

## **Automated Notification System for Follow-Up Testing Recommendations Across Care Settings**

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## **Abstract )**

**Purpose:** To evaluate the impact of a system designed to communicate radiologists' follow-up recommendations to ambulatory primary care physicians (PCP) on timely implementation of recommended follow-up procedures for two critical imaging test results.

**Scope:** Transitions in care, especially for patients transitioning to ambulatory care from the emergency department (ED) and inpatient settings, can exacerbate failures in follow-up testing. We evaluated the impact of a discharge module that captures follow-up recommendations for further management on the study outcome – follow-up management of patients with pulmonary nodules and renal masses – within one year after discharge.

**Methods:** After IRB approval, we collected data on all patients undergoing chest or abdominal CT exams over a 12-month baseline and 12-month intervention period at an academic medical center. The inpatient module was implemented in November 2011; the ED module was implemented in May 2012. Logistic regression was performed to account for care setting, imaging modality, recommendations, and patient demographics.

**Results:** Implementing a discharge module resulted in improved follow-up of patients with pulmonary nodules (OR=1.64, p=0.01); the ED implementation resulted in better follow-up compared to the inpatient module (OR=2.24, p<0.01). No significant effect on renal mass follow-up was identified.

**Key Words:** critical result, communication system, patient safety

## **Purpose**

The Joint Commission has emphasized the need for improved communication of critical test results as one of its National Patient Safety Goals (NPSG).(1) This goal includes implementation of follow-up procedures for managing critical test results upon communication. We previously implemented an automated alert system, Alert Notification of Critical Test Results (ANCR), and evaluated it with funding support from the Agency for Healthcare Research and Quality.(2, 3) ANCR enables alert notification of referring providers when results from imaging exams are deemed critical or unexpected by a radiologist at the time of interpretation.(2, 3) All unacknowledged alerts are monitored and provided to radiologists and referring providers for feedback, to encourage notification adherence.

Although ANCR produced an increase in documented communication of critical results between caregivers, a deficit remained in adherence to recommended follow-up testing. In particular, critical result follow-up testing was not being performed, especially when the recommendations were less urgent. These less urgent critical results accounted for 75% of all critical result communications, and included findings such as incidental pulmonary nodules which could actually represent undiagnosed lung cancer.(3) Although they may be identified in emergency or inpatient settings, follow-up of these critical results is primarily the responsibility of providers in ambulatory settings, including health care clinician offices and outpatient clinics. As such, identifying and communicating them at times of patient transitions in care between a non-ambulatory setting and an ambulatory setting, is crucial.

We therefore undertook to expand the intervention to facilitate notification of primary care providers for performing follow-up testing recommendations, especially during transitions in patient care settings, and thereby improve patient safety. The project had the following specific aims:

Specific Aim 1: Use a computerized system to communicate the radiologist's follow-up recommendations to the ambulatory primary care physician (PCP), and enable the follow-up recommendations to be included in the discharge plan, available to ambulatory primary care providers of discharged patients.

Specific Aim 2: Evaluate the impact of the system on timely implementation of recommended follow-up procedures for two critical imaging test results – pulmonary nodules and renal masses – in two patient care transition scenarios: (1) transition from the emergency department (ED) to ambulatory care, and (2) transition from inpatient to ambulatory care.

**Scope:** (Background, Context, Settings, Participants, Incidence, Prevalence)

In a 2009 study, lack of documented follow-up was noted in 11% of abnormal imaging reports.(4) This is a substantial finding considering over 500,000 imaging tests are performed annually in our institution alone. In addition, during care transitions and across care settings, responsibility for follow-up management is often unclear, and this transfer of responsibility between acute care and ambulatory clinicians may exacerbate failures to follow-up nonurgent but critical test results.(4) Missed or delayed follow-up of abnormal test results leads to additional interventions or complications.(5-7)

