UT SOUTHWESTERN MEDICAL CENTER

A Test Without Risk and Variable Benefit:

The Story of the Unsustainable Growth of Echocardiography

University of Texas Southwestern Medical Center
Internal Medicine Grand Rounds

Susan Matulevicius, M.D., M.S.C.S., F.A.C.C.
4/11/2014

This is to acknowledge that Susan Matulevicius, M.D., M.S.C.S., F.A.C.C., has disclosed that she does not have any financial interests or other relationships with commercial concerns related directly or indirectly to the program. Dr. Matulevicius will not be discussing off-label uses in her presentation.

Susan A. Matulevicius, M.D., M.S.C.S., F.A.C.C.

Assistant Professor of Internal Medicine

Division of Cardiology

Susan A. Matulevicius, M.D., M.S.C.S., F.A.C.C., is an Assistant Professor of Internal Medicine in the Division of Cardiology. She is an active contributor to the noninvasive imaging program with both a clinical and research interest in cardiac MRI and its application to the understanding of right heart function in health and disease as well as in echocardiography and its contribution to high-value care. Dr. Matulevicius received her M.D. from the University of Pennsylvania where she completed internal medicine residency training. She then moved to Dallas and completed her cardiology and advanced cardiac imaging fellowships at the University of Texas Southwestern. She joined the faculty at UT Southwestern in 2009, successfully competed for a career development award from the American College of Cardiology Foundation/GE Healthcare to study the contribution of right atrial structure and function and pulmonary compliance to right heart function in systolic heart failure and obtained her Masters in Clinical Science. Dr. Matulevicius is a clinically active member of the echocardiography lab and it is through her clinical reading experience that she became interested in high-value care and use of diagnostic testing. She was the winner of the Jeremiah Stamler, M.D., Distinguished Young Investigator Award for her work on Appropriate Use Criteria and clinical impact of echocardiography.

Purpose and Overview:

The purpose of this presentation is to educate the clinician about the dramatic rise in the contribution of diagnostic testing to the cost of care, to discuss the concepts of overuse in the context of echocardiography, to evaluate the contribution of Appropriate Use Criteria to echocardiography, and to discuss roadblocks and potential solutions to combatting overuse of diagnostic testing in the provision of high-value health care.

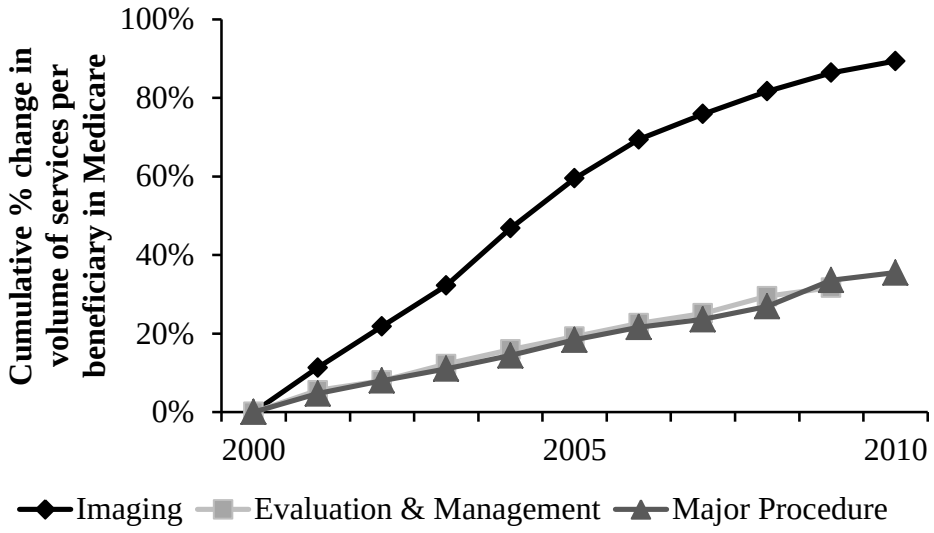
Educational Objectives:

1. To describe the growth of transthoracic echocardiography over the past few decades;
2. To recognize the potential contributors to the growth in echocardiography;
3. To introduce the concept of Appropriate Use Criteria in echocardiography;
4. To recognize reasons for over-testing;
5. To recognize ways to maximize high-value care.

Introduction:

In 2011, U.S. health care spending grew 3.9% to reach $2.7 trillion, and 17.9% of the gross domestic product (GDP). In 2014, health care spending is expected to grow at 6.1%/year and 6.2%/year thereafter so that by 2021, health care spending will account for to $4.8 trillion and 19.6% of GDP.[1,2]A major contributor to these costs has been the dramatic growth in diagnostic imaging services which have significantly outpaced the growth of evaluation and management and major procedure volume over the past decade (Figure 1).[3]

Figure 1. The Growth of Imaging Services in Medicare



Modified from "Report to the Congress: Medicare and the Health Care Delivery System (June 2011)."

In cardiology, one of the major contributors to the growth of imaging has been echocardiography. In fact, the use of echocardiography has doubled over the past decade,[4] comprising approximately half of all cardiac imaging services among Medicare beneficiaries and accounting for 11% and over 1.1 billion dollars of total Medicare diagnostic imaging spending in 2010.[3,4]

The relative ease, convenience, and low risk of echocardiography makes it a powerful and appealing diagnostic tool, however these same characteristics create opportunities for overuse/misuse in patients who may derive no benefit or could have derived similar benefit without the test. In fact, almost 30% of all Medicare Beneficiaries have had a transthoracic echocardiogram (TTE) performed, over 50% of whom had a repeat TTE within 3 years.[5] Although the risks of TTE are low, the consequences of over-testing may be great in terms of false positive tests, downstream utilization of resources, and overall costs. The use of TTE has widespread variation by state, being performed in 5% of Medicare beneficiaries in Oregon but 15% of beneficiaries in Michigan in 1995.[6] Hospitals with the highest rates of imaging for evaluation of potential cardiac ischemia have higher rates of diagnostic cardiac angiography and hospital admission without substantial difference in therapeutic interventions or readmission rates for acute myocardial infarction. In these cases, imaging is causing greater downstream resource utilization without any significant impact on patient care. [7] This is likely driven by

differences in local physician and patient preference. Finding the optimal use of diagnostic testing, including TTEs, in patient evaluation and management is essential in order to become stewards of our healthcare resources and partners in providing high-value care.

