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2016 Update on Medical Overuse
A Systematic Review

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IMPORTANCE Overuse of medical care is an increasingly recognized problem in clinical medicine.

OBJECTIVE To identify and highlight original research articles published in 2015 that are most likely to reduce overuse of medical care, organized into 3 categories: overuse of testing, overtreatment, and questionable use of services. The articles were reviewed and interpreted for their importance to clinical medicine.

EVIDENCE REVIEW A structured review of English-language articles on PubMed published in 2015 and review of tables of contents of relevant journals to identify potential articles that related to medical overuse in adults.

FINDINGS Between January 1, 2015, and December 31, 2015, we reviewed 1445 articles, of which 821 addressed overuse of medical care. Of these, 112 were deemed most relevant based on their originality, methodologic quality, and number of patients potentially affected. The 10 most influential articles were selected by consensus using the same criteria. Findings included a doubling of specialty referrals and advanced imaging for simple headache (from 6.7% in 2000 to 13.9% in 2010); unnecessary hospital admission for low-risk syncope, often leading to adverse events; and overly frequent colonoscopy screening for 34% of patients. Overtreatment was common in the following areas: 1 in 4 patients with atrial fibrillation at low risk for thromboembolism received anticoagulation; 94% of testosterone replacement therapy was administered off guideline recommendations; 91% of patients resumed taking opioids after overdose; and 61% of patients with diabetes were treated to potentially harmfully low hemoglobin A_{1c} levels (<7%). Findings also identified medical practices to question, including questionable use of treatment of acute low-back pain with cyclobenzaprine and oxycodone/acetaminophen; of testing for *Clostridium difficile* with molecular assays; and serial follow-up of benign thyroid nodules.

CONCLUSIONS AND RELEVANCE The number of articles on overuse of medical care nearly doubled from 2014 to 2015. The present review promotes reflection on the top 10 articles and may lead to questioning other non–evidence-based practices.

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Supplemental content

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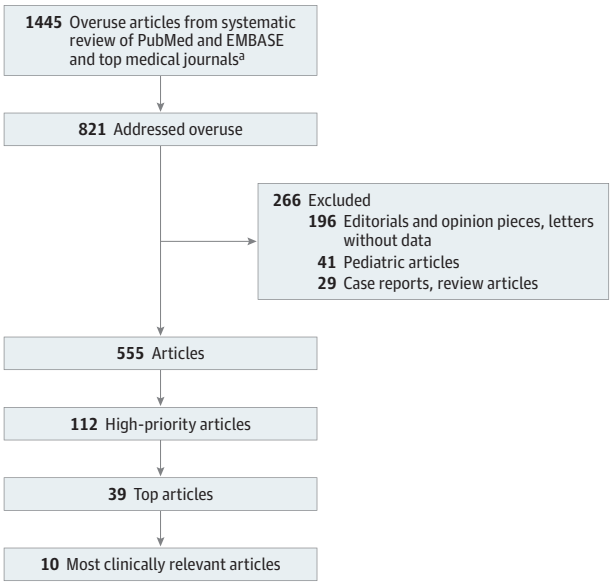
Over the 3 years that our research team has been completing updates on the overuse of medical care,[1,2] the field has evolved a standardized terminology and focused research agendas related to the care of both adults and children.[3,4] *Overuse* is defined as the delivery of medical care for which the potential harms outweigh the potential benefits.[3,5,6] Overuse encompasses different problems, including the use of diagnostic and screening tests that are not needed or risky, use of therapeutic procedures or medications where harms outweigh benefits, and use of overly intensive or expensive health care settings. Overuse can be subdivided into 3 areas: (1) overuse of testing, which can lead to overdiagnosis of disease that would never cause symptoms; (2) overtreatment, which involves providing treatment that is either not indicated or otherwise inappropriate; and (3) treatment of overdiagnosed disease.[3,7]

The literature on overuse of medical care has focused on clarifying the benefits and harms of clinical services or approaches, the prevalence of use of services without benefit, and understanding factors that lead to overuse. All 3 lines of investigation are growing, despite inherent challenges related to defining benefits and harms for individual patients and the complex motivations for providing or seeking care. Recent scholarship has attempted to uncover and explain some of the drivers of overuse; these include patients' tendencies to overestimate benefits and underestimate harms

Figure. Study Acquisition Flowchart



[a] *Lancet*, *BMJ*, *JAMA*, *JAMA Internal Medicine*, *New England Journal of Medicine*, *Annals of Internal Medicine*, *Medical Care*, *PLOS Medicine*, *Journal of General Internal Medicine*, and *Journal of Hospital Medicine*.

associated with care[8] and physicians' desires to provide comfort and reassurance—both for their patients and for themselves.[9]

The present review evaluates 10 of the most important studies published in 2015 on the overuse of medical care in adult patients.

