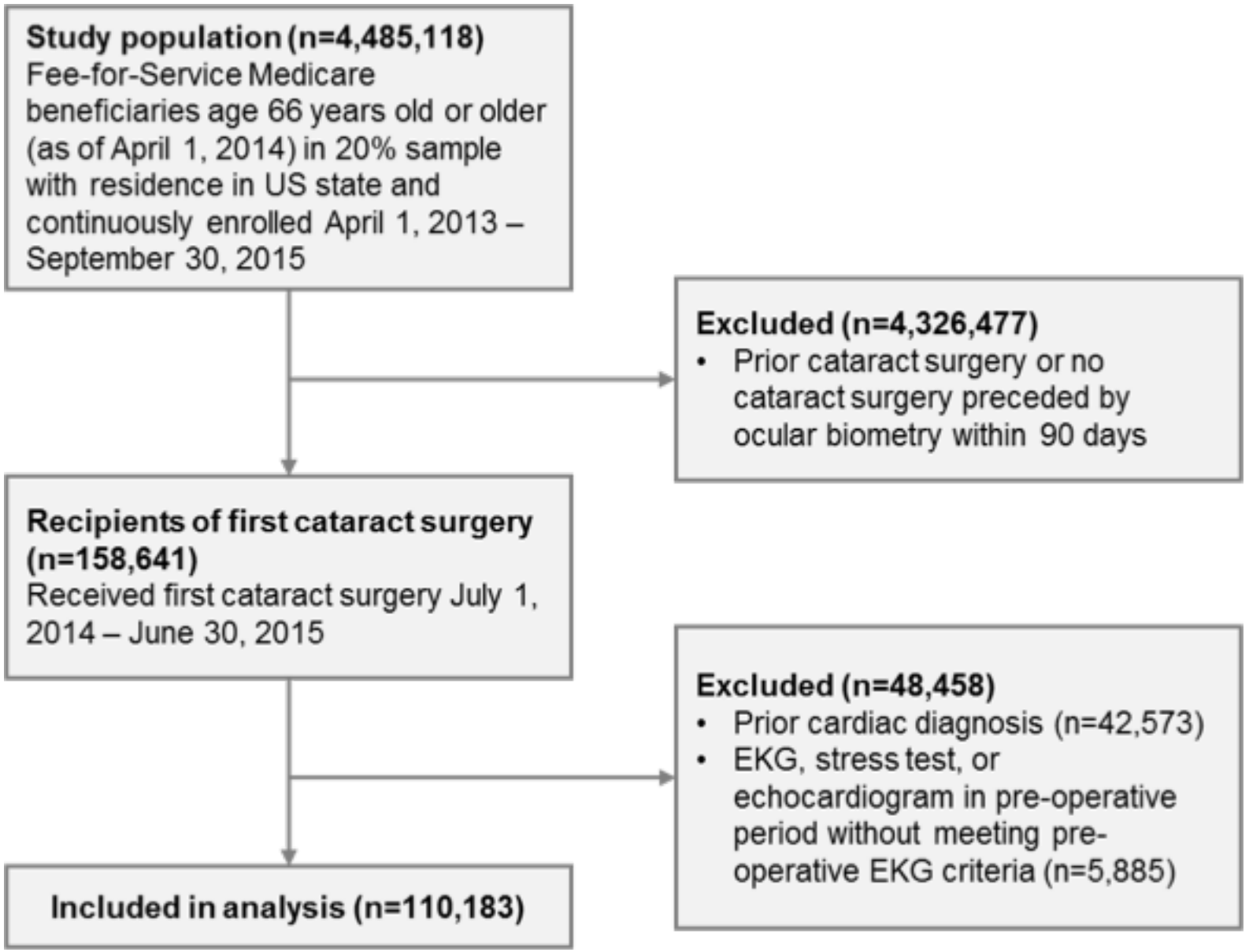


Ganguli I, et al. *JAMA IM* 2019

Appendix


Start of pre-operative period
Pre-operative EKG
Cataract surgery
Time (days relative to cataract surgery)
-90
-60
-30
0
30
60
90
Look back period
12 months preceding the pre-operative period
Pre-operative period
Starts at day of biometry claim (if biometry 31-90 days before surgery) or 30 days before surgery (if biometry within 30 days of surgery)
Cascade period
EKG group - 90 days after pre-operative EKG
Comparison group - 90 days after mean time before cataract surgery in exposure group (13 days)
Note: In a sensitivity analysis, EKGs, stress tests, and echocardiograms that occurred after the pre-operative EKG but before cataract surgery did NOT count as cascade events.

