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ORIGINAL ARTICLE

The fate of radiology report recommendations at a pediatric medical center

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Abstract
Background The American College of Radiology (ACR) practice parameters for communication dictate that follow-up recommendations be suggested when appropriate. Radiologists assume that referring physicians read their reports and heed their advice. In reality, recommendations might not be carried out or even acknowledged.
Objective We aimed to determine the proportion of imaging recommendations that are acknowledged and acted upon.
Materials and methods We conducted a retrospective review of all consecutive radiology reports containing "recommend" in the impression at a single academic children's hospital over a 1-month period. We documented point of care (emergency department, inpatient, outpatient), study type, recommendation wording, and communication method (report only or direct verbal). We reviewed medical records to ascertain whether the recommendations were acknowledged or executed. We used chi-square tests to evaluate associations between variables. $P<0.05$ was considered significant.
Results We reviewed 526 reports and excluded 73. We included the remaining 453 reports, from 370 unique patients (201 male, 169 female). Inpatients comprised most reports (n=223), followed by emergency department (ED) patients (n=118) and outpatients (n=112). Among these reports, 69% (n=313) of recommendations were executed. Of the 140 recommendations not carried out, 14% were acknowledged in clinical notes. Compliance correlated with point of care (ED>inpatient>outpatient; P=0.001) but not with additional verbal communication (P=0.33), study type (radiograph vs. other; P=0.35) or type of follow-up recommendation (follow-up imaging vs. other; P=0.99).
Conclusion Nearly one-third of radiology report follow-up recommendations are not executed. Recommendations are most commonly neglected for outpatient imaging reports. The radiology community should take steps to improve recommendation adherence.

Keywords Children · Follow-up · Radiology · Recommendations · Reporting

Introduction

The radiology report is a multipurpose document that serves as the primary method of communication between radiologists and referrers [1, 2]. Foremost, it represents the culmination of image acquisition and human interpretation [3]. Implicit is that pathology is extracted from the images and that the interpreted importance of these findings is explained and emphasized. Beyond these fundamental expectations is that clinical and imaging follow-up recommendations be explicitly stated, if necessary, in order to address imaging uncertainties, confirm or disconfirm a suspected diagnosis, narrow the differential diagnosis, and inform the ordering physician about the next step in management or surveillance. This principle stands in accordance with the American College of Radiology (ACR) practice parameters for communication of imaging findings, which advise that recommendations for follow-up and additional studies be suggested when appropriate [4]. Because live

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interactions between radiologists and clinicians have become less frequent, radiology reports play an increasingly critical role in the communication of information [5, 6].

Previous literature has demonstrated that follow-up imaging recommendations in radiology reports range 8–37% [7–12]. Report recommendations and follow-up compliance are often discordant [7, 9, 12–15]. Recommendations must be viewed and acted on as suggested to be of value. With the exception of breast imaging, most radiology specialties do not routinely perform audits on follow-up compliance. In this cross-sectional study, we aimed to determine the proportion of report recommendations at an academic children's hospital that are acknowledged and acted upon.

Materials and methods

We conducted a retrospective review of all consecutive radiology reports containing "recommend" in the impression section; we used Montage (Montage Healthcare Systems, Philadelphia, PA) at a single stand-alone academic children's hospital over a 1-month period (May 1, 2016, to June 1, 2016) after receiving an institutional review board waiver. The data collection time range was specifically chosen to be both close enough to present time to be temporally relevant but far enough in the past to mitigate any effect of incomplete follow-up data. Montage is a radiology report data-mining system that can find all reports containing specific keywords and derivations thereof with perfect accuracy — in this case the keywords were "recommend" and "recommendation." A board-certified radiologist (M.T.W., 6 years of post-fellowship experience) also manually reviewed each radiology report to ensure concordance.