Appropriate Use Criteria in Echocardiography

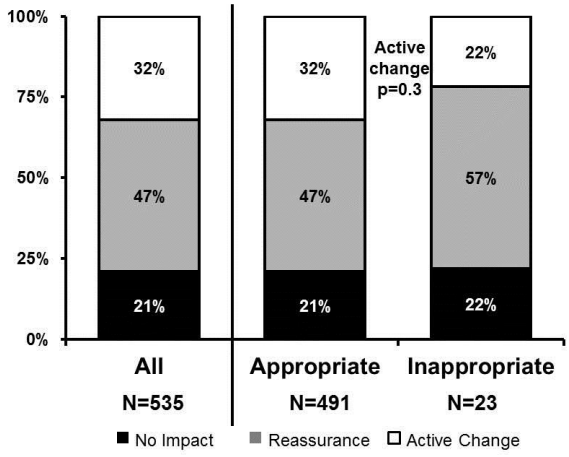
In 2007, with revisions in 2011, the American College of Cardiology Foundation in association with other imaging subspecialty societies, including the American Society of Echocardiography, developed appropriate use criteria (AUC) for echocardiography[8,9] to "respond to the need for the rational use of imaging services in the delivery of high quality care", and to potentially "impact physician decision making" with an ultimate objective to " improve patient care and health outcomes"[8]. The Appropriateness Criteria were established using the RAND/UCLA Rating Method in which the literature is reviewed and a list of clinical scenarios are created and then sent to a diverse expert panel including experts in echocardiography, health service research, insurance companies and private and academic practice. Each panel member rates the appropriateness of each scenario on a scale of 1-9 first on their own and then after meeting with the entire panel. A final score is obtained assigning each indication either an 1) appropriate (appropriate care), 2) inappropriate (rarely appropriate care), or 3) uncertain (may be appropriate care) score. [10]

Both the 2007 and 2011 AUC have been applied in a variety of clinical settings. In a U.S. study of 384 inpatient and outpatient TTEs at a tertiary care academic medical center in New York, 92% were appropriate, 2% inappropriate, 0.5% uncertain, and 5.5% were unable to be classified. [11] In a U.S. study of 1080 inpatient TTEs in a regional, community hospital, 97% were appropriate, 2%, inappropriate, and < 1% uncertain.[12] In the largest study to date, performed in 1,820 inpatients and outpatients from a single U.S. Midwest academic center, 82% of TTEs were appropriate, 12% inappropriate, 5% uncertain, and 0.4% unclassifiable. Overall, inappropriate TTEs account for approximately 2-20% of all TTEs. Repeat TTEs appear to have a slightly higher inappropriate rate (27%) than first time TTEs.[13] Cardiologists (44%) and internists (36%) are the most common referring specialties for TTE and cardiac specialists are less likely to order inappropriate TTEs than internists.[14] In a retrospective review of TTEs performed at the University of Texas Southwestern, 31% of all inpatient and outpatient TTEs in a one month period were requested by cardiologists while 53% of TTEs were requested by internists (38% general internal medicine, 15% pulmonary/critical care) with similar rates of inappropriate studies among all requesting specialties (4% pulmonary critical care, 5% cardiology, 7% internal medicine).

Ideally, if AUC were successful in "impacting physician decision making" and "improving patient care", appropriate TTEs should be more likely to affect patient management than inappropriate TTEs. However, prior publications have not thoroughly investigated this association. At UT Southwestern, we examined the proportion of TTEs that impact clinical care overall and in subgroups defined as appropriate and inappropriate by AUC. All TTEs ordered between April 1st and April 30th, 2011 were retrospectively reviewed. A TTE was excluded from review if 1) it was not performed, 2) there was no clinical data available for review, or 3) it was done for left ventricular assist device patients or post-cardiac transplant. Two independent cardiologists, blinded to clinical impact assessment, reviewed the electronic medical record (EMR) to select an AUC for each TTE. Two additional cardiologists blinded to AUC assignment, reviewed the EMR to assign clinical impact to each study. In 535 TTEs included in

the analysis, 92% of TTEs were classified as appropriate, 4% as inappropriate, and 4% as uncertain , while 32% of TTEs resulted in an active change in care, 47% led to continuation of current care, and 21% led to no change. There was no statistically significant difference in the proportion of appropriate versus inappropriate TTEs that lead to active change (Figure 2). The proportion of TTEs resulting in active change (32%) was markedly lower than the proportion of appropriate TTEs based on AUC (92%) and did not correlate with AUC classification. Similarly, the proportion of TTEs resulting in no change in care (21%) was markedly higher than the proportion of TTEs classified as inappropriate by AUC (4%), suggesting important limitations for AUC in optimizing TTE utilization. In exploratory analysis where TTEs that led to active change were rated on a scale of 1-5 by consensus of two independent cardiologists as: 5) Very useful; 4) Useful; 3) Neutral; 2) Not useful; or 1) Misused for impacting patient care, , only 19% (n=32/170) of all active change TTEs were rated as a 4 or 5 which equates to only 6% (n=32/535) of all TTEs in our study actually actively impacting care in a useful or very useful manner, further highlighting the inefficient use TTE in the provision of high-value care in routine clinical practice. [15]

Figure 2. Association between Appropriate Use Criteria and Clinical Impact at UT Southwestern



If AUC had an impact on physician decision making, the rates of appropriate TTEs should increase and that of inappropriate TTEs should decrease following the publication of AUC. However, data from a major U.S. academic medical center demonstrated no change in the proportion of TTEs classified as appropriate pre-AUC publication in 2000 and post-AUC publication in 2007 (87% vs. 85%, p=0.6). Over this same time period, however, TTE volume increased 85%.[16] Similarly, inappropriate AUCs should be associated with a lower prevalence of active change and higher prevalence of no change than appropriate TTEs; however in our study, there was no difference in the prevalence of active change or no change in appropriate versus inappropriate TTEs.

Although AUC were well-intended, there has been little change in clinical impact since their establishment. In 1980's and 1990's, before the advent of AUC, there were several studies evaluating the clinical impact of TTE. In the 1980s, the clinical impact of TTE was estimated to

be about 9-11%.[17,18] With the establishment of evidence-based guidelines in the mid-1990s, like ACE inhibitors in patients with reduced ejection fraction, clinical impact increased to 36-38%, which is similar to our findings of 32%. [19,20] Interestingly, in the setting of meaningful active change assessed by experienced cardiologists in an academic medical center in 1994, only 6% of all TTEs resulted in a definable and reasonable change which is exactly the same as the 6% of all TTEs resulting in useful or very useful active change in our study.[15,21]

Reasons for Over-testing

There are multiple physician-related, societal-related, and patient-related factors that promote over-testing in our current healthcare environment, including patient demands and direct to consumer advertising for testing, medical liability or "defensive medicine", financial incentives for and accessibility to testing, and physician training which encourages completeness in evaluation and reduction of uncertainty no matter the cost.

