Design and perceived value of a novel solution for asynchronous communication in radiology

Sevenster, M.; Hergaarden, K.; Hertgers, O.; Nguyen, D.; Wijn, V.; Vlachomitrou, A.S.; ... ; Lamb, H.J.

Current Problems in Diagnostic Radiology 53 (2024) 96–101

Current Problems in Diagnostic Radiology

journal homepage: www.cpdrjournal.com

Design and Perceived Value of a Novel Solution for Asynchronous Communication in Radiology

Merlijn Sevenster[a,b,#,*], Kenneth Hergaarden[b,#], Omar Hertgers[b], Duc Nguyen[a], Victor Wijn[a], Anna S. Vlachomitrou[a], Sandra Vosbergen[a], Hildo J. Lamb[b]

[a] Royal Philips Electronics, High Tech Campus 34, 5656AA Eindhoven, the Netherlands
[b] Leiden University Medical Center, Albinusdreef 2, 2333ZA Leiden, the Netherlands

A B S T R A C T

Rationale and Objectives: Communication with and within the Radiology Department is typically initiated over phone, face-to-face or general-purpose chat, causing frequent interruptions, additional mental workload, workflow inefficiencies and diagnostic errors. We developed and evaluated a new communication solution that aims to reduce avoidable interruptions caused by technologist-radiologist communication.
Materials and Methods: Following an iterative design process with future end users, a scalable web-based software solution, RadConnect, was developed enabling a chat-based communication workflow between a technologist and a radiologist. As a first experimental implementation, technologists can send categorized tickets to a radiology section account. Radiologists receive the tickets in a worklist that is prioritized by urgency. Consented radiologists and technologists performed scripted tasks in 2 hr sessions and completed a structured questionnaire on perceived value and comparison to standard communication modes.
Results: Of 17 participants from three academic European institutes, 65% (11/17) believed they would use RadConnect frequently; 53% (9/17) believed that it reduces phone calls >80%; and 88% (15/17) believed it adds value compared to general-purpose enterprise chat applications.
Discussion: Participants recognized the value of RadConnect especially its categorized tickets, prioritized worklist and role-based interaction model. Inter-institute differences in perceived value of RadConnect may have been caused by technologist-radiologist proximity and communication alternatives in the institutions.
Conclusion: Chat-based role-based communication might be a viable mode of communication between technologists and radiologists to reduce avoidable interruptions. Tailoring the chat solution to the needs of and tightly integrated with the radiology workflow is valued by future end users after exposure to the tool in a simulated environment.

Introduction

Radiologists play a critical role in the imaging value chain by interpreting medical images in the context of patient information, but they also support stakeholders, such as referring physicians and technologists. These stakeholders often expect prompt and well-informed responses when they reach out to the Radiology Department.[1] To meet these expectations, radiologists must balance their primary medical responsibilities with stakeholder consultations.[2,3]

At many institutions, communication with and within the Radiology Department is done through personal conversations, which are typically initiated by phone call or by physically walking over to the radiologist. These synchronous conversations cause interruptions that require radiologists to pause their current activities and shift their attention to the question at hand[4]. These interruptions are frequent,[5,6,7] cause additional mental workload and have been associated with decreased efficiency[8] and diagnostic accuracy.[9,10,11] General-purpose chat applications are also used, even though they are not optimized for use in healthcare, let alone radiology, potentially leading to unsafe situations caused by patient identity mix-up.[12]

In this study, we develop a new and safe communication solution that aims to reduce avoidable interruptions caused by technologist-radiologist communication, by involving them in the iterative software design process. We report on the design and perceived value of the developed solution by means of a scripted usability study and questionnaire. The study was conducted with participants from three academic hospitals in Europe.

Methods

The study was performed under a study protocol (ICBE-S-000556) that was approved by the Internal Committee for Biomedical Experiments of Royal Philips (Amsterdam, The Netherlands).

Design and Development

Communication challenges were discussed with radiologists and technologists from Institution 1, an academic single-site

*Corresponding author.
E-mail address: merlijn.sevenster@philips.com (M. Sevenster).
#Authors contributed equally to the work.

https://doi.org/10.1067/j.cpradiol.2023.10.008
0363-0188/

hospital in Leiden, The Netherlands. The aim was to develop a "minimally viable prototype", a software prototype that contains just enough features so that it can be tested safely in clinical practice. A clickable demonstrator was created and exposed to the radiologists and technologists to gather their feedback. Advantages and risks associated with the use of the clickable demonstrator in clinical practice were discussed. A next version of the clickable demonstrator was then created to improve the user interface and address potential risks.

A web-based software solution was developed based on the final clickable demonstrator, RadConnect. The solution enables an end-to-end communication workflow between a technologist and a radiologist.

Usability Study and Questionnaire

Participating radiologists and technologists signed an informed consent form. Participants were instructed to perform tasks in RadConnect that are typical for their professional profile according to a script that was prepared before the usability study. For instance, technologist participants were asked to request radiologist support for inspection of a suspicious finding in a scan while the patient occupies the scanner. Radiologist participants were asked to accept an incoming consultation request and respond to it. One researcher (S.V.) facilitated each session following the script, while another (D.N., V.W.) acted as the participant's communication counterpart. Both researchers observed the session and made notes. Afterwards, participants completed a questionnaire on the perceived value of RadConnect with responses on a five-point Likert scale. A semi-structured interview was conducted that was recorded and analyzed (S.V.). Feedback on usability and perceived value were transcribed and tabulated.