Consistent with the Joint Commission Safe Practice Recommendations, the Brigham and Women's Hospital (BWH) Department of Radiology developed and implemented a process for communicating critical imaging results as part of an institution-wide Communication of Critical Test Results (CCTR) policy.(8) In addition, the Controlled Risk Insurance Company/Risk Management Foundation (CRICO/RMF) funded an initiative by the BWH Department of Radiology to develop an automated system, ANCR, to fully integrate the CCTR policy into the radiology workflow.(2) ANCR was implemented (integrated into physician workflow) at BWH beginning in January 2010, with increasing adoption over the next year. Evaluation of ANCR and development of an implementation toolkit was funded by AHRQ.(3)

Building an improved communication system addresses a key element in the care coordination model in that connectivity is encouraged in transition of care settings in a timely and effective information flow between providers – from inpatient to ambulatory care, from ED to ambulatory care, and between ambulatory providers (such as specialists and primary care providers). Recently Dalal, et al demonstrated that responsible inpatient and ambulatory providers are substantially more aware of the finalized results of tests pending at discharge and initiate subsequent action when automated notification systems are used; moreover, both inpatient and ambulatory providers reported a high degree of satisfaction with this approach.(9) We hypothesized that facilitating inclusion of follow-up testing recommendations in inpatient and ED discharge modules for critical imaging results would diminish the burden of remembering these necessary follow-ups, and promote patient safety in a timely and efficient manner.

### Setting

The project was based at the BWH Center for Evidence-Based Imaging (CEBI). BWH is a 750-bed urban adult quaternary referral academic medical center which performs more than 500,000 radiological procedures annually. Apart from the main hospital, participants included patients and clinicians in the ED and two associated off-site outpatient facilities.

### Study Population

Within the study site, all of the ordering clinicians and radiologists were participants. A waiver of informed consent for medical record review was granted by the BWH institutional review board for this HIPAA-compliant study. A random sample of radiology reports between July 2009 and June 2014 were included in evaluating documented communication of critical imaging findings through ANCR.

In addition, the hospital implemented an electronic inpatient discharge module in November 2011 and an ED discharge module in May 2012. All patients who were seen at the ED and inpatient services one year before (baseline) and after (intervention) implementation of these systems were included in the study. We selected all patients who received a chest or abdominal

CT scan as they are a common source of pulmonary nodules and renal masses discovered at imaging.

#### AHRQ Target Population

Baseline characteristics of the target population for this study include mean age of 60 years, and gender distribution with 45% female and 55% male. Racial distributions are as follows: White 59%, Black 7%, Asian 3%, Others 31%. A total of 7% of the study population were of Hispanic ethnicity. We included children between the ages of 18 and 21, elderly, patients in inner-city population, and those needing chronic care.

## **Methods:** (Study Design, Data Sources/Collection, Interventions, Measures, Limitations)

### Study Design

In a retrospective review to evaluate the impact of ANCR on reducing missed transmission of clinically significant imaging results, we performed a manual review of 42 randomly selected radiology reports semiannually from the second half of 2009 to the first half of 2014, for a total of 420 reports, from reports that had no documented communication between a radiologist and another care provider. We measure the proportion of reports with critical and clinically significant results among all radiology reports that did not contain documentation of communication.

In addition, in a before-after study design, we selected all patients who received a chest or abdominal CT scan as they are a common source of pulmonary nodules and renal masses discovered at imaging. Our cohort consisted of 22,079 and 22,670 inpatients in the baseline and intervention periods, respectively, and 23,757 and 26,234 ED patients in the baseline and intervention periods, respectively.

### Data Sources

The institutional radiology information system and the research patient data repository provided data for medical record review.

