Author’s response to reviews

Title: Assessment of Inpatient Multimodal Cardiac Imaging Appropriateness at Large Academic Medical Centers

Authors:
Andrew Remfry (remf3@hotmail.com)
Howard Abrams (Howard.Abrams@uhn.ca)
David Dudzinski (DDUDZINSKI@mgh.harvard.edu)
Rory Weiner (rweiner@partners.org)
Rajan Bhatia (sacha.bhatia@wchospital.ca)

Version: 1 Date: 05 Oct 2015

Author’s response to reviews:

Dear Dr. Sicari,

Thank you very much for the opportunity to revise our manuscript for Cardiovascular Ultrasound. We have taken the comments and suggestions by the reviewers seriously, and have provided a point by point response to each of the concerns raised.

We believe this process has significantly improved the quality of the manuscript and that it is suitable for publication in Cardiovascular Ultrasound.

Sincerely,

Dr. R. Sacha Bhatia MD, MBA, FRCPC

Dear Dr. Bhatia,

Your manuscript "Assessment of Inpatient Multimodal Cardiac Imaging Appropriateness at Large Academic Medical Centers" (CARU-D-15-00007) has been assessed by our reviewers. Although it is of interest, we are unable to consider it for publication in its current form. The reviewers have raised a number of points which we believe would improve the manuscript and may allow a revised version to be published in Cardiovascular Ultrasound.
Their reports, together with any other comments, are below. Please also take a moment to check our website at http://caru.edmgr.com/ for any additional comments that were saved as attachments.

If you are able to fully address these points, we would encourage you to submit a revised manuscript to Cardiovascular Ultrasound. Once you have made the necessary corrections, please submit online at:

http://caru.edmgr.com/

If you have forgotten your username or password please use the "Send Username/Password" link to get your login information. For security reasons, your password will be reset.

Please include a cover letter with a point-by-point response to the reviewer comments, describing additional experiments that were carried out and including a detailed rebuttal of any criticisms or requested revisions that you disagreed with. Please also ensure that your revised manuscript conforms to the journal style, which can be found in the Instructions for Authors on the journal homepage.

The due date for submitting the revised version of your article is 16 Dec 2015.

I look forward to receiving your revised manuscript soon.

Best wishes,

Rosa Sicari, MD, PhD, FESC
Cardiovascular Ultrasound
http://www.cardiovascularultrasound.com/

We thank the Editors and reviewers for the careful review of our manuscript and have offered a point by point response below.

Reviewer #1:

1. More cautious wording in the Introduction regarding the growth of imaging. There has been some moderation in growth in the United States within the last few years that has often been cited in the belief that the problem of growth in imaging is "controlled".

We agree and are happy to make that change. The paragraph now reads: ‘Advances in cardiac imaging have led to vast improvements in our ability to diagnose heart disease. This has also lead to growth in cardiac imaging utilization and healthcare spending in this area as a result’. 
2. The authors are using an "old" vocabulary: in 2013 the terms "inappropriate" and "uncertain" were changed with "rarely appropriate" and "may be appropriate".

We agree with the reviewer’s point, and we have updated the manuscript to reflect the new 2013 vocabulary.

3. One of the most important weaknesses of this study is its methodology. There was only one reviewer who scored the test according to the AUC. There is no additional information about the background of this reviewer and his knowledge/training about AUC: was the individual performing the determination of appropriateness connected to the imaging laboratory and in any way "blinded" to the hypothesis of the study? We do not know if the study is reproducible due to there is no comparison between the characterization of appropriateness by different reviewers. This raises substantial doubt about the overall integrity of this body of literature.

We appreciate the concerns of the reviewer regarding the methods. Our research group has extensively published applying AUC to cardiac imaging studies. The senior author (RSB) trained the first author (AR) in the application of AUC to cardiac imaging studies. AR is a senior resident in Internal Medicine who had no affiliation or contact with the cardiac imaging laboratories studied. Three authors (RSB, DD and RW) with expertise in AUC reviewed the results of the manuscript, which were in keeping with prior studies on this topic. During the study period, AR would ask for clarification from RSB on any cardiac testing that he had difficulty classifying. This occurred fewer than 5 times.

In response to the reviewers concerns, however, the senior author (RSB) conducted a blinded review of random sample of 232 cardiac imaging studies (48 TTEs, 29 TEEs, 26 SPECT and 49 cardiac catheterizations) the degree of concordance was:

1) 96% for TTE, 93% for TEE, 92% for SPECT, and 96% for cardiac catheterization. This high degree of concordance was in keeping with prior studies from our group (Bhatia et. al JACC Imaging, 2014). There are multiple reasons we think for this high degree of concordance. One is the significant experience of the research team in using the AUC. Second is the robust electronic medical record available at the study hospitals. The EMRs contain all clinical notes, prior cardiac testing and other laboratories.

We have updated the manuscript as follows:

Data was collected and appropriateness category assigned (appropriate, may be appropriate, or rarely appropriate) by the principal investigator (A.R.), a trainee in Internal Medicine with no connection to the cardiac imaging service at any site. A secondary reviewer (R.S.B) is a level 3 Echocardiographer with a special interest in the Appropriate Use Criteria. We used the most recent Appropriate Use Criteria for each of the individual modalities, as opposed to the disease-based multi-modality AUC. Studies that did not have an associated AUC clinical scenario were considered unclassified. Cases where there was uncertainty regarding the classification of a study were reviewed with the second reviewer and consensus was reached, though this occurred fewer
than 5 times over the study period. RSB conducted a blinded classification of a random sample of 262 cardiac imaging studies and found concordance of 96% for TTE, 93% for TEE, 92% for SPECT, and 96% for cardiac catheterization.