Literature Search and Article Selection Process

We selected articles through a structured review of studies published in 2015 in PubMed with the Medical Subject Headings term *health services misuse* or with any of the following terms in the title: *overuse*, *overtreatment*, *overdiagnosis*, *inappropriate*, and/or *unnecessary*. In EMBASE, we performed a search using the same terms as in PubMed with the additional Emtree term *unnecessary procedure*. We excluded articles with the terms *overuse injury* and/or *overuse injuries* in the title. Searches were limited to human studies and the English language. One of 3 authors (D.J.M., S.S.D, or D.K.) reviewed all titles for relevance to medical care overuse. One of the same 3 authors reviewed all 2015 titles from 10 major medical journals (**Figure**) and read abstracts and full journal articles for those of potential relevance based on the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-analyses).[10]

The structured review identified 1445 articles, 821 of which addressed medical care overuse. After excluding 41 pediatric articles, 168 editorials or opinion pieces, 28 letters without data, 29 case reports or review articles, we reviewed 555 articles. Of these, 112 (20.1%) were ranked as most relevant by at least 1 of the 3 reviewing authors based on quality of methods, magnitude of clinical effect, and number of patients potentially affected (Figure). Using the same criteria, all 4 of us rated these 112 articles, 39 of which were highest rated. The 10 most relevant studies (**Box**)[11-20] were then selected by consensus among all 4 authors and are highlighted in the present review, organized into the categories of overuse of testing, overtreatment, and questionable use of services. The 29 highest-rated articles not detailed in the present article are summarized in the eTable in the Supplement.

Box. The Top 10 Articles on Overuse of Medical Care

Overuse of Testing
Mafi et al[11]
Canzoniero et al[12]
Johnson et al[13]

Overtreatment
Hsu et al[14]
Jasuja et al[15]
Larochelle et al[16]
Lipska et al[17]

Questionable Services
Friedman et al[18]
Polage et al[19]
Durante et al[20]

The 10 Most Relevant Articles on Overuse of Medical Care

Overuse of Testing

Unnecessary Imaging and Referrals for Low-Risk Headache[11]

Background | Headache is prevalent, with approximately 15% of adults reporting headache within a 3-month period.[21] Almost all headaches are benign. Clinical criteria are recommended to identify the small subset of patients with acute headache for whom imaging or specialist referral is indicated,[22] and an American College of Radiology "Choosing Wisely"[23] item recommends against imaging in patients with uncomplicated headache. Overuse of these services has not been well studied.

Results | A retrospective cohort study of 9362 patients used representative 1999-2010 US data from the National Ambulatory Medical Care Survey and the National Hospital Ambulatory Medical Care Survey to assess services provided to patients seen in the physician's office or the emergency department (ED) with headache and without trauma or high-risk clinical features.[11] The study found that the use of advanced imaging nearly doubled over time: 6.7% of patients received computed tomography (CT) or magnetic resonance imaging (MRI) of the head in the 1999-2000 period compared with 13.9% in 2009-2010 period ($P < .001$). There was a similar rise in specialty referrals (6.9% to 13.2%, $P = .01$). The frequency of lifestyle modification counseling declined over time from 23.5% in the 1999-2000 period to 18.5% in the 2009-2010 period ($P = .04$), while use of opioids remained constant. Adjustment for confounders did not meaningfully change these results.

Implications | Overuse of advanced imaging and referral is common in ambulatory patients with headache and increased through 2010

(although rates decreased slightly by 2013).[24] Clinicians should familiarize themselves with the indications for more aggressive care of these patients to avoid overuse. Conservative management, including behavior change and watchful waiting, is thought to be the most reasonable approach.