Medical Liability

There is significant concern in cardiology and medicine about medical malpractice and liability. Many cite "defensive medicine" as a reason for ordering excessive testing even in the face of a low pre-test probability of disease. Between 1991 and 2005, 8.6% of cardiologist faced a medical practice liability (MPL) claim compared to 7.4% of physicians overall. The total indemnity payment for cardiologists between 1985 and 2007 in the Physicians Insurers Association of America Registry was $191 million. [22] Cardiovascular medicine ranks number 14th among 28 medical specialties in the number of total closed MPL claims; however the number of closed claims resulting in indemnity payment is among the lowest of all physician groups. Diagnostic error (n=878/4248, 20%) represented the most common indication for a MPL claim against a cardiologist.[23] Interestingly, errors of omission (failures or delays in an action) are more likely to result in paid claims and higher indemnity settlements than claims of commission, lending some credence to physician perception that doing "something" is better than doing nothing. However, the filing of MPL claims for cardiologists are multifactorial, including the high acuity of cardiovascular disease, the procedural nature of the field, and the importance of patient-centered care and communication and its failure. Although the issue of medical liability is real, the fact that 27% of MPL claims for overtreatment resulted in payment also highlights the risk associated with over-testing as well.[23]

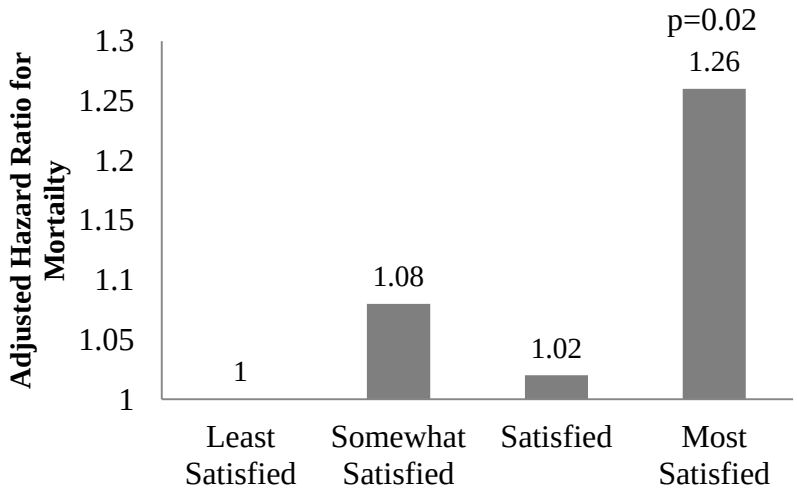
Patient and Referring Physician Demands and Patient Satisfaction.

Many companies offer direct-to-consumer cardiac screening tests to empower patients to take control of their health (http://healthylifescreening.com/screening.html). Several have been endorsed by individual patient accounts as well as on television (http://healthfair.com/healthfair-on-fox-business-national/). However, there are no guideline recommendation for screening for asymptomatic left ventricular dysfunction in the general population and in fact, there is data that screening the general population is of no benefit.[24] The prevalence of sudden cardiac death in the normal population is low therefore the risk of a false positive test and the psychological, economical, and possible physical risks inherent in more testing are of great concern but are frequently unrecognized and misunderstood by the general population. Similarly, outside the context of a qualified medical evaluation, a single negative result may lead participants to not

seek routine preventive care or be falsely reassured when in reality they do have disease and symptoms.[25]

Many physicians cite reassurance or confirmation of suspected disease and patient satisfaction as major contributors to ordering of diagnostic testing. In our study, we found that 47% of TTEs resulted in patient reassurance or continuation of current management. Although the societal importance of testing that reassures physicians and patients needs to be further explored, the likely contribution of diagnostic testing to patient reassurance is likely overestimated by physicians. In a meta-analysis evaluating the effects of diagnostic testing on worry about illness, anxiety, symptom persistence, and health care utilization in patients with symptoms and a low pre-test risk of serious illness, there was no overall effect of diagnostic testing on patient anxiety (O.R. 0.87 (95% C.I. 0.55-1.39)), no change in symptom persistence ((O.R. 0.99 (95% C.I. 0.85-1.15)), and only a small reduction in physician visits after testing ((O.R. 0.77 (95% C.I. 0.62-0.96)). [26] A prospective cohort study of adult respondent to the National Expenditure Panel Survey who had at least 2 years or follow-up (n=36,428) examined the relationship between patient satisfaction, health care utilization, expenditures, and outcomes. In multi-variable analyses adjusted for multiple confounders, the most satisfied patients were less likely to go the emergency room (adjusted OR 0.92 (95% CI 0.84-1.0)), more likely to be directly admitted (adjusted OR 1.12 (95% CI 1.02-1.23)), had higher total healthcare (8.8% (95% CI 6%-16.6%)) and prescription drug expenditures (9.1% (95% CI 2.3-16.4%)), and were more likely to die (H.R. 1.26, p =0.2) in 2 years of follow-up than the least satisfied patients (Figure 3).[27] Although this analysis was limited by the ability to correct for all confounders, it does suggest that testing for the sake of patient satisfaction may not be the best use of resources.

Figure 3. Patient Satisfaction and Mortality



Adjusted for age, sex, race, education, income, census region, urban setting, insurance coverage, source of care, panel year, smoking status, count of chronic disease, Short Form Health Survey mental and physical component summary scores, self-rated health, year 1 total health expenditures, year 1 office visits, year 1 ER visits, year 1 admission, year 1 prescription drugs. Adapted from Fenton, J.J. et al. Arch Intern Med, 2012; 172(5):405-411.