We documented point-of-care location (emergency department, inpatient, outpatient), study type (modality and location), follow-up recommendation (follow-up imaging vs. other), and communication method (report or telephone/direct). Communication method was considered direct if there was documentation of physician contact in the imaging report; otherwise, it was assumed that the report itself was the only means of information transfer. We reviewed the electronic medical record (EMR) in each case for up to 1 year beyond the time of imaging to ascertain whether the recommendations were acknowledged or executed. There were no time-specific recommendations that fell outside this time range.

Although authors of medical notes at our institution include trainees, physician extenders, and attending physicians, all final EMR notes are ultimately revised (if necessary), acknowledged, and signed off as final reports by attending physicians. It was these final reports that we used for analysis; therefore, any initial discrepancies in medical notes among trainees, physician extenders, and attending physicians were null. We assessed whether "clinical correlation" was achieved, to the greatest extent possible, by examining each subsequent EMR note following the imaging exam for the documented presence of all specific recommended correlations (e.g., "correlate for point tenderness" — physical examination of the region of interest). More general recommendations (e.g., "correlate clinically") were assumed to be done if the medical history and physical exam of the imaged body part was documented in subsequent EMR notes. We excluded cases that lacked concurrent and follow-up clinical notes in our electronic medical record. We also excluded cases that did not contain "recommend" in the impression section of the report because referring physicians might not read the findings section [16]. Furthermore, it has been shown that referring clinicians feel more obliged to follow recommendations set apart from other parts of the report [17]. We used chi-square tests to evaluate potential associations between categorical variables. $P<0.05$ was considered significant.

Results

A total of 526 of 11,751 (4.5%) reports contained the term "recommend." We excluded 73 of these 526 studies for lack of corresponding clinical information in the electronic medical record or absence of "recommend" in the impression section. We reviewed 453 reports from 370 unique patients (201 male, 169 female), with a mean age of 5±6 years (range 0–22 years). Inpatients comprised the bulk of the reports (n=223), followed by emergency department patients (n=118) and outpatients (n=112).

Sixty-nine percent (n=313) of recommendations were executed. Of the 140 recommendations that were not carried out, just 14% (19/140) were acknowledged in clinical notes, whereas 67% (209/313) of executed recommendations were acknowledged ($P<0.001$). Non-executed recommendations comprised several categories, including: (1) Follow-up (time-specific) — same imaging modality; (2) follow-up (not otherwise specified) — same imaging modality; (3) follow-up as clinically indicated — same imaging modality; (4) follow-up with a different imaging modality or view; (5) action (line/tube reposition); (6) attention to a specific imaging area or detail on follow-up; (7) clinical, physical or lab correlation; or (8) subspecialty consultation (Table 1). In most of these cases (80/140), the ultimate outcome was unknown. Clinical observation (n=29, 21%), treatment (n=8, 6%) or follow-up with an imaging modality different from that recommended (n=3, 2%) were elected as alternatives to the recommendations in the radiology report in some of these cases. Four cases had documented adverse or detrimental outcomes including progressive pulmonary edema, development of bowel obstruction, development of necrotizing enterocolitis and progressive peritoneal metastases (Table 1). Neither the type nor the strength of recommendation correlated with

Table 1 Radiologist report recommendations and their outcomes

Recommendation type	Done	Not done	No change	Line/tube removed	Med/surg treatment	Clinical observation	FU[a] other modality	Outcome unknown	Detrimental outcome[b]
Follow-up (time-specific) *Same modality*	31	19	0	0	0	11	0	5	3
Follow-up (general) *Same modality*	48	24	0	0	3	3	0	18	0
Follow-up as clinically indicated *Same modality*	7	0	0	0	0	0	0	0	0
Other imaging exam or view	105	51	0	0	5	4	3	39	0
Action (line/tube reposition)	43	14	10	4	0	0	0	0	0
Attention on follow-up	17	11	2	0	0	8	0	0	1
Clinical, physical or lab correlation	52	19	0	0	0	3	0	16	0
Subspecialty consultation	10	2	0	0	0	0	0	2	0
Total	313	140	12	4	8	29	3	80	4

FU follow-up, *med* medical, *surg* surgical

[a] Follow-up imaging performed was different from what was recommended

[b] Including progressive pulmonary edema, development of bowel obstruction, development of necrotizing enterocolitis and progressive peritoneal metastases

whether the recommendation was carried out (P=0.295). Non-executed, non-acknowledged recommendations included follow-up, time-specific (n=18); follow-up, general (n=19); follow-up with a different imaging modality or view (n=39); action (line/tube reposition; n=14); attention to a specific imaging area or detail on follow-up (n=11); clinical, physical or lab correlation (n=18); or subspecialty consultation (n=2).