Unnecessary Hospitalization for Low-Risk Syncope Associated With Unnecessary Testing and Harm[12]

Background | Syncope is common; it often leads to unnecessary hospitalization and low-yield diagnostic testing.[25] The scope of inappropriate syncope hospitalization and the associated harms have not been well described.

Results | A retrospective chart review evaluated testing and outcomes in 72 patients hospitalized at a single academic medical center for low-risk syncope, a condition for which guidelines do not recommend hospitalization.[12] These admissions represented 34% of all syncope admissions. Patients with low-risk syncope received a mean of 10.8 tests, which commonly included head CT (88%), head MRI (19%), echocardiography (64%), telemetry monitoring (93%), and multiple laboratory tests. Nine patients (13%) had adverse events during hospitalization. Nearly one-third of patients had incidental findings, leading in most cases to performance of or recommendation for further evaluations. Few patients (7%) had incidental findings with the potential to result in clinical benefit.

Implications | Hospitalization for low-risk syncope is common and is associated with unnecessary testing, patient harm from adverse events, and workup of incidental findings. Overhospitalization and overtesting were also found in a 2015 survey of US hospitalists in which 83% recommended unnecessary tests in response to a vignette about a patient with syncope.[9] Physicians should be mindful of the potential harms associated with hospitalizing and working up patients with low-risk syncope.

Colonoscopy Screening at Shorter-Than-Recommended Intervals[13]

Background | Colorectal cancer is the second leading cause of cancer death in the United States. While screening has been shown to reduce mortality, overall screening rates remain low at 60% to 65%. The timing of follow-up colonoscopy among previously screened patients has not been well studied and represents overuse if the screening interval is shorter than recommended.

Results | A retrospective study evaluated follow-up testing recommendations in 1455 patients with no cancer history who underwent colonoscopy at 1 of 25 Veterans Affairs hospitals.[13] Compared with a multispecialty guideline, the follow-up interval was shorter than recommended in one-third (34%) of patients and was longer than recommended in only 2%. Short-interval follow-up recommendation was associated with a finding of hyperplastic polyps on the index study (odds ratio [OR], 3.1; 95% CI, 1.7-5.8), and regionally (Northeast region OR, 5.4; 95% CI, 2.1-13.8).

Implications | These findings are similar to those of a smaller 2015 study[26] that found 69% of 871 follow-up screening or surveillance colonoscopies were performed at least 1 year sooner than recommended by guidelines. That study also noted wide variation among individual clinicians within a multispecialty group practice. Given the potential harms associated with colonoscopy and the importance of improving access to screening for large numbers of unscreened patients, overuse of colonoscopy is a public health problem. Primary care clinicians and gastroenterologists need to partner to secure follow-up colonoscopies at the appropriate time but not sooner.

Overtreatment

Unnecessary Anticoagulation Therapy for Young, Healthy Patients[14]

Background | The $CHADS_2$ and CHA_2DS_2-VASc scores[27] provide guidance on which patients with atrial fibrillation should receive oral anticoagulants for the prevention of thromboembolism. Guidelines state that it is reasonable to avoid anticoagulation in patients with nonvalvular atrial fibrillation without any risk factors for stroke (ie, a score of 0).

Results | This study[14] analyzed the National Cardiovascular Data Registry's Practice Innovation and Clinical Excellence Registry of over 10 000 patients younger than 60 years with atrial fibrillation and no structural heart disease. These patients were then divided into 2 cohorts, one with a $CHADS_2$ score of 0, the other with a CHA_2DS_2 score of 0. In the 2 cohorts, 2561 $CHADS_2$ patients (23.3%) and 1787 $CHADS_2DS_2$-VASc patients (26.6%) were prescribed an oral anticoagulant. In both cohorts, patients prescribed oral anticoagulants were older (mean age, 51 years), had a higher body mass index, were more frequently either insured by Medicare or uninsured, and were less likely to have paroxysmal atrial fibrillation. There were also regional differences in oral anticoagulant prescriptions.

Implications | Unless patients with atrial fibrillation and a $CHADS_2$ or CHA_2DS_2-VASc score of 0 have other reasons for anticoagulation therapy, these medications should be avoided. In these patients, bleeding risks outweigh potential benefits.