Patients, just like physicians, want to reduce uncertainty and sometimes just "want to know" that they are ok. In one population-based survey of people's willingness to pay for a

predictive test despite being told by their physician that they were healthy and the likelihood of the tested disease was low, most participants preferred to be tested even if there were no treatment options for the tested disease. They were willing to pay reasonably large amounts of money for the test regardless of the test's accuracy or positive predictive value. The majority of participants stated they would likely get a second medical opinion or seek subspecialty care, confirming concerns about screening leading to potentially inappropriate increased medical resource utilization.[28]

Financial Incentives & Test Accessibility

Doing more equates to more revenue and increased overall clinical volume. A level 4 cardiology new patient visit (CPT 99204), which requires documentation of a comprehensive history and examination, as well as documentation of moderate medical decision making complexity is reimbursed at approximately 2.4 work relative value unit (wRVU) while a complete TTE is 1.3 wRVUs. Typically, once scanned, a TTE takes 10-15 minutes to interpret, therefore in 45 minutes (comparable to the 40 minutes allotted a new patient visit in cardiology) , 3.9 wRVUs can be generated from TTE compared to only 2.4 wRVUs from a new patient visit. In a wRVU-driven incentive program, a day spent reading TTEs is more attractive financially than a day spent evaluating and managing patients in the outpatient setting.

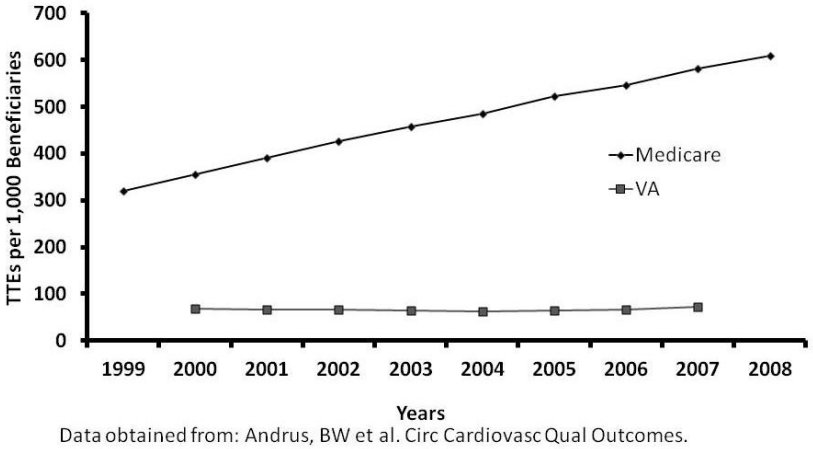
Among the countries in the Organization of Economic Cooperation and Development (OECD), the U.S. has one of the lowest number of doctor visits per capita (US: 3.9 versus OECD overall: 6.5) but one of the highest number of MRI scans per 1000 population (US: 91.2 versus OECD overall:46.6).[29] In cardiology, the potential for financial incentives to influence diagnostic test ordering is evident in the use of stress testing after revascularization. Current AUC guidelines do not recommend routine stress testing within 2 year of coronary stenting or 5 years of cardiac bypass surgery in otherwise asymptomatic patients. [30] In a recent study evaluating the association between physician billing and cardiac stress testing after revascularization, nuclear and echocardiographic stress testing were more frequent among patients who were treated by physicians who billed the technical and/or professional fees than those treated by physicians who did not bill for those services. [31]

Accessibility to testing may also contribute to the increased use of testing in the US. The largest study of clinical impact of TTE to-date was performed in Italy in 917 patients referred for TTE after discharge from an Italian hospital. Clinical impact was defined as a change in diagnostic management, therapeutic decision, or follow-up planning due to the TTE result. In that study, overall clinical impact (76%) was significantly higher than in our American study (32%), suggesting that potential differences between U.S. and Italian health care practice patterns, rates of referral to TTE, and reimbursement may lead to differences in TTE utilization and impact .[32]

The potential for differences in accessibility and reimbursement impacting TTE utilization can also be demonstrated within the U.S. system by comparing TTE utilization between Medicare and the U.S. Veterans Affairs (VA) healthcare system. Between 1999 and 2008, TTE utilization increased by 90% among Medicare beneficiaries, compared to a 4% increase in TTE utilization within the VA healthcare system over the same time period (2000 – 2007) (Figure 4).[4,33] The increase in TTE utilization in the Medicare population may be due to significant variations in physician testing thresholds, ease of access to TTEs, patient

demographics, and potential differences in financial incentives associated with increased diagnostic testing.

Figure 4. Comparison of Growth in Transthoracic Echocardiography Volume between Medicare and the Veterans Affairs Healthcare System between 2000-2007.



Data obtained from: Andrus, BW et al. Circ Cardiovasc Qual Outcomes. 2012;5:31-36; Okrah, K et al. Am Heart J. 2010; 159:477-483.

Physician Training

As technology has evolved, physical exam and history taking skills have decreased. As increased patient volumes and complexity of care have expanded, physician reliance on heuristics or mental shortcuts has contributed to the quick applications of diagnostic protocols (ex., numbness in an arm equals transient ischemic attack (TIA) which leads to TTE with bubble study, telemetry, aspirin, statin) instead of thoughtful contemplation (ex., numbness in an arm may be peripheral nerve injury, TIA, atypical migraine, or other non-life threatening cause). In one multicenter study of clinical exam skills, the clinical exam skills of internal medicine faculty, residents were only better than first and second year medical student and equivalent to the skills of third year medical students. The detection of systolic murmurs was high (0.84) but the specificity was low (0.35), while the sensitivity for detecting diastolic murmurs was poor (0.49) and the specificity was only moderate (0.67) for all participants.[34] Simulator training for undergraduate, graduate, and continuing medical education may be important in order to improve the skills of all providers.

Ways to Address Over-testing

There are several ways to potentially impact over-testing including clinical practice guideline recommendations, changes in financial incentives for testing, education and training opportunities, national campaigns, as well as modifying our methods for assessing the value of diagnostic testing in the provision of patient-centered care.

Clinical Practice Guidelines and Appropriate Use Criteria

Clinical practice guidelines as well as Appropriate Use Criteria can help to establish normative standards of care for multiple conditions and scenarios but must not be used blindly in the pursuit of patient-centered care. Although guidelines are frequently regarded as the ultimate

synthesis of evidence-based medicine, the evidence behind many guideline recommendations is often lacking. The American College of Cardiology and American Heart Association have published multiple guidelines addressing recommendations for care of a variety of cardiovascular conditions. Among the 16 guidelines that reported level of evidence, only 314/2711 (11%) were classified as level of evidence A (recommendation based on evidence from multiple randomized trials or meta-analyses) while 1246/2711 (46%) were level of evidence C (recommendations based on expert opinion, case studies, or standards of care). [35] While helpful in attempting to standardize care of common conditions, their weight in decision-making must be carefully balanced with individual patient needs.