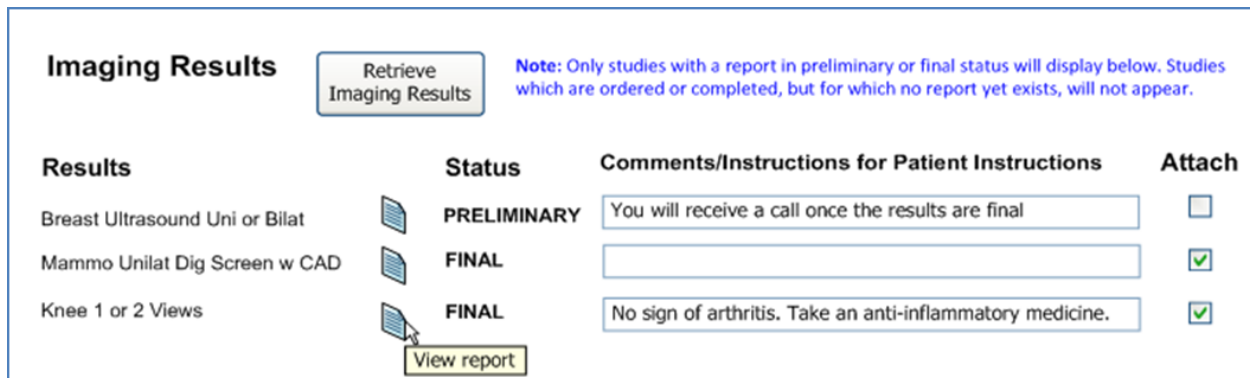
### Interventions

The health IT interventions included ANCR and discharge modules for both ED and inpatient settings. ANCR is an electronic alert notification system that facilitates communication of critical and clinically significant imaging results between the radiologist and referring physician. The radiologist uses ANCR when he/she identifies a critical and clinically significant result, and integration with the institution's picture archiving and communication system automates availability of patient and examination information for notifying another provider. We previously demonstrated that ANCR resulted in increased adherence to our critical result communication policy.<sup>(3)</sup> ANCR notifications are recorded in the official radiology reports, and document critical imaging findings. ANCR was implemented in January 2010.

The discharge modules for both ED and inpatient settings provided access to radiology reports, including critical findings and recommendations for follow-up management in radiology reports. The discharge modules and EHR conform to federal interoperability standards and are certified by the Certification Commission for Health Information Technology (CCHIT). The online modules, described previously,<sup>(10-12)</sup> enable physicians caring for patients in the ambulatory setting to access these recommendations after patients are discharged. The module for the ED was developed to replace a paper-based discharge instruction form.<sup>(10)</sup> An interdisciplinary team designed the system to improve the quality and completeness of discharge instructions, with particular attention to five specific elements—chief complaint or diagnosis, major procedures or tests performed, patient care instructions, follow-up instructions, and new/changed medications. The ED discharge module included the ability to include a list of imaging studies performed in the ED with free text comments entered by the ED provider. A copy of the finalized radiology reports, including the presence of nodules and follow-up recommendations, could also be optionally included for patients, with a single click (Fig. 1). These features make it easier for emergency physicians to summarize findings and provide follow-up recommendations. Recommendations for findings communicated through ANCR can

also be visible, when reports are added in the discharge module. The inpatient discharge module is available for all patients discharged from the hospital. It includes a section for discharge instructions, specifically "Instructions to PCP/Outpatient" at the bottom of the module.(12) Documentation of relevant data elements, including studies pending at discharge, was especially given priority during development. Integration with the radiology information systems enables full radiology reports to be included in the discharge summary. The two modules, although implemented separately, were both web-based and integrated with existing clinical information systems at the study institution.

Figure 1: Section in the Discharge Module to include Imaging Test Results and Recommendations



## Measures

An automated document retrieval toolkit, Information from Searching Content with an Ontology-Utilizing Toolkit (iSCOUT), was used to identify reports with no documented communication, defined as not containing terms that are related to 'communication' and the name of another care provider (e.g., ordering physician). Reports extracted through iSCOUT are then reviewed manually by two reviewers (a radiologist and an internist).

They adjudicated reports that contained critical and clinically significant results based on available documentation in the report of the test indication, clinical presentation and characteristics of the findings (i.e., whether new or unexpected). The semiannual proportion of reports containing critical and clinically significant results among those reports with no documented communication were analyzed for trend, from 2009 to 2014. Cochran–Armitage trend analysis was used to determine statistical significance.