Inappropriate Testosterone Replacement Therapy[15]

Background | Testosterone prescriptions have increased substantially in the past decade, with nearly 4% of men in their 60s taking androgen replacement drugs.[28] This therapy may be associated with increased risk of cardiovascular disease.[29] Male androgen deficiency is diagnosed by signs, symptoms, and findings of low testosterone levels on 2 sequential morning measurements. Guidelines recommend against androgen therapy in patients with elevated hematocrit levels or elevated prostate-specific antigen (PSA) levels without further evaluation.

Results | Of 111 631 men in the Veterans Health Administration who first received testosterone prescriptions between 2009 and 2012,[15] only 5.4% had a diagnosis of androgen deficiency established by 2 sequential morning measurements; 16.5% had no testosterone levels checked; over 15% had no baseline hematocrit level checked, and 24% had no baseline PSA level checked. Nearly 13% of patients had a relative contraindication (obstructive sleep apnea, hematocrit >50%, PSA >4.0 ng/dL), and 1.4% had prostate cancer, which is an absolute contraindication.

Implications | Almost 95% of testosterone replacement therapy is prescribed in ways that are inconsistent with guideline recommendations. Clinicians should limit testosterone replacement to patients with signs and symptoms of deficiency and for whom there are no contraindications.

Continued Opioid Treatment Even After Overdose[16]

Background | Prescription opioid use has increased substantially in recent years, with 259 million such prescriptions written in 2012. Over 420 000 patients present annually to EDs because of nonmedical prescription opioid use.[30]

Results | A retrospective cohort study of a large US health insurer evaluated prescription patterns in patients with nonfatal opioid overdoses during long-term therapy.[16] Within 10 months of overdose, 91% of these patients again received opioid prescriptions; one-third received high-dose opioids; 58% received a benzodiazepine; and repeated overdose occurred in 7% of patients. Discontinuation of opioid treatment was associated with a lower risk of subsequent overdose.

Implications | Prescribing guidelines state that patients with nonfatal overdoses should have opioid prescriptions discontinued when possible.[30] Emergency department presentation or hospitalization for nonfatal opioid overdose is an opportunity to identify and refer patients for substance abuse treatment to discontinue opioid prescriptions.

Overly Tight Glycemic Control in Older Adults With Diabetes Mellitus[17]

Background | For many older adults with type 2 diabetes, attempts to achieve intensive glycemic control will lead to net harm such as hypoglycemia.[31] A 2012 American Diabetes Association and American Geriatrics Society consensus statement[32] endorses less aggressive glycemic targets in older patients with limited life expectancy for whom tight glycemic control is unlikely to be beneficial.

Results | In a National Health and Nutrition Examination Survey study[17] of 1288 adults 65 years or older (mean age, 73.2 years) with diabetes and an available hemoglobin A_{1c} measurement, 61.5% had a hemoglobin A_{1c} level lower than 7%. Of these patients, 54.9% were treated with either insulin or sulfonylureas, and 4.0% received both. Among older adults with complex or intermediate health and very complex or poor health, 63.0% and 56.4%, respectively, had hemoglobin A_{1c} levels lower than 7%, and 44.9% and 37.9%, respectively, had levels lower than 6.5%. The proportion of older adults with hemoglobin A_{1c} levels lower than 7% remained stable from 2000 to 2010.[17]

Implications | A large proportion of older adults with diabetes, including many patients with poor health. are treated with intensive glycemic control. This aggressive therapy likely results in harms exceeding benefits. These findings are consistent with another 2015 study,[33] which found that de-intensification of diabetes therapy was rare in patients with low hemoglobin A_{1c} levels.

Medical Practices to Question

Poor Harm-Benefit Ratio of Oxycodone/Acetaminophen Combination and Cyclobenzaprine Therapy for Patients With Acute Low Back Pain Treated With Naproxen[18]

Background | Back pain is among the most common complaints leading to ambulatory visits.[34] It also results in over 2.5 million annual ED visits in the United States.[35] Nearly two-thirds of patients seen in the ED for acute low-back pain are prescribed opioids; over 40% are prescribed muscle relaxants[35]; and most are prescribed combinations of therapies. However, the efficacy of these therapies is not clear.