Appropriate Use Criteria are helpful in identifying potential scenarios that have a higher pretest probability of yielding abnormal echocardiographic results. However, the clinical impact of TTE does not solely depend on the detection of TTE abnormalities. A normal TTE for an indication like "hypotension or hemodynamic instability of uncertain or suspected cardiac etiology" may result in the pursuit of non-cardiac diagnoses and therapies. Similarly, an indication like "initial evaluation when there is a reasonable suspicion of valvular or structural heart disease" may detect moderate aortic stenosis, but if the patient has a terminal illness and/or refuses or is not a candidate for future surgical or percutaneous valve interventions, care may not change. The RAND/UCLA method requires that a working group review the literature and develop list of clinical indications to be rated. A standardized literature review is then performed for each indication and evidence tables are formed when significant evidence is available for a specific indication, recognizing that many imaging studies are observational cohort studies and may have inherent bias and many indications may have no available evidence. In fact, only 2 of the 92 AUCs are based on evidence that is more than expert opinion. By having a group of diverse interests comprise the panel, including mostly experts in echocardiography, the consensus ratings will likely represent current clinical thinking and less likely challenge current TTE ordering practices and therefore allow for liberal use of echocardiography. Others have advocated for incorporating a concept of "necessity" into AUC development in order to maximize the benefit of testing.[36]

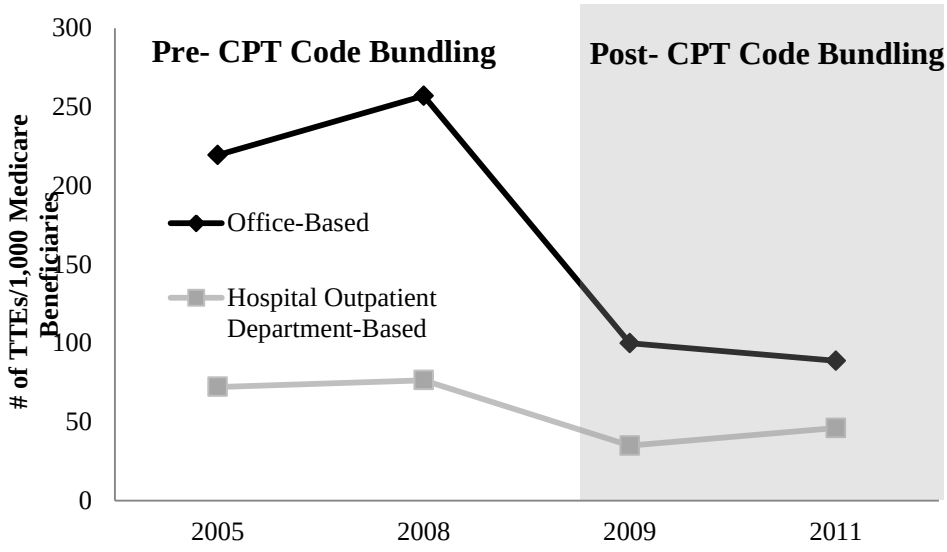
Changes in Financial Incentives

The ACC and AHA along with other major societies issued a health policy statement on the use of noninvasive cardiovascular imaging. [37] In their statement, they acknowledge that our goal is to use diagnostic imaging "optimally" but in order to accomplish this, clear limits must be set. We must understand the population in which we want to improve outcomes, have a limited and explicitly specified healthcare budget allocated to this task, and high quality data on the incremental costs and benefits of all management options. [37] Currently, the limits on healthcare expenditures in the U.S. are unclear. Once this limit is stated, we can begin to evaluate the societal benefits of diagnostic testing which confirms current management or offers reassurance to patients, the likely first targets in reducing excess testing in the healthcare system.

Several cuts in Medicare reimbursement have resulted in decreases in medical imaging costs and growth since 2006. In 2009, the add-on CPT codes for spectral and color-flow Doppler were bundled into the code for a complete TTE (CPT 93306) with a RVU that was 22% less than the sum of the three former codes.[38] With this change, both private office-based and hospital outpatient department based TTE significantly decreased initially (Figure 5). After this initial sharp decline in volume, however, there was a shift in TTE performance setting: office- based

TTE volume decreased by 269,274 TTEs between 2009 and 2011 while hospital outpatient department TTEs increased by 451,872.[39] Currently, Medicare pays 141% more for a TTE performed in a hospital outpatient department versus a physician's office. [40] From 2010 to 2011, the performance of TTEs and nuclear cardiology studies in hospital outpatient departments increased by 15% and 22%, respectively. If these rates continue through 2021 and reimbursement rates stay at 2013 levels, overall Medicare spending will increase be $1.1 billion just due to the shifting of studies from the office setting to the hospital setting.[40]

Figure 5. Temporal Trends in Office-Based and Hospital Department Based Echocardiograms



TTE: transthoracic echocardiogram; Modified from Levin, D.C. et al; Journal of the American College of Radiology, 2013 in press.

The 2013 Medicare Physician Fee Schedule (PFS) final rule has plans to expand the multiple procedure payment reduction (MPPR) concept used currently in radiology to echocardiography. MPPR is a policy in which payments are adjusted if >1 imaging service is provided to a patient on the same day. The 2013 Medicare PFS will cause a 25% reduction in the technical component of the lower priced cardiovascular service on the same day for office procedures but not for hospital-based outpatient departments. If a TTE and a nuclear stress test are performed on the same patient on the same day, there will be a 25% reduction in the technical component of the TTE. [38] Although it is too early to know the effect of this payment change, just like was seen with code bundling, there likely will be a shift of office-based procedures to hospital outpatient department-based procedures with a marginal effect on overall cost-containment.

Other methods for controlling costs include pre-authorization through a radiology benefits manager (RBM. The RBM is frequently an independent company that is hired by a private insurance company to assess the necessity and appropriateness of testing in the provision of care. They have been associated with slower growth in utilization but the data relating quality of care with RBM utilization is lacking. The additional costs of these private companies to the overall cost of care, the potential decrease in efficiency of care provided by including additional

pre-authorization steps, and the lack of data on patient outcomes and quality make this a less appealing option.

Potential moves towards value-based care, capitation, or bundled payment systems may lead to decrease utilization of advanced cardiac imaging. Similarly, reductions in hospital-based outpatient department payments may ultimately reduce imaging payment further.[38,40] A fine balance will need to be achieved to ensure that the pendulum does not swing the other way, and imaging becomes underused in the provision of a high-value care to our patients.