Appendix


Study population (n=4,485,118)
Fee-for-Service Medicare beneficiaries age 66 years old or older (as of April 1, 2014) in 20% sample with residence in US state and continuously enrolled April 1, 2013 – September 30, 2015
Excluded (n=4,326,477)
• Prior cataract surgery or no cataract surgery preceded by ocular biometry within 90 days
Recipients of first cataract surgery (n=158,641)
Received first cataract surgery July 1, 2014 – June 30, 2015
Excluded (n=48,458)
• Prior cardiac diagnosis (n=42,573)
• EKG, stress test, or echocardiogram in pre-operative period without meeting pre-operative EKG criteria (n=5,885)
Included in analysis (n=110,183)

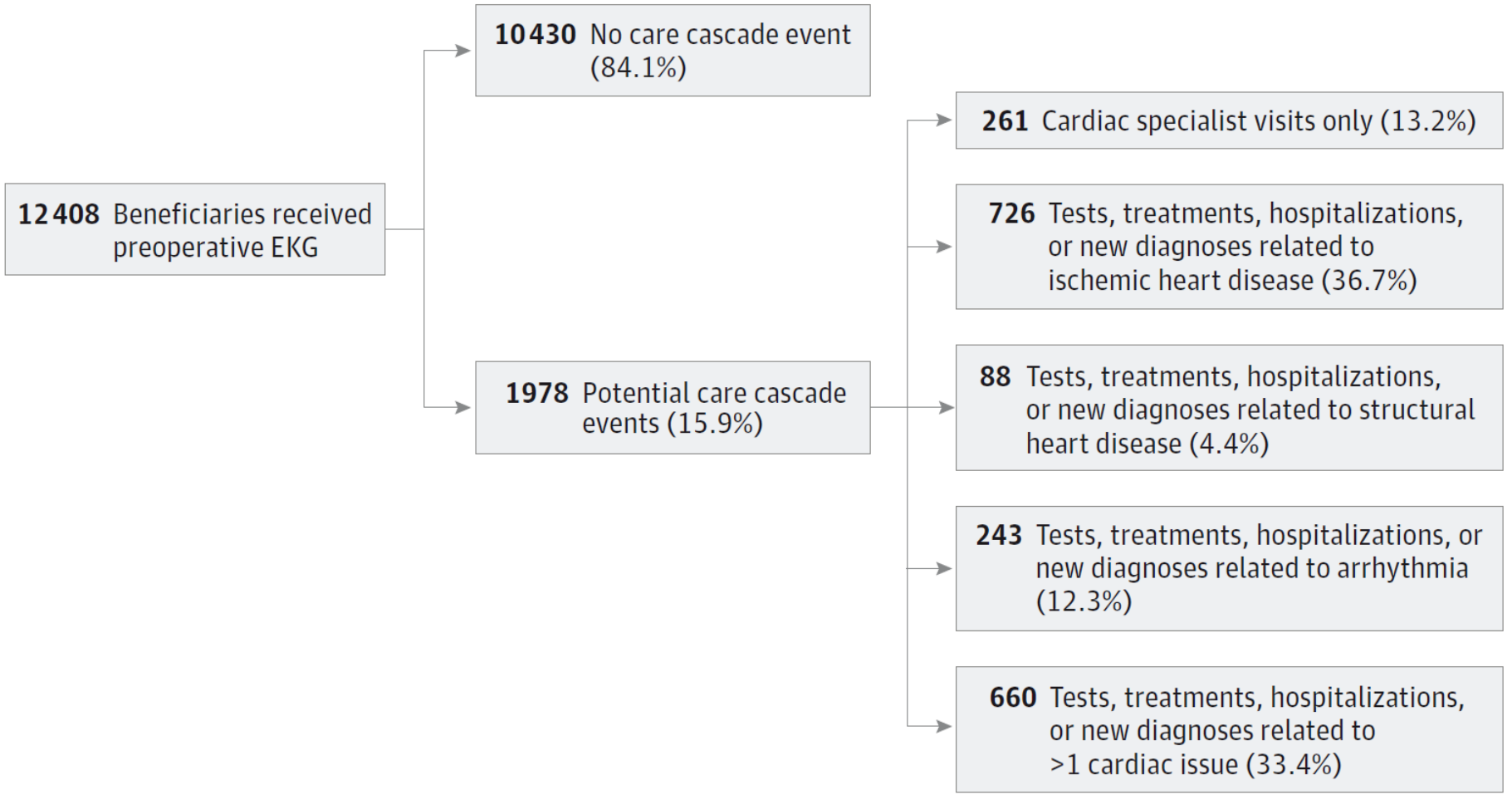
Appendix

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)

