Journal of Medical Systems (2019) 43: 30
https://doi.org/10.1007/s10916-018-1150-z

SYSTEMS-LEVEL QUALITY IMPROVEMENT

Improving Communication of Actionable Findings in Radiology Imaging Studies and Procedures Using an EMR-Independent System

Steven J. Baccei[1] · Cole DiRoberto[1] · Janet Greene[1] · Max P. Rosen[1]

Received: 18 November 2017 / Accepted: 25 December 2018 / Published online: 5 January 2019

Abstract

The primary purpose of this study is to determine if the implementation of an actionable findings communication system (PeerVue) with explicitly defined criteria for the classification of critical results, leads to an increase in the number of actionable findings reported by radiologists. Secondary goals are to 1) analyze the adoption rate of PeerVue and 2) assess the accuracy of the classification of actionable findings within this system. Over a two-year period, 890,204 radiology reports were analyzed retrospectively in order to identify the number of actionable findings communicated before (Year 1) and after the implementation of PeerVue (Year 2) at a tertiary care academic medical center. A sub-sample of 145 actionable findings over a two-month period in Year 2 was further analyzed to assess the degree of concordance with our reporting policy. Before PeerVue, 4623/423,070 (1.09%) of radiology reports contained an actionable finding. After its implementation, this number increased to 6825/467,134 (1.46%) ($p < 0.0001$). PeerVue was used in 3886/6825 (56.9%) cases with actionable findings. The remaining 2939/6825 (43.1%) were reported using the legacy tagging system. From the sub-sample taken from PeerVue, 104/145 (71.7%) were consistent with the updated reporting policy. A software program (PeerVue) utilized for the communication of actionable findings contributed to a 34% ($p < 0.0001$) increase in the reporting rate of actionable findings. A sub-analysis within the new system indicated a 56.9% adoption rate and a 71.7% accuracy rate in reporting of actionable findings.

Keywords Communication · Actionable findings · Critical results · Improve · Radiology

Introduction

The permanent record for a diagnostic imaging study is the written report by the interpreting radiologist. However, there are many instances in which—in addition to the final report—special communication is made by the radiologist. The ACR defines this special communication(s) as "non-routine communications" [1]. The extent and timeliness of this special (non-routine) communication depends on the urgency of the radiologist's findings.

Failure to communicate actionable findings can result in negative consequences for patient care, healthcare costs, provider liability, and physician satisfaction [2–4]. Although technologies such as the Picture Archiving and Communication System (PACS) as well as integrated electronic medical records (EMR) have clear benefits to health care, they reduce direct contact between referring clinicians and radiologists, creating opportunities for a breakdown in the communication of critical results. Our project is novel in that we analyze the extent to which an independent software program can increase the reporting of actionable findings at an institution lacking a fully integrated EMR.

Baseline audits at our institution have found a roughly 90% compliance rate with our "Critical Results Reporting Policy" that was in place prior to the initiation of this study. (This "baseline" system relied on the radiologist tagging critical findings in the impression of their report). Types of noncompliance included failure to communicate the actionable finding, improper documentation of the communication, or improper method of communication. These problems occur only after an actionable finding has been recorded. However, there are many cases in which an actionable finding has been overlooked, and this type of failure is the most problematic.

This article is part of the Topical Collection on *Systems-Level Quality Improvement*

✉ Steven J. Baccei
steven.baccei@umassmemorial.org

[1] UMass Memorial Medical Center, Worcester, MA, USA

The primary goal of this study is to determine if implementing a system dedicated to the communication of critical results at an institution lacking a fully integrated EMR is successful in increasing the number of actionable findings reported. This system consists of a critical results communication software, (PeerVue, McKesson Corporation, San Francisco, CA), an updated protocol for the identification and classification of critical results, and "critical results switchboard operators," designated to facilitate communication between radiologists and referring physicians. Two secondary goals of the study are to analyze the adoption rate of PeerVue and assess the accuracy of the classification of actionable findings by the radiologist. Similar quality improvement projects focused on increasing the communication of actionable findings have been undertaken with varying degrees of success [5–8].