Education and Training

The key to changing physician behaviors is education, awareness, auditing, and feedback. A recent study evaluated the effects of physician education, a decision support tool (a laminated card with common clinical scenarios and the use of TTE), and biweekly e-mailed feedback about TTE ordering behavior and appropriateness on clinician ordering behavior. This intervention led to a decrease in the number of TTEs ordered per day as well as a decrease in the proportion of inappropriate and increase in the proportion of appropriate TTEs ordered during the intervention. [41] However, long-term follow-up once the study period was completed showed a return to the same pre-intervention TTE volume and proportion of inappropriate TTEs ordered, suggesting that for change to be sustained, auditing, feedback, and education must constantly be provided.[42]

The Accreditation Council for Graduate Medical Education mandates that "consideration of cost awareness" be incorporated into medical education. In response to that need, the American College of Physicians and Alliance of Academic Internal Medicine have developed a free curriculum on high-value, cost conscious care which incorporates the important ideas of self-reflection, auditing, and feedback in ensuring residents are exposed to the importance of cost, high value, and necessity of testing in providing care. [43] With its development and implementation at the University of California San Francisco, there was an increase in the incorporation of these concepts into daily rounds, attending behaviors, and resident projects and ideas. [44]

The Mayo Clinic has developed an electronic tool called the "Checkbook" which provides data and charges for patient cared for at the Mayo Clinic in a web-based format which can automatically retrieve selected real-time patient costs and billing data. Before implementation of the Checkbook, residents were likely to overestimate costs of individual test and felt they knew very little about costs of testing. After its implementation, resident estimates of common procedure costs improved, they felt that they better understood the role of cost in their decision-making, and felt that their attending physicians encouraged them to consider costs more frequently. [45]

National Campaigns and Public Awareness

After the publication of the Institute of Medicine's "Best Care at Lower Cost" report, which estimated that $750 billion annually is spent on wasteful health care, several national organizations began to publicize information about high-value care, including the American Board of Internal Medicine's "Choose Wisely" campaign, the "Less is More" series in the *Journal of the American Medical Association Internal Medicine*, and the American College of Physicians' "High-Value, Cost-Conscious Care" initiatives. [46] The Choose Wisely campaign, in

collaboration with multiple specialty societies, has created lists of specific, evidence-based recommendations of tests and procedures that should likely not be performed because they have little benefit of patient benefit and may have a risk of harm. The American Society of Echocardiography as well as the American College of Cardiology have provided lists as well as patient educational resources about common cardiac symptoms and their work-up and therapy (http://www.choosingwisely.org/doctor-patient-lists/american-society-of-echocardiography/; http://www.choosingwisely.org/doctor-patient-lists/american-college-of-cardiology/). Through public and physician awareness, open-discussions about patient-centered care can be intelligently discussed and unnecessary testing can potentially be avoided.

Change in Assessment of the Value of Diagnostic Testing

Diagnostic testing has traditionally been evaluated for its sensitivity, specificity, and accuracy but has rarely been evaluated for its impact on patient care and outcomes. It is difficult to assess the value of a test in isolation, since medical decision-making often involves the incorporation of multiple sources of data and information. A more comprehensive framework for the assessment of diagnostic efficacy was proposed in the 1990s by Dr. Fryback and Dr. Thornbury and recently endorsed by the American College of Cardiology in their health policy position paper. This framework proposes a 6-tiered hierarchical model of efficacy (Table 1).

Table 1. Six Tiered Hierarchical Model of Diagnostic Efficacy Assessment

Level	Examples of Areas of Assessment
Technical Efficacy	Spatial and temporal resolution, reproducibility of the technology, standardization across laboratories
Diagnostic Efficacy	Accuracy, sensitivity, specificity, positive and negative predictive value
Decision-Making Efficacy	"helpfulness" in making a diagnosis, change in post-test probability of disease
Therapeutic Efficacy	"helpfulness" in planning management, change in medications, consultations, procedures after testing
Patient Outcome Efficacy	Improvements in patient outcomes (morbidity and mortality) after testing, change in quality of life as well as quality-adjusted life years (QALYs), cost per QALY
Societal Efficacy	Cost-benefit and cost-effectiveness analysis from a societal/population perspective

First, a diagnostic test must have proven technical efficacy, in that it can be performed and interpreted reproducibly in a variety of settings and laboratories. This is initially assessed by engineers and physicists who develop the technology for clinical use. Ultimately, societies and accrediting boards, like the American Society of Echocardiography and the Intersocietal Accreditation Commission for Echocardiography, developed specific guidelines for the performance and interpretation of TTE, and audit the performance of all accredited laboratories to establish a baseline standard of imaging and care. The second level involves diagnostic accuracy efficacy, and includes test characteristics like sensitivity, specificity, positive and negative predictive value in a variety of clinical contexts. This is the level of assessment where

the Appropriate Use Criteria are helpful in that they identify scenarios where the pre-test probability of an abnormal TTE finding is high or low. Appropriate TTEs have a higher prevalence of clinically significant TTE abnormalities than inappropriate TTEs. [47] Although AUC have helped to establish indications in which TTE will likely yield an abnormality, they have yet to address higher levels of efficacy in Fryback's model. The third level addresses diagnostic thinking efficacy, which assesses the effect of testing on diagnostic thinking. For this level, assessing physician thoughts on how "helpful" the study was to their evaluation as well as changes in post-test probability of the diagnosis are helpful. The fourth level addresses therapeutic efficacy which assess if the percentage of time a diagnostic test helps plan management, alters management, or alters the clinicians' prospectively stated clinical changes in management. The fifth level evaluates patient outcomes such as percentage of patients who had an improvement in quality of life or death or other hard outcomes with testing compared to without testing or the percentage of patients who avoided morbidity or procedures because of testing. The sixth and highest level of efficacy is societal efficacy, where the cost of the diagnostic test or testing strategy is evaluated from a societal standpoint.

These higher levels of diagnostic efficacy assessment have been performed in small studies in TTE. In the 1980's and early 1990's, TTE in the U.S. led to a change in management 7-11% of time.[17,21] In the mid-1990s after trial data suggested benefit of certain therapies, like angiotensin-converting enzyme inhibitors in patients with depressed LV systolic function,[48] clinical impact increased to 36-38% [19,20], similar to the 32% active change seen in our study in 2011. The next steps should be to assess if from a societal standpoint, 30% is the correct yield or if it should be lower or higher and how to best maximize the value of TTE.