Appendix

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



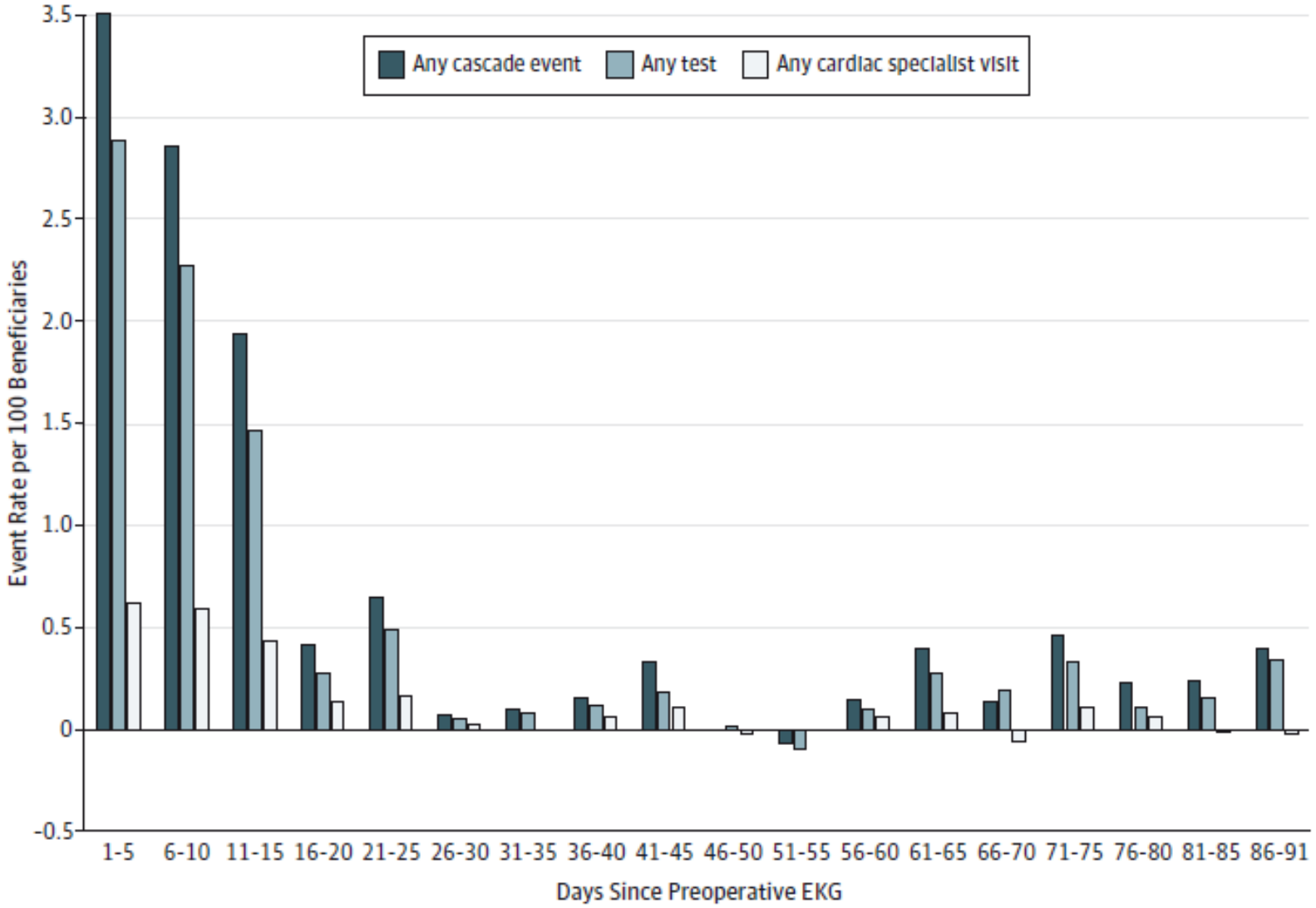
Appendix

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

Event Rate Per 100 Beneficiaries	Group, No. (%)		Cascade-Attributable Event Rate	Adjusted Cascade-Attributable Event Rate (95% CI)[a]
	EKG (n = 12 408)	Comparison (n = 97 775)		
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]

Appendix

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



Appendix

eTable 1. Cardiac diagnoses

Diagnosis	ICD-9 Codes*
Coronary artery disease	410, 410.0-1, 410.00-2, 410.10-2, 410.20-2, 410.30-2, 410.40-2, 410.50-2, 410.60-2, 410.70-2, 410.80-2, 410.90-2, 411.0-1, 411.81, 411.89, 412, 413.0-1, 413.9, 414.00-7, 414.10-2,414.19, 414.2-4, 414.8-9
Heart failure	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0-1, 428.9, 428.20-3, 428.30-3, 428.40-3
Valvular disease	394.0-2, 394.9, 395.0-2, 395.9, 396.0-3, 396.8-9, 397.0-1, 397.9, 421.2, 424.0-3
Arrhythmia	426.0, 426.2-7, 426.10-13, 426.50-4, 426.81-2, 426.89, 426.9, 427.0-2, 427.9, 427.31-2, 427.41-2, 427.60-1, 427.69, 427.81, 427.89

*Based on diagnoses in Medicare Chronic Conditions Data Warehouse

Appendix

Pre-operative electrocardiogram (EKG) definition
Definition of pre-operative EKG - EKG (CPT codes: 93000, 93005, 93010, 93040-2, G0403-5) with pre-operative (ICD-9 codes: V7281-4, V7263) or cataract-related diagnosis code (ICD-9 codes: 366.00, 366.04, 366.10, 366.13, 366.15-7, 366.19, 366.30, 366.34, 366.8, 366.9) and no excluding diagnoses (eTable 2).