Methods

Actionable findings communication Year 1

Prior to the implementation of PeerVue, radiologists were required to manually insert a "tag" at the end of the dictated, final report to indicate the presence of an actionable finding. The tag, "*+* Critical Result," allowed the report generating software (PowerScribe 5.1, Nuance, Burlington, MA) to identify the final report as containing an actionable finding during a text search. Within this system, only those actionable findings identified during the search could be examined. Searching reports containing the "critical results" tag required additional manual processing to determine compliance with the critical results communication policy. In addition, the determination of what constituted an actionable finding was subjective, based entirely on each individual radiologist's discretion during image interpretation. Once a finding was deemed actionable, the radiologist called the responsible clinician him/herself and recorded the communication, along with the tag at the end of the report. Thus, our intervention was comprised of three components: 1) the implementation of the PeerVue Software, 2) the establishment of clear definitions as to which findings warranted communication as an actionable findings, and 3) the hiring of "telephone operators" to help the radiologist communicate actionable findings.

Data collection Year 1 (prior to PeerVue implementation)

All radiology reports generated during a one-year period (October 6, 2013 to October 6, 2014) were scanned for the appropriate *+* tag. After converting this data into an Excel spreadsheet, we counted the total number of actionable findings for this one-year period.

Actionable findings communication Year 2 (after PeerVue implementation)

PeerVue was implemented on October 6, 2014. This software program facilitates the delivery, documentation, and archiving of actionable findings communications. PeerVue is integrated directly into our PACS, so radiologists can initiate the actionable findings communication pathway without disruption of the image interpretation process. When an actionable finding is identified, the radiologist opens the PeerVue dashboard and chooses the category of actionable finding (red, yellow or orange, as defined below) and method of communication (verbal or e-mail with read receipt recorded). In addition, coincident with the implementation of PeerVue, our department developed and introduced a list of findings that required reporting as a critical result.

As part of PeerVue, radiologists share the workload of conveying actionable findings with a "critical results switchboard operator." The critical results switchboard operator receives actionable findings communication requests from the radiologists through the PeerVue dashboard and, in many cases, conveys the results directly to the ordering clinician, further incentivizing the radiologists to utilize the program. During this process, PeerVue automatically logs the details of the communication into a database, which can be easily and rapidly accessed at any time. The PeerVue database also allows for the rapid, seamless generation of reports.

Updated actionable findings protocol

To fully benefit from the implementation of PeerVue, our Department of Radiology simultaneously updated the critical results reporting policy. This updated policy was tailored to the increased functionality of PeerVue, which allows for the categorization of actionable findings based on their level of urgency—an option unavailable to us in the prior tagging system. The categories and the recommended time required from image interpretation to closed loop communication with referring provider are outlined in the updated protocol:

> *Red Alert:* Findings that could lead to immediate death or significant morbidity if not promptly recognized, communicated, and acted upon clinically. Red Alert findings require verbal communication between interpreting radiologists and responsible providers within an hour. Communication with the responsible provider could be initiated by the radiologist him/herself or by the telephone operator, but the actual communication was required to be verbal, and directly between the radiologist and the responsible provider.
> *Orange Alert:* Clinically significant observations that generally explain a patient's acute presentation and require specific medical or surgical treatment but do not

have the same urgency and severity as those in the Red Alert category. Orange Alert findings require verbal or responsible clinical-provider-acknowledged written communication between interpreting radiologist and/or radiology administrative staff and the responsible clinical provider within 24 h.

Yellow Alert: Typically incidental or unexpected findings that generally do not require any immediate treatment or other action, but in the long term, could be significant. Follow-up imaging is often required but, in some cases, not for many months. Yellow Alert findings require acknowledged written communication between radiology administrative staff and responsible provider within 7 days.