4. In general, this study did not add on what is already known. Although the majority of studies come from the US, there are several studies that show the appropriateness trends in other countries and several of them have shown similar results when comparing cardiologists to internal medicine specialists and other specialties.

While we appreciate the reviewer’s concerns, this study does add significantly to the current literature in a couple of ways. First, this is the first study looking at multiple cardiac imaging modalities at the same time. We think this is an important consideration, because prior studies have focused exclusively on single modality studies. This is important because studies focused on one modality may under- or overestimate overall appropriate use of all cardiac imaging. Certain hospitals and attending physicians within hospitals may have developed certain practice patterns regarding ordering certain modalities, and this may change as attending physicians change. The holistic approach this study takes to appropriate ordering account for practice variation among clinicians and sites, and does suggest the creation of a multimodal appropriateness metric for cardiac imaging.

Second, this is the first Canadian study to assess appropriateness of cardiac imaging. This is relevant because Canada’s single payer system, similar to that of the UK, is somewhat unique in that it does not allow for private payment of medical services. This does add to the literature, as most the other countries that have published studies in this area do also have some form of private payment model.

5. References may be updated. Some studies have been published in the second half of 2014 and during 2015.

We have updated the references as suggested by the reviewers.

Reviewer #2:

1. Regarding the Methods section the Authors stated that "Repeated investigations on the same patient were treated as independent events". This needs an explanation.

Each individual investigation (TTE, SPECT, cardiac catheterization) were assessed for appropriateness separately, even if conducted on the same patient. We have changed the text to read, ‘all investigations ordered by the attending team on in-patients during the study period were included’.
2. The study was carried out in 2 different months (in different years). Did the Authors found any differences regarding the appropriateness data in these periods?

We found no significant differences in terms of the volume or appropriateness of imaging at each site between each collection period.

3. Surprisingly, there was no inappropriate application considering neither perfusion scintigraphy nor heart catheterization. One of the reasons might be the significantly lower number of these 2 imaging modalities in the study population. The reason should be explained.

We think the reason there were fewer inappropriate cardiac catheterizations and SPECT imaging could in part be explained by a lower sample size, but also because patients admitted to hospital are likely there because of either a new set of symptoms suggestive of cardiac disease, or an exacerbation of a known chronic cardiac condition, all of which would constitute an appropriate indication for testing. A large study by Chan and colleagues of appropriateness of PCI found over 98% of PCI done in the US for acute indications were appropriate, and this our study is consistent with that.

‘The low rates of rarely appropriate use we observed likely represent the fact that the acute change in clinical status that brings most patients to hospital often justifies in-hospital cardiac imaging. This is reflected in the acuity of the most common indications for testing in each modality, which broadly included a new diagnosis of heart failure (TTE AUC #70), suspicion for infective endocarditis (TTE AUC #52 and TEE AUC #108), confirmed or suspected ACS with adjunctive work up (diagnostic catheterization AUC #3, TTE AUC #24 and SPECT AUC #6), new arrhythmia (TEE AUC #112) or worsening symptoms in patients with known coronary disease (SPECT AUC #30). This has been noted in previous studies, such as that by Matulevicius et al.[9], who noted higher rates of appropriate trans-thoracic echo in in-patients compared to out-patients. Studies looking at perfusion stress imaging have generally not separated in-patient and out-patient groups however, the most common reasons for rarely appropriate studies in these investigations usually involve asymptomatic, low risk patients or those with known stable coronary disease [10,11,16]. As hospitalised patients tend to be symptomatic and have a greater number of risk factors than the out-patient population, it is unlikely that many in-patients will be in a low risk category. The rate of rarely appropriate diagnostic angiograms seen here was also lower here than that reported elsewhere. Studies by Hannan and Mohareb [13] (who also performed their study in Ontario) both found higher rates of rarely appropriate use - 24.9% and 10.8% respectively; however both of these studies excluded both investigation of acute coronary syndrome and valvular heart disease, which made of 72% of our studies and are deemed appropriate by the AUC in all circumstances. A large study by Chan and colleagues assessed appropriateness of percutaneous coronary interventions and found an appropriateness rate of 98.6% in patients having PCI for an acute indication, which is consistent with the low rarely appropriate rate in our study.’
4. Furthermore, the distribution of the different exam types was not well balanced because of the low sample size (scintigraphy, TEE) neither in the whole study nor between sites (see perfusion imaging section) which could influence the statistical analysis, as well.

   We agree with the reviewer that the distribution of exam types had significant variance, which underscores the importance of this study’s approach. We know that individual hospitals, and physicians within hospitals have significantly different ordering practices. This is reflected in the study results. Studies that focus on only one modality, as most prior studies have, will lead to potential distortions in appropriateness, whereas the approach of classifying multiple modalities can give hospitals an overall sense of the appropriateness of cardiac imaging across multiple modalities.

5. Both the Methods and Discussion section should be shortened.

   We have worked to significantly reduce the word count, particularly in the discussion. The total manuscript length is 3029 words, which is reduced from 3430 words.