Results | A randomized clinical trial of 323 patients presenting to the ED with acute low-back pain without inciting trauma or radicular symptoms compared functional and pain outcomes at 1 week.[18] Patients were randomized to treatment with placebo; cyclobenzaprine, 5 mg; or oxycodone/acetaminophen combination, 325/5 mg, in addition to naproxen, and instructed to take 1 to 2 pills of study drug every 8 hours as needed. At 1 week, the groups did not differ in functional status (the primary outcome), pain, use of health care resources, or return to work or usual activity. Adverse events, such as drowsiness, dizziness, and nausea, were more common in the oxycodone/acetaminophen (number needed to harm [NNH], 5) and cyclobenzaprine (NNH, 8) groups compared with the placebo group.

Implications | Treating ED patients with acute musculoskeletal low-back pain with either oxycodone/acetaminophen or cyclobenzaprine appears to result in harm and is without apparent benefit beyond that achieved with naproxen alone. While the study did not address patients seen in primary care practices,[18] it seems prudent to avoid these therapies in this population as well because patients presenting to the office may have less severe complaints than ED patients; they may be less likely to benefit from add-on therapies; and they are equally likely to experience harms.

Overdiagnosis of *Clostridium difficile* Infection With Molecular Testing[19]

Background | *Clostridium difficile* infection (CDI) is epidemic worldwide, and CDI testing has evolved from a simple toxin test to the ultrasensitive polymerase chain reaction (PCR) testing in many laboratories. Many more patients are colonized than are infected with *C difficile*.

Results | In a 2-year cohort study at a US medical center, 1416 hospitalized patients were tested for CDI with the toxin test only. Samples were also evaluated with PCR testing, without results being reported to clinicians. A total of 293 samples were found to be positive by PCR, but only 131 (44.7%) were found to be positive by the toxin test. Toxin-positive/PCR-negative patients had lower bacterial loads, less antibiotic exposure, and less inflammation than toxin-positive/PCR-negative patients. Very few toxin-negative/PCR-positive patients were treated, and their clinical outcomes were similar to those of toxin-negative/PCR-negative patients (a median of 2 days of diarrhea in both groups).

Implications | A PCR test detected more than twice as much *C difficile* as the toxin method.[19] Given that the outcomes in patients who were toxin-negative/PCR-positive were comparable to those who were toxin-negative/PCR-negative, PCR testing leads to overdiagnosis. Continuing testing primarily with the toxin assay, or perhaps using a multistep testing strategy, will help avoid overdiagnosis and overtreatment.

Serial Follow-Up of Benign Thyroid Nodules Likely Unnecessary[20]

Background | Thyroid nodules are present in as many as two-thirds of the adult population.[36] Despite growing awareness that thyroid cancer is overdiagnosed and overtreated, and a paucity of evidence to inform practice, clinical practice guidelines recommend routine imaging to follow up most nodules.[37]

Results | A prospective study evaluated 992 patients with benign thyroid nodules up to 4 cm in diameter.[20] Over 5 years, 88.3% of patients had no change in nodule number, and 69.0% had no change in nodule size. Seven patients (0.7%) were diagnosed with thyroid cancer, among whom 3 had nodule growth, and 3 had stable nodule size; the seventh cancer case was discovered incidentally during an unrelated thyroidectomy.

Implications | Benign thyroid nodules are unlikely to change during surveillance over 5 years, and the diagnosis of thyroid cancer is very rare. Routine follow-up testing rarely affects care and should be questioned by individual clinicians and reexamined by organizations issuing guidelines.

Conclusions

In 2015, the literature on overuse of medical care continued its rapid expansion: we found 821 related articles compared with the 440 we reported in 2014.[2] The studies selected for this review emphasized overuse of testing, referrals, and hospital admissions for low-risk syncope, uncomplicated headache, and colon cancer screening; overtreatment with testosterone replacement therapy, aggressive glycemic control among older patients with diabetes, continuing opioid treatment following overdoses, anticoagulation of low-risk younger adults with atrial fibrillation; and practices to be questioned including prescribing secondary medications beyond nonsteroidal anti-inflammatories for uncomplicated acute low-back pain, using PCR to detect the presence of *C difficile*, and performing ultrasonography to follow up small thyroid nodules. All of these studies have implications that could affect health care outcomes, safety, quality, and economics.