In addition to establishing these three categories, the Department provided an extensive list of example diagnoses in all the respective radiology divisions that are inherent to each of the three categories [9].

Prior to implementation of PeerVue, radiology staff and trainees were educated on this protocol and taught how to operate the PeerVue software during both group and one-on-one sessions. Similarly, all radiology technical leads and managers were trained to use PeerVue. Monthly, quarterly, and annual reports measure a variety of quality metrics (including actionable findings communication). These reports are reviewed by technical leads as well as the vice-chair for radiology quality, patient safety, and process improvement and are presented at quarterly radiology quality committee meetings and morbidity and mortality conferences.

Data collection Year 2

We collected actionable findings from the year-long period of October 7, 2014 to October 7, 2015. The actionable findings from PeerVue were converted into an Excel spreadsheet and counted. Some radiologists still used our legacy system of reporting actionable findings rather than PeerVue. To account for this, we scanned all reports for the *+* tag, as we did for the data from Year 1. We converted this data into an Excel spreadsheet, merged it with the spreadsheet containing actionable findings collected from PeerVue, and counted the total number while excluding duplicates (actionable findings reported in both PeerVue and the tagging system).

To assess the characterization accuracy of actionable findings, an audit was done on all entries (with the exception of those entries recorded by radiologists who were a part of this study) containing a critical result from a six-week period between February and March of Year 2. This subset of 145 actionable findings entries was evaluated for accuracy utilizing the established definitions for each category (red, orange, and yellow) with reference to the example diagnoses included in. (We were not able to perform this type of sub-analysis for data collected during Year 1, as our categorization of critical results definitions had not been implemented during Year 1). A communication was considered an "overcall" if it was marked as requiring a higher degree of urgency than necessary. An example of an overcall is a finding reported as a Red Alert, but according to the definitions in our reference list, should have been categorized as an Orange Alert. A communication was considered an "undercall" if it was marked as requiring a lower degree of urgency than necessary. For example, an undercall would be an Orange Alert categorized as a Yellow Alert.

Results

Reporting of actionable findings

Figure 1 shows a comparison of the data before and after the implementation of PeerVue. In Year 1, 4623/423,070 (1.09%) of radiology reports contained an actionable finding. After the implementation of PeerVue, this number increased to 6825/467,134 (1.46%), a 34% ($p < 0.0001$) increase from the previous year. We assumed that the true occurrence rate of critical diagnoses in radiology studies remained the same over the two-year period, so the increase was attributed to PeerVue. In Year 2, radiologists used PeerVue to report actionable findings in 3886/6825 (56.9%) cases. The remaining 2939/6825 (43.1%) cases were reported using the legacy tagging system (Fig. 1).

Within the PeerVue system, 711/3886 (18.3%) actionable findings were Red Alerts, 1939/3886 (49.9%) were Orange Alerts, and 1236/3886 (31.8%) were Yellow Alerts (Fig. 2).

Accuracy of actionable findings classification in Year 2

The subset analysis of all actionable findings taken from the six-week audit period in February and March of Year 2 revealed that 104/145 (71.7%) actionable findings were correctly classified as Red Alert, Orange Alert, or Yellow Alert respectively. Concordance was determined by the definition of each category.

The accuracy of the actionable findings classification was further broken down by radiology division (Fig. 3). Fifty actionable findings were associated with the chest division. Twenty-five findings were marked as Red Alert, and out of those, 20 were concordant and 5 were overcalls (as defined in the Methods section of this paper). Nineteen Orange Alerts were reported for the chest section: there was 1 overcall and 2 undercalls. Six reports were entered as Yellow Alert; one was considered an undercall requiring a more urgent Orange Alert. Fifty-seven actionable findings were associated with the body