Radiology reports for patients with lung nodules and renal masses were also identified using iSCOUT.(13) From patients with pulmonary nodules identified through iSCOUT, we included those who had findings that were reported in our critical results notification system, ANCR. Two researchers performed a manual review of a subset of radiology reports (i.e., identified through iSCOUT and ANCR) to document the presence and size of pulmonary nodules. Other factors collected in the study included the presence of radiologists' recommendations for follow-up, presence of discharging clinicians' recommendations for follow-up, imaging modality (e.g., chest CT scan), characteristics of the nodules/masses, and patient demographics. Descriptive statistics were calculated for patient demographics and key factors. Unadjusted analysis was performed using chisquare test to assess the impact of the discharge modules on pulmonary nodule and renal mass follow-up management. In addition, multivariate analysis was performed using logistic regression (R 3.2.2 software, Vienna, Austria).

## Limitations

This is a before-and-after study, and may not take into account trends in follow-up management due to secular trends. However, we did not expect any significant change in follow-up management of pulmonary nodules or renal masses during the study period. In addition, we did not evaluate patient comprehension of ED discharge instructions and we did not measure the impact on patient outcomes.



**Results:** (Principal Findings, Outcomes, Discussion, Conclusions, Significance, Implications)

### Principal Findings

Inpatient and ED discharge modules were implemented, and enabled inclusion of critical imaging test results, recommendations for follow-up management, and radiology reports designed to provide access for ambulatory providers. Implementation of this health IT intervention of web-based discharge modules in both inpatient and ED settings was associated with significantly improved follow-up management of patients with pulmonary nodules within one year after discharge. The increased follow-up persisted, even in a multivariable model that accounts for patient age, sex, race, nodule size, and documented recommendation for follow-up. No significant effect on renal mass follow-up was identified. However, univariate analysis revealed that the presence of an explicit radiologist recommendation was a significant predictor ( $p < 0.05$ ) for completion of the recommended follow-up examination.

### Outcomes

We published our findings highlighting the positive impact of ANCR on reducing missed transmission of clinically significant imaging results:

**Lacson R, O'Connor SD, Sahni VA, Roy C, Dalal A, Desai S, Khorasani R. Impact of an electronic alert notification system embedded in radiologists' workflow on closed-loop communication of critical results: a time series analysis. *BMJ Qual Saf.* 2015 Sep 15. pii: [bmjqs-2015-004276](#). doi: [10.1136/bmjqs-2015-004276](#). PMID: [26374896](#).**

The abstract is as follows:

#### Introduction

Optimal critical test result communication is a Joint Commission national patient safety goal and requires documentation of closed-loop communication among care providers in the medical record. Electronic alert notification systems can facilitate an auditable process for creating alerts for transmission and acknowledgement of critical test results. We evaluated the impact of a patient safety initiative with an alert notification system on reducing critical results lacking documented communication, and assessed potential overuse of the alerting system for communicating results.

#### Methods

We implemented an alert notification system—Alert Notification of Critical Results (ANCR)—in January 2010. We reviewed radiology reports finalised in 2009–2014 which lacked documented communication between the radiologist and another care provider, and assessed the impact of ANCR on the proportion of such reports with critical findings, using trend analysis over 10 semiannual time periods. To evaluate potential overuse of ANCR, we assessed the proportion of reports with non-critical results among provider-communicated reports.

#### Results

The proportion of reports with critical results among reports without documented communication decreased significantly over 4 years (2009–2014) from 0.19 to 0.05 ( $p < 0.0001$ , Cochran–Armitage trend test). The proportion of provider-communicated reports with non-critical results remained unchanged over time before and after ANCR implementation (0.20 to 0.15,  $p = 0.45$ , Cochran–Armitage trend test).

#### Conclusions

A patient safety initiative with an alert notification system reduced the proportion of critical results among reports lacking documented communication between care providers.