Recommendation compliance correlated with point of care (ED>inpatient>outpatient; P=0.001) but not with communication type (report only vs. direct verbal/telephone; P=0.18), study type (radiograph vs. other; P=0.51) or type of follow-up action (imaging vs. other; P=0.23). Details are described in Table 2.

Discussion

The majority of radiology report recommendations are acted upon; however a sizeable minority of radiology report recommendations are not followed or acknowledged by clinicians. Point of care was the only variable found to be associated with execution of recommendations, with compliance likelihood in the following descending order: emergency department, inpatient and outpatient. Neither study type, nor communication type, nor type of follow-up action recommendation significantly affected recommendation achievement.

Imaging plays a critical role in modern medicine. A single radiologic study is sometimes enough to make a confident

Table 2 Proportion of acknowledged (A) and executed (E) radiology report recommendations, classified by variable

Variable	A+/E+	A−/E+	A+/E-	A−/E-	TOTAL	E+ Total	E- Total	P*
Emergency department	73	14	9	20	116	87	29	*0.001*
Inpatient	98	66	5	56	225	164	61	
Outpatient	40	22	6	44	112	62	50	
Direct communication	76	32	10	46	164	108	56	0.33
Report	133	70	10	76	289	203	86	
Radiograph	131	67	12	71	281	198	83	0.35
Other	79	35	9	49	172	114	58	
Follow-up imaging	125	63	19	80	287	188	99	0.99
Other	85	39	1	45	170	124	46	

A+ acknowledged, *A*- not acknowledged, *E*+ executed, *E*- not executed

*The likelihood of recommendation compliance correlated with point of care (emergency department>inpatient>outpatient; P=0.001) but not with type of communication (report vs. direct; P=0.18), study type (radiograph vs. other; P=0.51) or follow-up recommendation (follow-up imaging vs. other; P=0.23). P<0.05 was considered significant

diagnosis, but more commonly it is one of several components requisite to the diagnosis and clinical care of the patient. Most imaging modalities create images that are mere visual representations of body parts at one or more points in time. They lack clinical data that can be gleaned only from the patient's history, physical examination and other non-imaging medical tests. Recommendations may be useful in clarification or confirmation of an indeterminate imaging finding, temporal assessment of an abnormality, or to provide follow-up guidance based on the findings [4, 7, 11, 18]. ACR guidelines encourage the use of recommendations [4]. Furthermore, most clinicians prefer the inclusion of report recommendations *when appropriate* [3, 18, 19].

In recent years, follow-up imaging recommendations in radiology reports have more than doubled [11]. This growth has coincided with the implementation of picture archiving and communication systems (PACS), so it has been postulated that this growth in recommendations is a result of fewer direct discussions [11, 18]. Increasing follow-up recommendations could also be attributable to improved imaging equipment and display, increasing malpractice concerns or changes in reporting practices [11]. Radiology reports are more likely to contain recommendations (1) in older patients, (2) if there are positive findings and (3) if the point of care is the emergency department [10, 11]. Studies in adult populations have shown a radiology report follow-up recommendation prevalence of 8–37% [7–11]. Because only a small minority (4–5%) of high-cost imaging exams have had a prior imaging report recommending the need for follow-up, it may be that follow-up imaging is not undertaken in many cases [20]. This might be a result of clinician ignorance to the existence or significance of a recommendation, lack of indication based on clinical factors, ambiguity of duty, patient refusal, lack of medical insurance coverage, or treatment or alternative diagnostic exams in lieu of follow-up imaging [7, 10, 11, 14]. It also raises questions of whether and to what extent referring clinicians are reading radiology reports and following up on recommendations. Although the incidence of pediatric radiology report recommendations has not been documented in the literature, the 5% prevalence we describe herein is below the 8–37% range documented in the adult literature. To some extent, this might be attributable to population differences because children generally harbor fewer incidental findings.