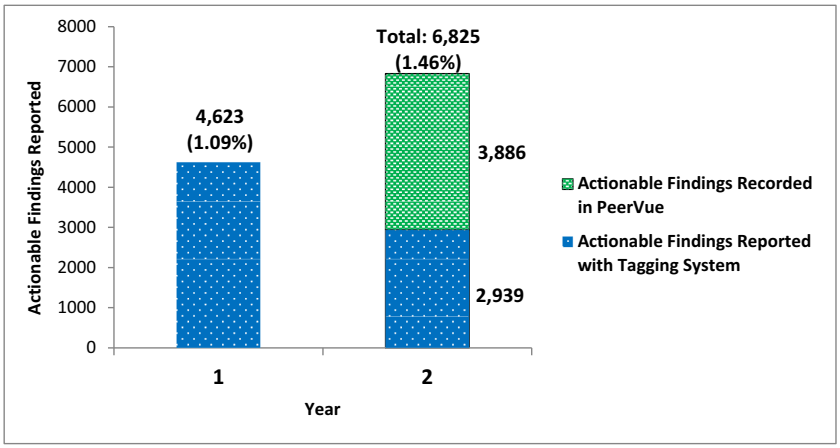

Fig. 1 Actionable findings reported before and after the implementation of PeerVue. Year 1 is data from October 6, 2013 to October 6, 2014 (the year prior to the implementation of PeerVue), and Year 2 is data from October 7, 2014 to October 7, 2015. The number of actionable findings and the overall reporting rate went from 4623 (1.09% reporting rate) to 6825 (1.46% reporting rate) ($p < 0.0001$) after the implementation of PeerVue. Many communications were still made with the old tagging system (2939) after the introduction of PeerVue

imaging section (23 Red Alerts, 28 Orange Alerts, and 6 Yellow Alerts). Thirteen of the 23 Red Alerts were overcalls, 9 Orange Alerts were overcalls, and 1 Yellow Alert was an undercall. For vascular imaging, 2 Red Alerts, 2 Orange Alerts, and 6 Yellow Alerts were found. One of the Red Alerts was an overcall; one Orange Alert was an undercall; and all of the Yellow Alerts were consistent with the protocol. For neuroradiology, 2 Red Alerts, 7 Orange Alerts, and 3 Yellow Alerts were entered during the audit period. One of the Red Alerts was an overcall; two of the Orange Alerts were overcalls and 1 was an undercall; and 2 of the Yellow Alerts were undercalls. For musculoskeletal imaging, 6 actionable findings were found, all categorized as Orange Alerts: one of them was an overcall. One actionable finding was found in pediatrics and it was consistent with our protocol.

Discussion

Systems of communication in radiology are often manually driven and, as a result, are subject to a variety of quality related issues and inconsistencies. With the primary focus of the radiologist on the correct interpretation of imaging findings, the reliable and timely flow of this information from radiologist to referring physician to patient may at times be inadequate and inefficient [10]. This inefficiency has led to a number of problems ranging from the unproductive use of radiologists' time (searching for contact information) to serious patient harm (lack of closed loop communication of a critical finding) [4, 11, 12]. Not only does failure to communicate results in a timely manner affect patient safety, but it can also cause serious financial problems [13–15]. A fully integrated EMR can alleviate some of the problems associated with the communication of critical results by facilitating a more synchronous workflow. However, as many institutions have not implemented a fully integrated EMR, it is necessary to find alternate solutions to improve communication between radiologists and referring physicians.