eTable 2. Excluding diagnoses for pre-operative EKG

Diagnosis	ICD-9 Codes
Chest pain	786.50-2, 786.59
Dyspnea	786.00-7, 786.09
Bradycardia	427.89
Congestive heart failure	428.0
Hypotension	458.9
Lower extremity edema	782.3
Tachycardia	785.0
Palpitations	785.1
Dizziness	780.4
Syncope	780.2
Cardiac ischemia	410–410.92, 427.5
Cardiac pacemaker	V45.01

Appendix

eTable 3. Cascade tests

Cascade pathway	Cascade cardiac tests	CPT Codes
Ischemic heart disease	Troponin	84484
	Electrocardiogram (EKG)*	93000, 93005, 93010, 93040-2, G0403-5, G0366-8, 3120F
	Stress test*	93015-8, 93350-1, 93024, 75563
	Coronary computed tomography angiography (CTA)	75571-4
	Coronary ultrasound	92978-9
	Cardiac positron emission tomography (PET)	78459, 78466, 78468-9, 78483, 78491-2, 78499
Structural heart disease	Brain natriuretic peptide (BNP)	83880
	Echocardiogram*	93303-4, 93306-8, 93312-93318, 93320-1, 93325, 93350-2, 93355
	Cardiac magnetic resonance imaging (MRI)	75557, 75559, 75561, 75563, 75565
	Nuclear imaging	78414, 78428, 78451-4, 78472-3, 78481, 78483, 78494, 78496
Arrhythmia	Holter monitor	93224-7
	Event monitor	93228-9, 93232, 93268, 93270-2, 93278
	Implantable loop recorder	33282, 33284, E0616
	Electrophysiology testing	93623 93600, 93602-3, 93609-10, 93612-3, 93615-6, 93618-22, 93624, 93631, 93640-2, 93644, 93650-4, 93656, 93660, 93662
	Pacer evaluation	93279-99

