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LETTER TO THE EDITOR

Response to Dr. Kamanahalli's Letter to the Editor

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I wish to thank Dr. Kamanahalli for his interest in my study, for bringing his astute and important observation to my attention, and for his kind words. I also appreciate the opportunity to clarify the methodology used in my study, "Reuse and reduce: abdominal CT, lumbar spine MRI, and a potential 1.2–3.4 billion dollars in cost savings [1]."

Dr. Kamanahalli raises the important point that when making multiple observations in a single patient, if analysis is done at the patient level, positive correlations (e.g., a foraminal stenosis at one level increases the probability that foraminal stenosis will be present at another level in the same patient) need to be considered so as not to artificially inflate the sensitivity and specificity of the study [2].

Data can be evaluated at the segment or patient level [3]. At the segment level, when analyzing sensitivity and specificity of cardiac CT angiography (CCTA) data, for example, using coronary angiography (CA) as the standard of reference, if significant stenosis is found with CCTA at a specific location, then the data point is counted as a TP only if CA also demonstrates significant stenosis at the same location. If either the degree of stenosis or location is discrepant between the two studies, then the data point is counted as a FP. If no significant stenosis is found at a specific location with CCTA, then the data point is counted as a TN if CA also shows no stenosis at the same location, and FN if CA shows significant stenosis at that location. When analyzing data at the patient level, observations are scored differently. If the CCTA shows a coronary artery stenosis anywhere in the patient's heart, the data point is TP if CA also shows a significant stenosis, even if that stenosis is not at the same location. If CA shows no significant stenosis anywhere in the heart, the CCTA data point is FP. If CCTA shows no significant stenosis anywhere in the heart, the data point at the patient level is TN if CA also shows no significant stenosis, and FN if CA shows a significant stenosis anywhere in the heart.

An alternative approach, however, using a combined segment and patient-level analysis, was used in my study. "A CT study was concordant only if there were no discrepancies between the abdominal CT reading and the lumbar spine MRI report. A CT study was discordant if any finding differed between the abdominal CT reading and the lumbar spine MRI report [1]." For example, if significant foraminal stenosis were diagnosed at left L4–5 on the abdominal CT study, but the lumbar spine MR study showed significant foraminal stenosis at another level (e.g., right L4–5) with only mild foraminal stenosis at left L4–5, the entire patient was classified as FP. No credit was given for the correct diagnosis at the wrong level. A strict patient-level analysis as described above would have counted this patient as a TP. Although a patient-level analysis could have been used in my study, since it was the patient who would or would not undergo a follow-up lumbar spine MRI, a stricter combined patient and segment-level approach was used for data collection. The reason for using this strategy in my study was to make it as difficult as possible to show a beneficial effect. Collection of the data in this way also provides fewer data points, widening confidence intervals, again to the detriment of my study's results. Using the combined patient- and segment-level analysis, if every lumbar spine finding, both normal and abnormal, corresponded in location, type, and degree between the abdominal CT and lumbar spine MRI studies, then it was postulated that the lumbar spine MRI could have been avoided. In 90% (73/81) of the lumbar spine MRI studies, this was the case, with a projected U.S. healthcare cost savings of 1.2–3.4 billion dollars per year [1].

Although an average of 2.2 abnormalities per patient was found in my study, most of the data collected (27 herniated discs, 34 central canal stenoses, 48 foraminal stenoses, 11 bone tumors, 2 fractures, 6 spondylolisthesis, and 1 arachnoiditis in 58 patients) were not, and would not be expected to be, positively correlated or clustered [1]. For example, central canal stenosis at one location would not be expected to be positively correlated with a bone tumor

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at another location. Alternatively, it might be expected that a bone tumor would be positively correlated with a fracture in a particular patient. However, none of the patients in my study had both a bone tumor and a fracture.

Lumbar spine findings are rarely reported on abdominal CT studies [4]. The results of my study suggest that the lumbar spine should be evaluated and significant abnormalities reported on abdominal CT studies. When a patient has an abdominal CT for right lower quadrant pain, for example, even though the radiologist may diagnose appendicitis to explain the patient's symptoms, if the patient also has a potentially significant finding in the lumbar spine, (e.g., a herniated disc at L5–S1), the lumbar spine finding should also be reported, even though it is unrelated to the reason for the abdominal CT. At a later date, the patient may be considered for lumbar spine evaluation for low back pain. By including lumbar spine findings in the abdominal CT report, the radiologist may help the patient avoid an unnecessary lumbar spine MRI, reducing healthcare costs and unnecessary patient testing. Moreover, if prior to performing lumbar spine MRIs, radiologists would evaluate a patient's prior abdominal CT study for lumbar spine pathology, then additional unnecessary lumbar spine MRI studies may be avoided. If many radiologists, clinicians, and patients become involved, the process could reach a "tipping point," with significant cost savings to the entire healthcare system [5].

In conclusion, positive correlations (clustered data), although an important consideration, did not exert a significant influence in "Reuse and reduce: abdominal CT, lumbar spine MRI, and a potential 1.2–3.4 billion dollars in cost savings [1]."

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