We subsequently documented increased documentation of follow-up recommendations in ED discharge instructions in an abstract presented in a Radiology research symposium. This paper has been recently submitted for publication.

**Lacson R, Gupta A, Silveira P, Haq S, Landman A, Khorasani R. Assessing Documentation of Critical Imaging Result Follow-up Recommendations in Emergency Department Discharge Instruction. The Brigham and Women's Hospital Annual Radiology Research Symposium, Boston MA, June 19, 2015.**

The abstract is as follows:

#### Objectives

To facilitate follow-up of critical test results across transitions in patient care settings, we implemented an electronic discharge module that enabled care providers to include follow-up recommendations in the discharge instructions. **Methods** We assessed the impact of this module on documentation of follow-up recommendations for critical imaging findings in Emergency Department (ED) discharge instructions. We studied 240 patients with critical imaging findings discharged from the ED before (n= 80) and after (n= 160) implementation of the module. We manually reviewed hand-written forms and electronic discharge instructions to determine if follow-up recommendations were documented.

#### Results

Follow-up recommendations in ED discharge instructions increased from 60.0% (48/80) to 73.8% (118/160) post-module implementation (p=0.03), a relative increase of 23%. There was no significant change in the rate of documented critical imaging findings in the discharge instructions (77.5% [62/80] before the intervention and 76.9% [123/160] after the intervention; p=0.91).

#### Conclusions

Implementation of a discharge module was associated with increased documentation of critical imaging finding follow-up recommendations in ED discharge instructions. However, one in four patients still did not receive adequate follow-up recommendations, suggesting further opportunities for performance improvement exist.

Finally, we document that an electronic discharge module is associated with improved follow-up management of patients with pulmonary nodules in the following paper.

**Lacson R, Desai S, Landman A, Proctor R, Sumption S, Khorasani R. Impact of a health information technology intervention on the follow-up management of pulmonary nodules. J Digit Imaging. 2017 Jun 29. doi: 10.1007/s10278-017-9989-y. [Epub ahead of print] PMID: 28664448.**

The abstract is as follows:

Lung cancer is the leading cause of cancer deaths in the USA. The most common abnormalities suspicious for lung cancer on CT scan include pulmonary nodules. Recommendations to improve care for patients with pulmonary nodules require follow-up management. However, transitions in care, especially for patients undergoing transitions to ambulatory care sites from the emergency department (ED) and inpatient settings, can exacerbate failures in follow-up testing and compromise patient safety. We evaluate the impact of a discharge module that includes follow-up recommendations for further management of pulmonary nodules on the study outcome and follow-up management of patients with pulmonary nodules within 1 year after discharge. After IRB approval, we collected data on all patients undergoing chest or abdominal CT exams over a 12-month baseline and 12-month intervention period at an academic medical center. The inpatient discharge module was implemented in November 2011; the ED module was implemented in May 2012. Multivariable logistic regression was performed to account for care setting, imaging modality, recommendations, and patient demographics. Implementation of a discharge module resulted in improved follow-up of patients with pulmonary nodules within 1 year after discharge (OR = 1.64,  $p = 0.01$ ); the ED implementation resulted in better follow-up compared to the inpatient module (OR = 2.24,  $p < 0.01$ ). Twenty-seven percent of patients with pulmonary nodules received follow-up management, which, although significantly improved from the 18% baseline, remains low. An electronic discharge module is associated with improved follow-up management of patients with pulmonary nodules, and may be combined with interventions to further improve management of these patients.