Patient Selection

Patient selection is a central aspect of quality in cardiac imaging.[49] In order for cardiac imaging to be used most effectively, the test must be applied to the proper patient subset, at the optimal time, and the results of the test must be actionable. No single research study or guideline will be universally applicable to every patient encountered. The key is to ask three simple questions:

1) What am I hoping to learn from obtaining this test?
2) How will it affect my care of this patient?
3) If I find an abnormality, are their therapeutic options available and will this patient be willing to undergo those potential therapies?

If we as clinicians critically assess our decisions to test, we will be better at discussing our diagnostic thought processes for testing, the information we plan to obtain from the testing, and the options the patient has for treatment in a more patient-centric and directed way as well as uphold our professional responsibility to be stewards of our limited healthcare resources for our individual patients as well as for the population for which we care.

Conclusions

Diagnostic imaging has grown over the past decade at unsustainable rates. There are several reasons for this growth including financial incentives for over-testing, patient and physician demands for technology, medical liability, and protocol/cookbook medicine. It is of

paramount importance that we as healthcare professionals become aware of the costs of testing, assess the incremental information and potential benefits of testing, and have open and patient-centric discussions about testing and its role in management so that we can provide cost efficient and high-value care.

REFERENCES:

1. National Healthcare Expenditure Projections 2012-2021. 2014. Accessed March 23, 2014, 2014.

2. Cuckler GA, Sisko AM, Keehan SP, et al. National health expenditure projections, 2012-22: slow growth until coverage expands and economy improves. *Health Aff (Millwood).* Oct 2013;32(10):1820-1831.

3. A Data Book: Health Care Spending and the Medicare Program. 2012. http://www.medpac.gov/documents/Jun12DataBookEntireReport.pdf. Accessed November 20, 2012.

4. Andrus BW, Welch HG. Medicare services provided by cardiologists in the United States: 1999-2008. *Circ Cardiovasc Qual Outcomes.* Jan 2012;5(1):31-36.

5. Welch HG, Hayes KJ, Frost C. Repeat Testing Among Medicare Benificiaries. *Arch Intern Med.* 2012:1-7.

6. Lucas FL, Wennberg DE, Malenka DJ. Variation in the use of echocardiography. *Effective clinical practice : ECP.* Mar-Apr 1999;2(2):71-75.

7. Safavi KC, Li SX, Dharmarajan K, et al. Hospital Variation in the Use of Noninvasive Cardiac Imaging and Its Association With Downstream Testing, Interventions, and Outcomes. *JAMA Intern Med.* Feb 10 2014.

8. Douglas PS, Khandheria B, Stainback RF, et al. ACCF/ASE/ACEP/ASNC/SCAI/SCCT/SCMR 2007 appropriateness criteria for transthoracic and transesophageal echocardiography: a report of the American College of Cardiology Foundation Quality Strategic Directions Committee Appropriateness Criteria Working Group, American Society of Echocardiography, American College of Emergency Physicians, American Society of Nuclear Cardiology, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, and the Society for Cardiovascular Magnetic Resonance endorsed by the American College of Chest Physicians and the Society of Critical Care Medicine. *J Am Coll Cardiol.* Jul 10 2007;50(2):187-204.

9. Douglas PS, Garcia MJ, Haines DE, et al. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography. *J Am Soc Echocardiogr.* Mar 2011;24(3):229-267.

10. Patel MR, Spertus JA, Brindis RG, et al. ACCF proposed method for evaluating the appropriateness of cardiovascular imaging. *J Am Coll Cardiol.* Oct 18 2005;46(8):1606-1613.

11. Parikh PB, Asheld J, Kort S. Does the revised appropriate use criteria for echocardiography represent an improvement over the initial criteria? A comparison between the 2011 and the 2007 appropriateness use criteria for echocardiography. *J Am Soc Echocardiogr.* Feb 2012;25(2):228-233.

12. Bailey SA, Mosteanu I, Tietjen PA, Petrini JR, Alexander J, Keller AM. The Use of Transthoracic Echocardiography and Adherence to Appropriate Use Criteria at a Regional Hospital. *J Am Soc Echocardiogr.* Jun 23 2012;25(9):1015-1022.

13. Ghatak A, Pullatt R, Vyse S, Silverman DI. Appropriateness criteria are an imprecise measure for repeat echocardiograms. *Echocardiography.* Feb 2011;28(2):131-135.

14. Ward RP, Mansour IN, Lemieux N, Gera N, Mehta R, Lang RM. Prospective evaluation of the clinical application of the American College of Cardiology Foundation/American Society of Echocardiography Appropriateness Criteria for transthoracic echocardiography. *JACC Cardiovasc Imaging.* Sep 2008;1(5):663-671.

15. Matulevicius SA, Rohatgi A, Das SR, Price AL, Deluna A, Reimold SC. Appropriate use and clinical impact of transthoracic echocardiography. *JAMA Intern Med.* Sep 23 2013;173(17):1600-1607.

16. Rahimi AR, York M, Gheewala N, Markson L, Hauser TH, Manning WJ. Trends in outpatient transthoracic echocardiography: impact of appropriateness criteria publication. *Am J Med.* Aug 2011;124(8):740-746.

17. Hanlon JT, Combs DT, Lowe RI, Bean B. The contribution of echocardiography to the community practice of cardiology. A prospective study. *Chest.* Feb 1984;85(2):244-247.

18. McDonald IG, Guyatt GH, Gutman JM, Jelinek VM, Fox P, Daly J. The contribution of a non-invasive test to clinical care. The impact of echocardiography on diagnosis, management and patient anxiety. *J Clin Epidemiol.* 1988;41(2):151-161.

19. Waggoner AD, Harris KM, Braverman AC, Barzilai B, Geltman EM. The role of transthoracic echocardiography in the management of patients seen in an outpatient cardiology clinic. *J Am Soc Echocardiogr.* Nov-Dec 1996;9(6):761-768.

20. Tam JW, Nichol J, MacDiarmid AL, Lazarow N, Wolfe K. What is the real clinical utility of echocardiography? A prospective observational study. *J Am Soc Echocardiogr.* Sep 1999;12(9):689-697.

21. Krumholz HM, Douglas PS, Goldman L, Waksmonski C. Clinical utility of transthoracic two-dimensional and Doppler echocardiography. *J Am Coll Cardiol.* Jul 1994;24(1):125-131.