Appendix

eTable 4. Cascade procedures and treatments

Cascade pathway	Cascade cardiac procedure	CPT Codes
Ischemic heart disease	Coronary repair	33500,33501-5, 33507
	Coronary artery bypass graft surgery	33510-23, 33530, 33533-48, 33572
	Percutaneous coronary angioplasty/cardiac catheterization	92920-1, 92924-5, 92928-33, 92933-4, 92937-8, 92941, 92943-4, 92973, 92975, 92977, 92980-4, 92995-6
Structural heart disease	Valve repair/replacement	33361-33403, 33405-18, 33420-30, 33460-5, 33474-5, 33478, 92986-7, 92990, 92992, 0343T
Arrhythmia	Electrophysiology procedures	33250-66, 92960-1, 92970-1, 93655-7
	Pacemaker procedures	93260-1, 33202-44, 33249, 33262-4, 33270-3, 92953

Cascade visit definitions – Code for new patient visit (CPT codes: 99201-5) or established patient visit (CPT codes: 99211-5) billed by physician with cardiac specialty (Appendix Table 5). Visit for abnormal findings defined by ICD-9 codes 793.2, 794.30-1, 794.39, 796.4. We also examined codes for emergency department visits (99281-5), observation status visits (99218-20, 99224-6, 99234-6), hospital outpatient visits (G0463), and federally qualified health center visits (G0466-9) and found that each of these categories of codes were billed too infrequently to count.

Appendix

eTable 5. Physician specialty codes

Specialty group	Specialty	Specialty code*
Primary care	General practice	01
	Family practice	08
	Internal medicine	11
	Pediatric medicine	37
	Geriatric medicine	38
	Preventive medicine	84
Cardiac specialty	Cardiology	06
	Cardiac electrophysiology	21
	Cardiac surgery	78
	Interventional cardiology	C3
Other	Includes ophthalmology, nurse practitioner, physician assistant	02, 03, 05, 09, 10, 12-3, 18, 25, 29, 30, 33-4, 36, 39, 44, 46, 50, 63, 66, 70, 79, 81, 83, 90, 93, 97-9

*Specialty codes used for definition of cardiac specialist visits and for specialty of physician performing the index EKG.

Appendix

eTable 6. Cascade new diagnoses

Cascade pathway	Cascade new diagnosis type	ICD-9 Codes*
Ischemic heart disease		410, 410.0-1, 410.00-2, 410.10-2, 410.20-2, 410.30-2, 410.40-2, 410.50-2, 410.60-2, 410.70-2, 410.80-2, 410.90-2, 411.0-1, 411.81, 411.89, 412, 413.0-1, 413.9, 414.00-7, 414.10-2,414.19, 414.2-4, 414.8-9
Structural heart disease	Heart failure	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0-1, 428.9, 428.20-3, 428.30-3, 428.40-3
	Valvular disease	394.0-2, 394.9, 395.0-2, 395.9, 396.0-3, 396.8-9, 397.0-1, 397.9, 421.2, 424.0-3
Arrhythmia		426.0, 426.2-7, 426.10-13, 426.50-4, 426.81-2, 426.89, 426.9, 427.0-2, 427.9, 427.31-2, 427.41-2, 427.60-1, 427.69, 427.81, 427.89

*Based on diagnoses in Medicare Chronic Conditions Data Warehouse. New diagnosis defined by diagnosis code on one inpatient claim or two outpatient claims during cascade period.

Appendix

eTable 7. Cascade hospitalizations

Cascade pathway	Diagnosis-related group (DRG) codes
Ischemic heart disease	410.01, 410.11, 410.21, 410.31, 410.70-2, 410.81, 410.91, 411.1, 413.1, 414.00-1, 440.29
Structural heart disease	426.0, 426.12-3, 427.0-1, 427.31-2, 427.41, 427.69, 427.81, 427.89, 427.9, 785.0
Arrhythmia	396.8, 402.91, 404.01, 420.9-1, 423.0, 423.8-9, 424.1, 425.4, 428.0, 428.21, 428.23, 428.31, 428.33, 428.40-1, 428.43, 429.83

Determined empirically based on clinical review of hospitalizations in study cohort and cardiac diagnoses in Medicare Chronic Conditions Data Warehouse (Appendix Tables 1, 6).