The impact of discharge modules in renal mass follow-up was less notable. The following abstract summarized these results:

**Introduction:** We evaluated the impact of a custom-developed electronic discharge instruction module integrated into our electronic health record (EHR) in improving communication of critical test results and corresponding follow-up recommendations in patients with renal masses/cysts. **Methods:** We performed a retrospective cohort before and after study in a single 793-bed urban academic medical center. For the purposes of narrowing this study, focus was placed on renal masses found on abdominal CT since they are relatively common and has published accepted guidelines for follow-up. The radiology administrative data repository was queried for all patients who were discharged from the hospital and

had an abdominal CT scan during the hospital encounter in the 1 year pre and post intervention periods, 2011 and 2013, respectively. We allowed for a 1-year acclimation period before assessing outcomes. Exclusion criteria included patients with known malignancy, deceased patients, and patients without a renal mass. The primary outcome is the rate of successful documentation of the incidental renal mass in the discharge summary. A secondary outcome is the rate of completion of the recommended follow-up exam.

**Results:** 120 CT exams met criteria above and were reviewed, 36 pre intervention and 84 post intervention. No significant effect was identified after the intervention in regards to the primary and secondary outcomes. Follow-up documentation remain unchanged from 39% pre-intervention to 49% post-intervention ( $p=0.43$ ), and follow-up completion was also unchanged from 33% to 27% ( $p=0.52$ ). However, univariate analysis did show that the presence of an explicit radiologist recommendation was a statistically significant predictor ( $p<0.05$ ) for both successful documentations in the discharge summary as well as completion of the recommended follow-up examination.

**Conclusion:** Explicit radiology follow-up recommendations for incidental findings, such as a renal mass on abdominal CT, are necessary for successful communication and completion of follow-

up exams. We failed to identify an effect of the custom-developed electronic discharge instruction module on completion of recommended follow-up exam.

## Discussion

Implementation of a health IT intervention of web-based discharge modules in both inpatient and ED settings was associated with significantly improved follow-up management of patients with pulmonary nodules. The increased follow-up persisted, even in a multivariable model that accounts for patient age, sex, race, nodule size, and documented recommendation for follow-up. Twenty-seven percent of patients with pulmonary nodules received either a follow-up imaging with a chest CT scan or a biopsy with corresponding pathologic report or cytology after module implementation. This percentage, although significantly improved from baseline, remains low, considering that majority of pulmonary nodules in the intervention cohort (51%) had nodule sizes above 4 mm for which Fleischner Society guidelines recommend follow-up management.(14)

No significant effect was identified after the intervention for renal mass follow-up. However, univariate analysis did show that the presence of an explicit radiologist recommendation was a statistically significant predictor ( $p < 0.05$ ) for both successful documentations in the discharge summary as well as completion of the recommended follow-up examination. Similar to results for follow-up of lung nodules, follow-up imaging was noted in only 27% of patients with renal masses after module implementation.

## Conclusion

Access to an electronic discharge module is associated with improved follow-up management after discharge of patients with pulmonary nodules discovered in the ED and inpatient settings. Future studies should focus on the impact of more intensive interventions, in addition to health IT implementation, to further improve follow-up of critical findings.

## Significance

Delays in communicating and performing critical test follow-up pose a significant threat to patient safety. We demonstrate that a health IT initiative (ANCR) reduced the proportion of critical results among reports lacking documented communication between care providers. This initiative achieved significant and sustainable improvement in documented communication of imaging results. Another health IT initiative (discharge module) subsequently documented increased documentation of follow-up recommendations. Finally, the combination of ANCR and discharge modules implemented in the ED and inpatient settings resulted in improved performance of follow-up recommendations for patients with pulmonary nodules.

## Implications

Health IT initiatives, when used in conjunction with other patient safety initiatives and incorporated into physicians' workflow, are crucial in helping enhance communication and completion of critical test result follow-up management. Implementation of follow-up procedures for managing critical test results upon communication is a national Joint Commission patient safety goal.

**List of Publications and Products:** (Bibliography of Published Works and Electronic Resources from Study—Use AHRQ Citation Style for Reference Lists).