In careful reading of these 10 articles and review of many others from 2015, common themes and pearls emerge. The overuse of medications for which harms are likely to outweigh benefits is commonplace. Health care continues to be enthralled by high-technology innovation, including both therapies and tests. Once practice norms are established, clinicians are slow to de-implement services, even those that are found to be potentially dangerous. The small amount of data evaluating trends in overuse over time suggest an increase in overuse through 2010 without substantive improvement. However, heightened awareness of the problems associated with overuse and advances in the overuse literature make us hopeful that we are primed for reducing overuse in the near future.

ARTICLE INFORMATION

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Concept and design: All Authors.
Acquisition, analysis, or interpretation of data: All Authors.
Drafting of the manuscript: Morgan, Dhruva, Korenstein.
Critical revision of the manuscript for important intellectual content: All Authors.
Administrative, technical, or material support: Morgan.
Study supervision: Morgan, Wright.
No additional contributions: Dhruva, Korenstein.
Other: Wright.

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REFERENCES

1. Morgan DJ, Wright SM, Dhruva S. Update on medical overuse. *JAMA Intern Med*. 2015;175(1):120-124.

2. Morgan DJ, Dhruva SS, Wright SM, Korenstein D. Update on medical practices that should be questioned in 2015. *JAMA Intern Med*. 2015;175(12):1960-1964.

3. Morgan DJ, Brownlee S, Leppin AL, et al. Setting a research agenda for medical overuse. *BMJ*. 2015;351:h4534.

4. Coon ER, Quinonez RA, Moyer VA, Schroeder AR. Overdiagnosis: how our compulsion for diagnosis may be harming children. *Pediatrics*. 2014;134(5):1013-1023.

5. Welch HG, Schwartz L, Woloshin S. *Overdiagnosed: Making People Sick in the Pursuit of Health*. Boston, MA: Beacon Press; 2012.

6. Chassin MR, Galvin RW; Institute of Medicine National Roundtable on Health Care Quality. The urgent need to improve health care quality. *JAMA*. 1998;280(11):1000-1005.

7. Welch HG, Passow HJ. Quantifying the benefits and harms of screening mammography. *JAMA Intern Med*. 2014;174(3):448-454.

8. Hoffmann TC, Del Mar C. Patients' expectations of the benefits and harms of treatments, screening, and tests: a systematic review. *JAMA Intern Med*. 2015;175(2):274-286.

9. Kachalia A, Berg A, Fagerlin A, et al. Overuse of testing in preoperative evaluation and syncope: a survey of hospitalists. *Ann Intern Med*. 2015;162(2):100-108.

10. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Int J Surg*. 2010;8(5):336-341.

11. Mafi JN, Edwards ST, Pedersen NP, Davis RB, McCarthy EP, Landon BE. Trends in the ambulatory management of headache: analysis of NAMCS and NHAMCS data 1999-2010. *J Gen Intern Med*. 2015;30(5):548-555.

12. Canzoniero JV, Afshar E, Hedian H, Koch C, Morgan DJ. Unnecessary hospitalization and related harm for patients with low-risk syncope. *JAMA Intern Med*. 2015;175(6):1065-1067.

13. Johnson MR, Grubber J, Grambow SC, et al. Physician non-adherence to colonoscopy interval guidelines in the veterans affairs healthcare system. *Gastroenterology*. 2015;149(4):938-951.

14. Hsu JC, Chan PS, Tang F, Maddox TM, Marcus GM. Oral anticoagulant prescription in patients with atrial fibrillation and a low risk of thromboembolism: insights from the NCDR PINNACLE registry. *JAMA Intern Med*. 2015;175(6):1062-1065.

15. Jasuja GK, Bhasin S, Reisman JI, Berlowitz DR, Rose AJ. Ascertainment of testosterone prescribing practices in the VA. *Med Care*. 2015;53(9):746-752.

16. Larochelle MR, Liebschutz JM, Zhang F, Ross-Degnan D, Wharam JF. Opioid prescribing after nonfatal overdose and association with

repeated overdose: a cohort study. *Ann Intern Med*. 2016;164(1):1-9.

17. Lipska KJ, Ross JS, Miao Y, Shah ND, Lee SJ, Steinman MA. Potential overtreatment of diabetes mellitus in older adults with tight glycemic control. *JAMA Intern Med*. 2015;175(3):356-362.