Appendix

eTable 8. Prior Elixhauser conditions in order of prevalence

Condition	EKG group	Comparison group
Hypertension	38.08%	36.78%
Diabetes	14.98%	14.75%
Hypothyroidism	9.31%	9.04%

Appendix

eTable 9. Most common potential cascade treatments, new diagnoses, and hospitalization primary diagnoses, rate per 100 beneficiaries during 90 day cascade period

EKG group (N=12,408)			Comparison group (N=97,775)		
Treatments					
Rank	Event	Rate per 100 beneficiaries (#events)	Rank	Event	Rate per 100 beneficiaries (#events)
1	PTCA	0.23 (28)	1	PTCA	0.12 (121)
1	CABG	0.23 (28)	2	CABG	0.11 (105)
2	Pacemaker placement	<0.09 (<11)	3	Pacemaker placement	0.08 (79)
3	Electrophysiology	<0.09 (<11)	4	Electrophysiology	0.06 (57)
4	Valve repair	<0.09 (<11)	5	Valve repair	<0.01 (<11)
New diagnoses					
1	Coronary artery disease	3.55 (440)	1	Coronary artery disease	3.20 (3,125)
2	Heart failure/ Cardiomyopathy	0.94 (117)	2	Heart failure/ Cardiomyopathy	1.48 (1,445)
3	Diseases of mitral and aortic valves	0.70 (87)	3	Diseases of mitral and aortic valves	0.52 (506)
4	Conduction disorders	0.21 (26)	4	Conduction disorders	0.11 (109)
5	Diseases of tricuspid valve	<0.09 (<11)	5	Diseases of tricuspid valve	0.06 (58)
Hospitalization primary diagnoses					
1	Subendocardial infarction, initial	0.11 (14)	1	Atrial fibrillation	0.05 (50)
2	Coronary atherosclerosis	<0.09 (<11)	2	Subendocardial infarction, initial	0.05 (49)
3	Atrial fibrillation	<0.09 (<11)	3	Coronary atherosclerosis	0.04 (39)
4	Congestive heart failure	<0.09 (<11)	4	Diastolic heart failure	0.02 (15)
5	Aortic valve disorder	<0.09 (<11)	5	Acute MI inferior wall, initial episode	0.01 (14)

Appendix

eTable 10. Cascade-Attributable Event Rates and Spending Following Pre-Operative Electrocardiogram for Cataract Surgery, Sensitivity Analysis

Event rate per 100 beneficiaries	EKG group (N=12,408)	Comparison group (N=97,775)	Cascade-attributable event rate	Adjusted cascade-attributable event rate (95%CI)[a]
All events[b]	44.4 (5,506)	37.0 (36,173)	7.4	5.11[c] (3.96-6.25)
All events	50.4 (6,259)	37.0 (36,173)	13.4	10.92[c] (9.76-12.08)
All tests[b]	23.4 (2,901)	19.9 (19,488)	3.5	2.18 [c] (1.34-3.02)
All tests	29.5 (3,654)	19.9 (19,488)	9.6	7.98[c] (7.12-8.84)
All treatments	0.6 (74)	0.4 (368)	0.22	0.33[c] (0.19-0.46)
Tests and treatments				
Electrocardiogram[b]	11.5 (1,427)	10.7 (10,471)	0.79	-0.19[c] (-0.79-0.41)
Electrocardiogram	13.7 (1,697)	10.7 (10,471)	3.0	1.81[c] (1.20-2.42)
Stress test[b]	2.4 (297)	2.0 (1,928)	0.42	0.36[c] (0.10-0.63)
Stress test	4.1 (503)	2.0 (1,928)	2.1	2.03[c] (1.74-2.32)
Echocardiogram[b]	4.7 (582)	3.7 (3,625)	0.98	0.75[c] (0.38-1.11)
Echocardiogram	6.9 (859)	3.7 (3,625)	3.2	2.90[c] (2.51-3.28)
Medicare spending per beneficiary				
Allowable charges related to cascade events in 90-day period, $ mean (SD)[b]	1,778 (14,487)	1,201 (10,999)	577	559[c] (342-775)
Allowable charges related to cascade events in 90-day period, $ mean (SD)	1,789 (14,489)	1,201 (10,999)	588	565[c] (348-781)