Publications

1. ! Lacson R, O'Connor SD, Sahni VA, Roy C, Dalal A, Desai S, Khorasani R. Impact of an electronic alert notification system embedded in radiologists' workflow on closed-loop communication of critical results: a time series analysis. *BMJ Qual Saf*. 2015 Sep 15. pii: bmjqs-2015-004276. doi: 10.1136/bmjqs-2015-004276. PMID: 26374896.
2. ! Lacson R, Desai S, Landman A, Proctor R, Sumption S, Khorasani R. Impact of a health information technology intervention on the follow-up management of pulmonary nodules. *J Digit Imaging*. 2017 Jun 29. doi: 10.1007/s10278-017-9989-y. [Epub ahead of print] PMID: 28664448.

Abstract Presentation

1. ! Lacson R, Gupta A, Silveira P, Haq S, Landman A, Khorasani R. Assessing Documentation of Critical Imaging Result Follow-up Recommendations in Emergency Department Discharge Instruction. The Brigham and Women's Hospital Annual Radiology Research Symposium, Boston MA, June 19, 2015.

## References

1. The Joint Commission. National Patient Safety Goals 2013. 2013.
2. Lacson R, O'Connor SD, Andriole KP, Prevedello LM, Khorasani R. Automated critical test result notification system: architecture, design, and assessment of provider satisfaction. *AJR American journal of roentgenology*. 2014;203(5):W491-6.
3. Lacson R, Prevedello LM, Andriole KP, O'Connor SD, Roy C, Gandhi T, et al. Four-year impact of an alert notification system on closed-loop communication of critical test results. *AJR American journal of roentgenology*. 2014;203(5):933-8.
4. Singh H, Thomas EJ, Mani S, Sittig D, Arora H, Espadas D, et al. Timely follow-up of abnormal diagnostic imaging test results in an outpatient setting: are electronic medical records achieving their potential? *Archives of internal medicine*. 2009;169(17):1578-86.
5. Berlin L. Statute of limitations and the continuum of care doctrine. *AJR Am J Roentgenol*. 2001;177(5):1011-6.
6. Berlin L. Communicating findings of radiologic examinations: whither goest the radiologist's duty? *AJR American journal of roentgenology*. 2002;178(4):809-15.
7. Berlin L. Standards for radiology interpretation and reporting in the emergency setting. *PediatrRadiol*. 2008;38 Suppl 4:S639-S44.
8. Anthony SG, Prevedello LM, Damiano MM, Gandhi TK, Doubilet PM, Seltzer SE, et al. Impact of a 4-year quality improvement initiative to improve communication of critical imaging test results. *Radiology*. 2011;259(3):802-7.
9. Dalal AK, Roy CL, Poon EG, Williams DH, Nolido N, Yoon C, et al. Impact of an automated email notification system for results of tests pending at discharge: a cluster-randomized controlled trial. *Journal of the American Medical Informatics Association : JAMIA*. 2014;21(3):473-80.
10. Bell EJ, Takhar SS, Beloff JR, Schuur JD, Landman AB. Information technology improves Emergency Department patient discharge instructions completeness and performance on a national quality measure: a quasi-experimental study. *Appl Clin Inform*. 2013;4(4):499-514.
11. Mueller SK, Giannelli K, Boxer R, Schnipper JL. Readability of patient discharge instructions with and without the use of electronically available disease-specific templates. *Journal of the American Medical Informatics Association : JAMIA*. 2015;22(4):857-63.
12. Boxer R NN, Soukup J, Minahan J, Pelletier C, Cardito M, Joyce J, Welsh D, Poon E, Carty M, Miller A, Schnipper J, editor Impact of a Web-Based Discharge Module on Timeliness and Quality of Discharge Documentation [abstract]. Society of Hospital Medicine Annual Meeting; 2013; Las Vegas, NV: *Journal of Hospital Medicine*.
13. Lacson R, Andriole KP, Prevedello LM, Khorasani R. Information from Searching Content with an Ontology-Utilizing Toolkit (iSCOUT). *Journal of digital imaging*. 2012;25(4):512-9.
14. MacMahon H. Compliance with Fleischner Society guidelines for management of lung nodules: lessons and opportunities. *Radiology*. 2010;255(1):14-5.