Our institution utilizes an EMR-independent method that has proven successful in increasing the number of actionable findings reported and the overall reporting rate by our radiologists. By implementing the PeerVue critical results

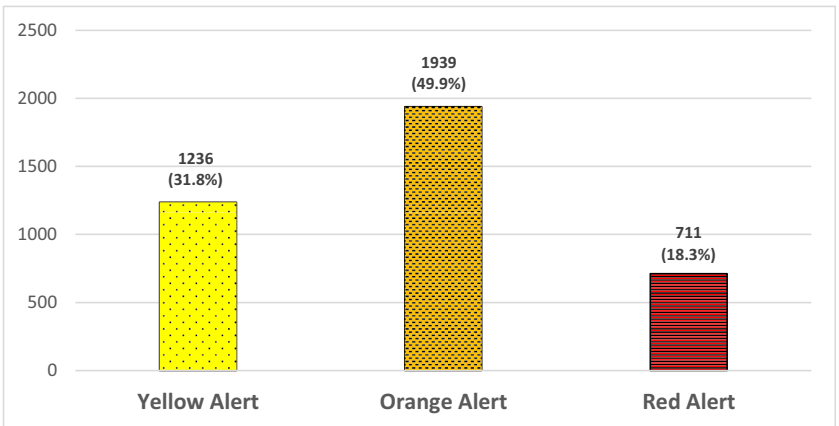

Fig. 2 PeerVue actionable findings reporting by category. Orange Alerts were most common, accounting for nearly 50% of the total reports of critical results