A number of factors influence the type and frequency of recommendations issued by the interpreting radiologist. These include personal characteristics of the reader (experience, training, personality), knowledge of existing literature guidelines, degree of diagnostic confidence, fear of litigation, and environmental practice patterns [11, 18]. Younger radiologists tend to make recommendations more frequently, perhaps because of either inexperience or heightened awareness of newer follow-up imaging techniques to help problem-solve [11, 18]. In any case, recommendations can sometimes be avoided if chronic stability can be ensured using remote comparison exams [21].

Researchers have demonstrated that report recommendations and actions are not always concordant. This is a multifactorial problem. Both patient and physician compliance are necessary for successful follow-up. Ultimately the decision to comply with or dismiss the recommendation is made by the referring physician and his or her consultants. Factors that have been cited to influence follow-up compliance in the adult population include health care access, health literacy, demographic variables, distance one lives from the hospital, recommended follow-up time frame, and seniority of ordering emergency department physician [7]. In one study, 50% of clinical and imaging follow-up recommendations in emergency department radiology reports were ultimately followed, more commonly those that were non-imaging and that proposed a shorter follow-up timeline [7]. This might have been a result of immediate access to follow-up tests or perceived relative urgency [7]. Our study demonstrates similar findings: recommendations were most likely to be carried out on patients in the emergency department. Baumgarten and Nelson [9] found that just 31% of follow-up imaging recommendations from abdominal CT reports were acted upon. Wickramarachchi and colleagues [13] found that only approximately 23% of recommendations for further imaging, consultation or biochemical assessment of incidental adrenal adenomas were followed. In a different study, only 19% of incidental thyroid nodules reported in the impressions of CT and MRI reports underwent further evaluation, with nodule size and patient age being variables that influenced whether workup was undertaken [12]. At U.S. Department of Veterans Affairs facilities, follow-up imaging recommendations were found to be less often followed than non-imaging recommendations within 4 weeks after the report was issued, supporting the need for improved monitoring and tracking safeguards [14]. In another study, timely follow-up of outpatient radiology report recommendations was not achieved in 8%, possibly contributing to adverse outcomes because these were considered clinically important for diagnosis and treatment [15]. Our study showed definitive adverse or detrimental outcomes in four cases and an unknown outcome in 56% of the 140 unexecuted recommendations.

We also found that only 14% of follow-up noncompliant cases had acknowledgment of the radiology report recommendation in a subsequent corresponding clinic note. In the other 86% of these cases, it is unclear whether the recommendation was even seen and understood by the clinician, let alone the patient. This perhaps is the bigger problem. If the clinician has digested the information from the imaging study and made a conscientious decision not to follow the recommendation, that might be a different problem altogether.

Insufficient communication is often cited as a factor for lack of follow-up [15, 22–25]. However, contrary to previous

literature [15], we found no significant differences in the likelihood of recommendation compliance with additional verbal communication to the ordering physician or provider. Although emergent or unexpected findings and secondary recommendations require higher-order communication [4], workload constraints prohibit the direct communication of non-emergent and expected imaging findings in most instances. In contradistinction to previous literature [13], we found that recommendations were more likely to be carried out if the clinician acknowledged them in the electronic medical record.

Communication is the cornerstone of excellent health care delivery. Although there is some intradepartmental variability among our radiologists, in general we believe that the onus is on the radiologist to ensure that an accurate exam interpretation is both delivered and comprehensively understood by the referring clinician. In certain circumstances, such as when time-sensitive or life-threatening pathology is encountered on imaging, this means that we must go beyond the basic call of duty by using a secondary form of communication to explain the findings including telephone, text page, closed-circuit email or face-to-face discussion. When imaging findings are more ambiguous, the ordering physician is often in a better position to decide whether the radiologist's recommendations are sensible and warranted based on history, physical exam findings and laboratory findings. We speculate that adult and pediatric health care practices differ in terms of radiology recommendation adherence, but no current literature exists that establishes the nature of these potential differences. We suspect that pediatricians and pediatric subspecialists might be more communicative with radiologists and more likely to read reports, but this is at best a gross anecdotal generalization that most certainly varies from person to person and among institutions.