22. Mangalmurti S, Seabury SA, Chandra A, Lakdawalla D, Oetgen WJ, Jena AB. Medical Professional Liability Risk among US Cardiologists. *American Heart Journal.* 2014.

23. Oetgen WJ, Parikh PD, Cacchione JG, et al. Characteristics of medical professional liability claims in patients with cardiovascular diseases. *Am J Cardiol.* Mar 1 2010;105(5):745-752.

24. Lindekleiv H, Lochen ML, Mathiesen EB, Njolstad I, Wilsgaard T, Schirmer H. Echocardiographic screening of the general population and long-term survival: a randomized clinical study. *JAMA Intern Med.* Sep 23 2013;173(17):1592-1598.

25. Lovett KM, Liang BA. Direct-to-consumer cardiac screening and suspect risk evaluation. *JAMA.* Jun 22 2011;305(24):2567-2568.

26. Rolfe A, Burton C. Reassurance after diagnostic testing with a low pretest probability of serious disease: systematic review and meta-analysis. *JAMA Intern Med.* Mar 25 2013;173(6):407-416.

27. Fenton JJ, Jerant AF, Bertakis KD, Franks P. The cost of satisfaction: a national study of patient satisfaction, health care utilization, expenditures, and mortality. *Arch Intern Med.* Mar 12 2012;172(5):405-411.

28. Neumann PJ, Cohen JT, Hammitt JK, et al. Willingness-to-pay for predictive tests with no immediate treatment implications: a survey of US residents. *Health economics.* 2012;21(3):238-251.

29. OECD. Health at a Glance -2011. http://www.oecd.org/health/health-systems/49105858.pdf. Accessed March 23, 2014.

30. American College of Cardiology Foundation Appropriate Use Criteria Task F, American Society of E, American Heart A, et al. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography. A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance American College of Chest Physicians. *J Am Soc Echocardiogr.* Mar 2011;24(3):229-267.

31. Shah BR, Cowper PA, O'Brien SM, et al. Association between physician billing and cardiac stress testing patterns following coronary revascularization. *JAMA.* Nov 9 2011;306(18):1993-2000.

32. Ballo P, Bandini F, Capecchi I, et al. Application of 2011 american college of cardiology foundation/american society of echocardiography appropriateness use criteria in hospitalized patients referred for transthoracic echocardiography in a community setting. *J Am Soc Echocardiogr.* Jun 2012;25(6):589-598.

33. Okrah K, Vaughan-Sarrazin M, Cram P. Trends in echocardiography utilization in the Veterans Administration Healthcare System. *Am Heart J.* Mar 2010;159(3):477-483.

34. Vukanovic-Criley JM, Criley S, Warde CM, et al. Competency in cardiac examination skills in medical students, trainees, physicians, and faculty: a multicenter study. *Arch Intern Med.* Mar 27 2006;166(6):610-616.

35. Tricoci P, Allen JM, Kramer JM, Califf RM, Smith SC, Jr. Scientific evidence underlying the ACC/AHA clinical practice guidelines. *JAMA.* Feb 25 2009;301(8):831-841.

36. Kahan JP, Bernstein SJ, Leape LL, et al. Measuring the necessity of medical procedures. *Med Care.* Apr 1994;32(4):357-365.

37. Mark DB, Anderson JL, Brinker JA, et al. ACC/AHA/ASE/ASNC/HRS/IAC/Mended Hearts/NASCI/RSNA/SAIP/SCAI/SCCT/SCMR/SNMMI 2014 Health Policy Statement on Use of Noninvasive Cardiovascular Imaging: A Report of the American College of Cardiology Clinical Quality Committee. *J Am Coll Cardiol.* Feb 25 2014;63(7):698-721.

38. Ferrari VA, Whitman B, Blankenship JC, et al. Cardiovascular imaging payment and reimbursement systems: understanding the past and present in order to guide the future. *JACC Cardiovasc Imaging.* Mar 2014;7(3):324-332.

39. Levin DC, Parker L, Halpern EJ, Rao VM. The Diversion of Outpatient Echocardiography From Private Offices to Higher Cost Hospital Facilities: An Unanticipated Effect of Code Bundling. *Journal of the American College of Radiology.* 2013.

40. MEDPAC. Report ro the Congress: Medicare and the Health Care Delivery System. http://www.medpac.gov/documents/Jun13_EntireReport.pdf, March 25, 2014.

41. Bhatia RS, Milford CE, Picard MH, Weiner RB. An educational intervention reduces the rate of inappropriate echocardiograms on an inpatient medical service. *JACC Cardiovasc Imaging.* May 2013;6(5):545-555.

42. Bhatia RS, Dudzinski DM, Milford CE, Picard MH, Weiner RB. Educational Intervention to Reduce Inappropriate Transthoracic Echocardiograms: The Need for Sustained Intervention. *Echocardiography.* Jan 22 2014.

43. Curriculum for Residents: Providing High Value Care. http://www.acponline.org/education_recertification/education/curriculum/. Accessed March 25, 2014, 2014.

44. Moriates C, Soni K, Lai A, Ranji S. The value in the evidence: teaching residents to "choose wisely". *JAMA Intern Med.* Feb 25 2013;173(4):308-310.

45. Post J, Reed D, Halvorsen AJ, Huddleston J, McDonald F. Teaching High-value, Cost-conscious Care: Improving Residents' Knowledge and Attitudes. *The American Journal of Medicine.* 9// 2013;126(9):838-842.

46. *IOM (Institute of Medicine). Best Care at Lower Cost: The Path to Continuously Learning Health Care in America.* Washington, DC: National Academies Press; 2012.

47. Bhatia RS, Carne DM, Picard MH, Weiner RB. Comparison of the 2007 and 2011 appropriate use criteria for transthoracic echocardiography in various clinical settings. *J Am Soc Echocardiogr.* Nov 2012;25(11):1162-1169.

48. Kober L, Torp-Pedersen C, Carlsen JE, et al. A clinical trial of the angiotensin-converting-enzyme inhibitor trandolapril in patients with left ventricular dysfunction after myocardial infarction. Trandolapril Cardiac Evaluation (TRACE) Study Group. *N Engl J Med.* Dec 21 1995;333(25):1670-1676.

49. Douglas P, Iskandrian AE, Krumholz HM, et al. Achieving quality in cardiovascular imaging: proceedings from the American College of Cardiology-Duke University Medical Center Think Tank on Quality in Cardiovascular Imaging. *J Am Coll Cardiol.* Nov 21 2006;48(10):2141-2151.