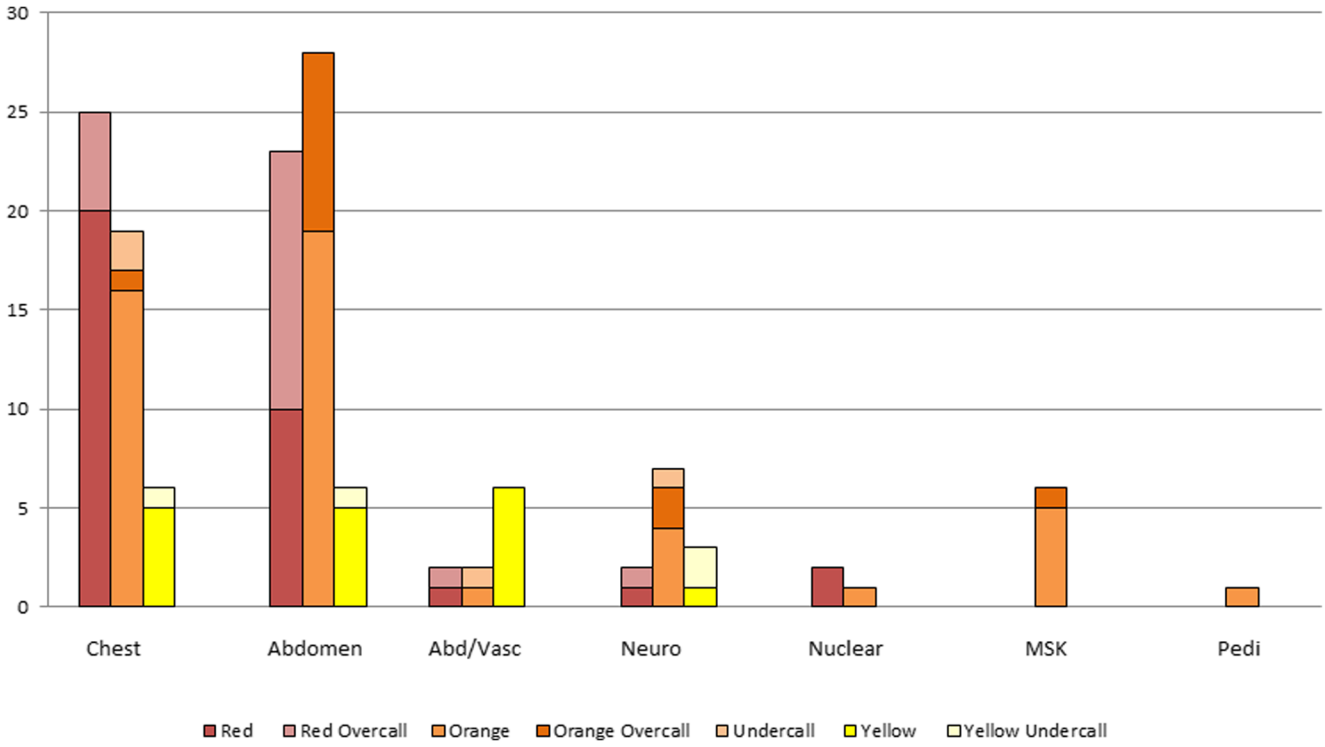

Fig. 3 Analysis of reporting accuracy in PeerVue. A sample of 145 critical results was taken randomly and categorized by the medical division in which the problem occurred and the urgency of the issue. Red alert is the most urgent critical result and Yellow Alert is the least. Accuracy was graded by "overcalls" and "undercalls," or reports incorrectly (with respect to our definitions) categorized as more or less urgent than required by our definition list

communication module, introducing a protocol with defined criteria for the classification of critical results, and employing critical results switchboard operators, we documented a 34% increase in the reporting of actionable findings ($p < 0.0001$).

Our system differs from similar actionable findings reporting systems in that we make use of a "critical results switchboard operator." Whereas other systems rely solely on automatic alert communication through e-mails and pages directly connected to the actionable findings module, we have staff that facilitates communication between the radiologist and the ordering physician [6, 7, 16]. This facilitation includes the management of sending actionable findings e-mails to referring providers, documenting e-mail read receipts in PeerVue, looking up contact information and transferring phone calls directly to the radiologist (primarily for red alert category findings). This hybrid "human-automated" system has multiple potential benefits. In this method of communication, referring physicians are less likely to be "burnt out" by automated messages, a problem that could potentially lead to a lack of action or stalled communication. Also, the switchboard operator naturally provides a level of human interaction with referring clinicians, not available in a fully automated system.

The success of our new system occurred despite the fact that the utilization rate of PeerVue for actionable findings was still only 57% during Year 2. As expected, when implementing a new system, many users failed to make the transformation from our legacy system to PeerVue. Therefore, we believe that the true benefits of using PeerVue will continue to develop in the following years through re-education efforts and as radiologists adapt to the new system.

Unlike our legacy system of actionable findings reporting, PeerVue also allows for the systematic categorization of types of actionable findings. We believe that separating alerts by level of urgency (Yellow, Orange, Red) has a number of benefits for patient satisfaction and safety, radiologists, and ordering physicians. Nevertheless, the benefits of this type of system rely on the accuracy of the categorization. Thus, inaccurate categorization of actionable findings within this system may cause a number of different problems. We had estimated a > 90% accuracy for correctly labeling categories of actionable findings within PeerVue, but after conducting an audit of 145 PeerVue reports, we identified a 71.7% accuracy rate. We found that the main cause of inaccuracy was overcalling, or categorizing a finding as more urgent than necessary; 80% of the incorrectly classified actionable findings were due to overcalls. Overcalling was highest in reports from the body imaging division; in fact, 56% of the total number of mischaracterized actionable findings in this category was due to overcalling. This type of error is far less problematic than an undercall, which could severely threaten patient safety by delaying further care. However, overcalls may be seen as disruptive to the workflow of referring providers.

There are several limitations to our study. The ultimate goal of implementing a new system of actionable findings reporting was to improve patient safety. Although our study demonstrated that the implementation of PeerVue led to a significant increase in the reporting of actionable findings, we have not demonstrated if patient care and safety were improved. Furthermore, we do not know the true rate of findings that should have been reported as actionable (only those findings reported either in PeerVue or with the * + * tag). There may have been an increase in the overall occurrence of actionable findings in Year 2, but because we are currently unable to identify the true incidence of actionable findings, we assumed that it stayed constant over the two-year period of our study.