18. Friedman BW, Dym AA, Davitt M, et al. Naproxen with cyclobenzaprine, oxycodone /acetaminophen, or placebo for treating acute low back pain: a randomized clinical trial. *JAMA*. 2015; 314(15):1572-1580.

19. Polage CR, Solnick JV, Cohen SH. Toxin immunoassays and clostridium difficile infection—reply. *JAMA Intern Med*. 2016;176(3):414-415.

20. Durante C, Costante G, Lucisano G, et al. The natural history of benign thyroid nodules. *JAMA*. 2015;313(9):926-935.

21. Centers for Disease Control and Prevention (CDC). UPDATED: Table 47: severe headache or migraine, low back pain, and neck pain among adults aged 18 and over, by selected characteristics: United States, selected years 1997-2012. http://www.cdc.gov/nchs/data/hus/2012/047.pdf. Accessed June 2, 2016.

22. Beithon J, Gallenberg M, Johnson K, et al. *Diagnosis and Treatment of Headache*. Bloomington, MN: Institute for Clinical Systems Improvement (ICSI); 2013.

23. American College of Radiology. Don't do imaging for uncomplicated headache. http://www.choosingwisely.org/clinician-lists/american-college-radiology-imaging-for-uncomplicated-headache/. Accessed June 2, 2016.

24. 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.

25. Mendu ML, McAvay G, Lampert R, Stoehr J, Tinetti ME. Yield of diagnostic tests in evaluating syncopal episodes in older patients. *Arch Intern Med*. 2009;169(14):1299-1305.

26. Kruse GR, Khan SM, Zaslavsky AM, Ayanian JZ, Sequist TD. Overuse of colonoscopy for colorectal cancer screening and surveillance. *J Gen Intern Med*. 2015;30(3):277-283.

27. January CT, Wann LS, Alpert JS, et al; ACC/AHA Task Force Members. 2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines and the Heart Rhythm Society. *Circulation*. 2014;130 (23):2071-2104.

28. Baillargeon J, Urban RJ, Ottenbacher KJ, Pierson KS, Goodwin JS. Trends in androgen prescribing in the United States, 2001 to 2011. *JAMA Intern Med*. 2013;173(15):1465-1466.

29. Vigen R, O'Donnell CI, Barón AE, et al. Association of testosterone therapy with mortality, myocardial infarction, and stroke in men with low testosterone levels. *JAMA*. 2013;310(17):1829-1836.

30. Dowell D, Haegerich TM, Chou R. CDC guideline for prescribing opioids for chronic pain—United States, 2016. *MMWR Recomm Rep*. 2016;65(1):1-49.

31. Lipska KJ, Krumholz H, Soones T, Lee SJ. Polypharmacy in the aging patient: a review of glycemic control in older adults with type 2 diabetes. *JAMA*. 2016;315(10):1034-1045.

32. Kirkman MS, Briscoe VJ, Clark N, et al; Consensus Development Conference on Diabetes and Older Adults. Diabetes in older adults: a consensus report. *J Am Geriatr Soc*. 2012;60(12): 2342-2356.

33. Sussman JB, Kerr EA, Saini SD, et al. Rates of deintensification of blood pressure and glycemic medication treatment based on levels of control and life expectancy in older patients with diabetes mellitus. *JAMA Intern Med*. 2015;175(12):1942-1949.

34. Schappert SM, Burt CW. Ambulatory care visits to physician offices, hospital outpatient departments, and emergency departments: United States, 2001-02. *Vital Health Stat 13*. 2006;159 (159):1-66.

35. Friedman BW, Chilstrom M, Bijur PE, Gallagher EJ. Diagnostic testing and treatment of low back pain in United States emergency departments: a national perspective. *Spine (Phila Pa 1976)*. 2010; 35(24):E1406-E1411.

36. Guth S, Theune U, Aberle J, Galach A, Bamberger CM. Very high prevalence of thyroid nodules detected by high frequency (13 MHz) ultrasound examination. *Eur J Clin Invest*. 2009;39 (8):699-706.

37. Haugen BR, Alexander EK, Bible KC, et al. 2015 American thyroid association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: The American thyroid association guidelines task force on thyroid nodules and differentiated thyroid cancer. *Thyroid*. 2016;26(1):1-133.