Reports with recommendations are more likely to trigger action than reports without recommendations [13]. Diction might influence compliance. Some words and phrases are perceived differently among radiologists and clinicians [6, 26]. Firm recommendations might be more influential than ambiguous language with qualifiers such as the phrase "consider follow-up as clinically indicated" [3]. Clinicians generally feel obliged to follow report recommendations if they are stated outright but feel less obliged to do so if the recommendations are modified by qualifying statements such as "if clinically indicated" [3, 17]. In general, radiologists and clinicians tend to agree that following words and phrases convey the strength of the radiologist's recommendation in the following descending order from strongest to weakest: "recommend," "advise," "consider" and "follow-up as clinically indicated" [6].

One potential solution to increase recommendation compliance would be the adoption of an enhanced radiology report template that provides personalized recommendations to direct clinicians on the need for and timing of follow-up imaging based on current guidelines [27]. Sample enhanced reports were not only viewed more favorably than traditional reports, but also improved anticipated follow-up compliance. Electronic decision support is another option to guide radiology recommendations, improve consistency and reduce unnecessary imaging follow-up [28]. However, this would be predicated on the refinement and expansion of consensus follow-up imaging guidelines. Guidelines would serve to enhance patient care and decrease inter-reader variability in recommendations. The latter would ostensibly improve the perception of radiologists among clinicians and facilitate research [28]. Many clinicians are overwhelmed by the sheer volume of test results that require review, action and patient follow-up to ensure that recommendations are carried out [17, 24]. Delayed interpretation, delivery and reception can compound the problem. Therefore improved test results alert systems and management systems are needed [24, 29]. Electronic notifications might improve follow-up compliance [15, 29], whether or not alerts are acknowledged [15].

There are several limitations to this study. We determined the recommendation follow-up rates retrospectively from reporting data that occurred over a 1-month span. Although a longer collection period could have altered our results, we believe that the sample size was sufficient for the purposes of this study. Future studies with larger data sets would be useful for confirmation. Second, we only evaluated cases with reports containing "recommend" in the impression because these have been shown to be more likely to garner attention and trigger action [12]. Third, we do not have a standard recommendation template at our institution; we did not account for recommendations outside the impression section and did not evaluate other action words such as "advise" and "suggest." However, we previously demonstrated that most radiologists and clinicians agree that "recommend" is a stronger term and more likely to influence action than "advise" or "suggest" [6]. Nonetheless, because we do not have a standard recommendation template at our institution, it is likely that some reports containing recommendations expressed by terms other than "recommend" were not captured in our search. Fourth, all recommendations were assumed to be appropriate; however, radiologist error and practice patterns, comorbid conditions, financial constraints and clinical judgment were not considered. We did not poll the referring providers as to whether they thought the recommendations were accurate or warranted. On the other hand, we were unable to conclude whether any of the recommendations would have been carried out regardless of whether the report contained a recommendation. We also assumed that any and all verbal discussion of recommendations were documented; while this cannot be verified, there were no significant differences between actions induced by report recommendations with and without direct communications. Finally, we were unable to capture which patients chose to have follow-up elsewhere. It is possible that some patients deemed to have not undergone follow-up actually had the recommendation performed at an outside institution.

Conclusion

Most (69%) pediatric radiology report recommendations are carried out; however nearly one-third of radiology report recommendations are not executed. Additional verbal communication did not significantly increase the compliance rate of follow-up recommendations. The radiology community should be wary of these findings and take steps to improve adherence to recommendations.

Compliance with ethical standards

Conflicts of interest None

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