Conclusion

We analyzed the effect that the implementation of 1) PeerVue critical results reporting software, 2) an updated protocol with defined criteria for reporting critical results, and 3) critical results switchboard operators had on the reporting of actionable findings at our institution. We found that this multi-component system led to a 34% increase in the reporting of actionable findings. The enhanced features of PeerVue permitted the categorization of actionable findings based on their level of urgency. We found that 71.7% of the studies that we analyzed were accurately identified as red, orange, or yellow alerts. Overall, PeerVue facilitated the increased rate of reporting actionable findings at a medical center without a fully integrated EMR. Future studies should analyze how improving the identification and communication of actionable findings—in both timeliness and accuracy—increases patient safety and well-being.

References

1. American College of Radiology, *ACR practice guideline for communication of diagnostic imaging findings. Revised 2014 (Res. 11)*. Reston: American College of Radiology, 2014.
2. Poon, E. G., Gandhi, T. K., Sequist, T. D., Murff, H. J., Karson, A. S., and Bates, D. W., "I wish I had seen this test result earlier!": Dissatisfaction with test result management systems in primary care. *Arch. Intern. Med.* 164:2223–2228, 2004.
3. Berlin, L., Communicating findings of radiologic examinations: Whither goest the radiologist's duty? *AJR* 178:809–815, 2002.
4. Gandhi, T. K., Fumbled handoffs: One dropped ball after another. *Ann. Intern. Med.* 142:352–358, 2005.
5. Towbin, A. J., Hall, S., Moskovitz, J., Johnson, N. D., and Donnelly, L. F., Creating a comprehensive customer service program to help convey critical and acute results of radiology studies. *AJR* 196:W48–W51, 2011.
6. Lacson, R., Prevedello, L. M., Andriole, K. P. et al., Four-year impact of an alert notification system on closed-loop communication of critical test result. *AJR* 203:933–938, 2014.
7. Lacson, R., O'Connor, S. D., Andriole, K. P. et al., Automated critical test result notification system: Architecture, design, and assessment of provider satisfaction. *AJR* 203:W491–W496, 2014.
8. Prevedello, L., and Khorasani, R., Alert Notification of Critical Radiology Results (ANCR): using IT tools to enhance monitoring and management of actionable findings in radiology. Partners Radiology Research and Education Retreat. 2010.
9. Larson, P. A., Berland, L. L., Griffith, B., Kahn, Jr., C. E., and Liebscher, L. A., Actionable findings and the role of IT support: Report of the ACR actionable reporting work group. *J. Am. Coll. Radiol.* 11(6):552–558, 2014.
10. Larson, D. B., Froehle, C. M., Johnson, N. D., and Towbin, A. J., Communication in diagnostic radiology meeting the challenges of complexity. *AJR* 203:957–964, 2014.
11. Fitzgerald, R., Error in radiology. *Clin. Radiol.* 56:938–946, 2001.
12. Whang, J. S., Baker, S. R., Patel, R., Luk, L., and Castro, III, A., The causes of medical malpractice suits against radiologists in the United States. *Radiology* 266:548–554, 2013.
13. Brenner, R. J., Lucey, L., Smith, J. J., and Saunders, R., Radiology and medical malpractice claims: A report on the practice claims survey of the Physician Insurers Association of America and the American College of Radiology. *AJR Am. J. Roentgenol.* 171:19–22, 1998.
14. Hanks, J.D. Jr., Radiology liability update. Presented at: Georgia & South Carolina Radiological Societies Meeting; Hilton Head Island, SC; June 19, 2011.
15. Thomson, N. B. I. I. I., and Patel, M., Radiology liability update: Review of claims, trends, high-risk conditions and practices, and tort reform alternatives. *J. Am. Coll. Radiol.* 9:729–733, 2012.
16. Parl, F. F., O'Leary, M. F., Kaiser, A. B., Paulett, J. M., Statnikova, K., and Shultz, E. K., Implementation of a closed loop reporting system for critical values and clinical communication in compliance with goals of the joint commission. *Clin. Chem.* 56:417–423, 2010.