The interviews were conducted at and with participants employed by three urban academic hospitals in Western Europe: Institution 1 in Leiden, The Netherlands; Institution 2 in Lyon, France; and Institution 3 in London, UK. Employees of Institution 1, a single-site hospital, that were involved in the design and development of RadConnect, were not involved in the usability study. Institutions 2 and 3 are multi-site hospitals. Interviews with participants from Institution 1 were held in Dutch, while interviews with participants from Institutions 2 and 3 were held in English. A French native speaker was present during the sessions in France to provide translation when necessary. Quotations from Dutch and French speaking participants are presented in English.

Results

Radconnect

RadConnect is a web-based software solution that allows a technologist to request a consultation with a radiologist by filling out a form ("ticket") with pre-determined question categories and associated pre-written editable question statements, see Fig. 1. The technologist can indicate the urgency of the request and provide context by indicating if the question pertains to a patient currently in the acquisition room. They can also select the recipient subspecialty section, such as neuro or thorax, and there is no need to enter a specific recipient radiologist. A presence indicator reflects if at least one radiologist from the targeted section is active in RadConnect. The radiologists that are active in

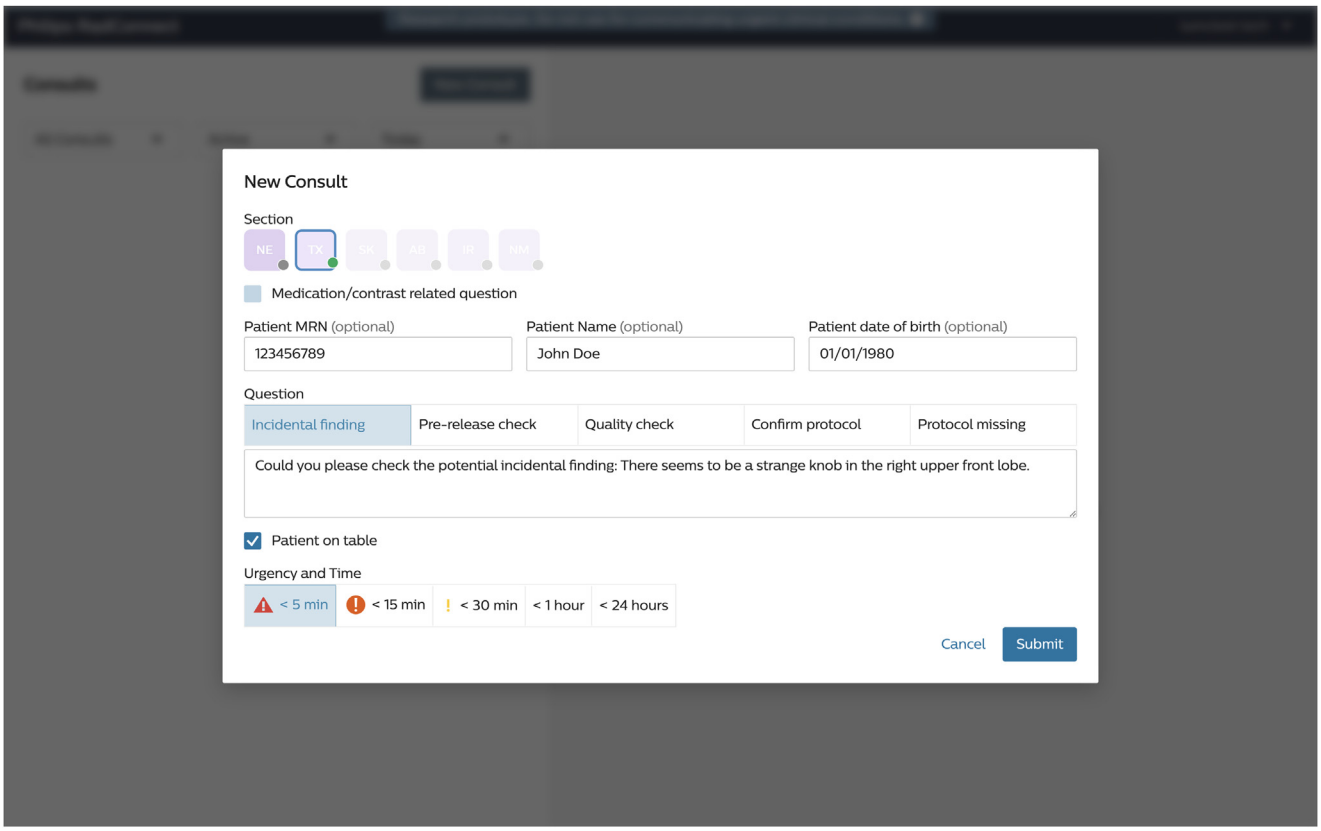

FIG. 1. Ticket interface in which the technologist can capture a consultation request for a radiologist. In this example, the technologist prepares a request for the thorax section ("TX") that has a green presence circle, indicating that a thorax radiologist is using RadConnect. The technologist has a question about a potential incidental finding and requests a response within 5 min. The patient is on the table.

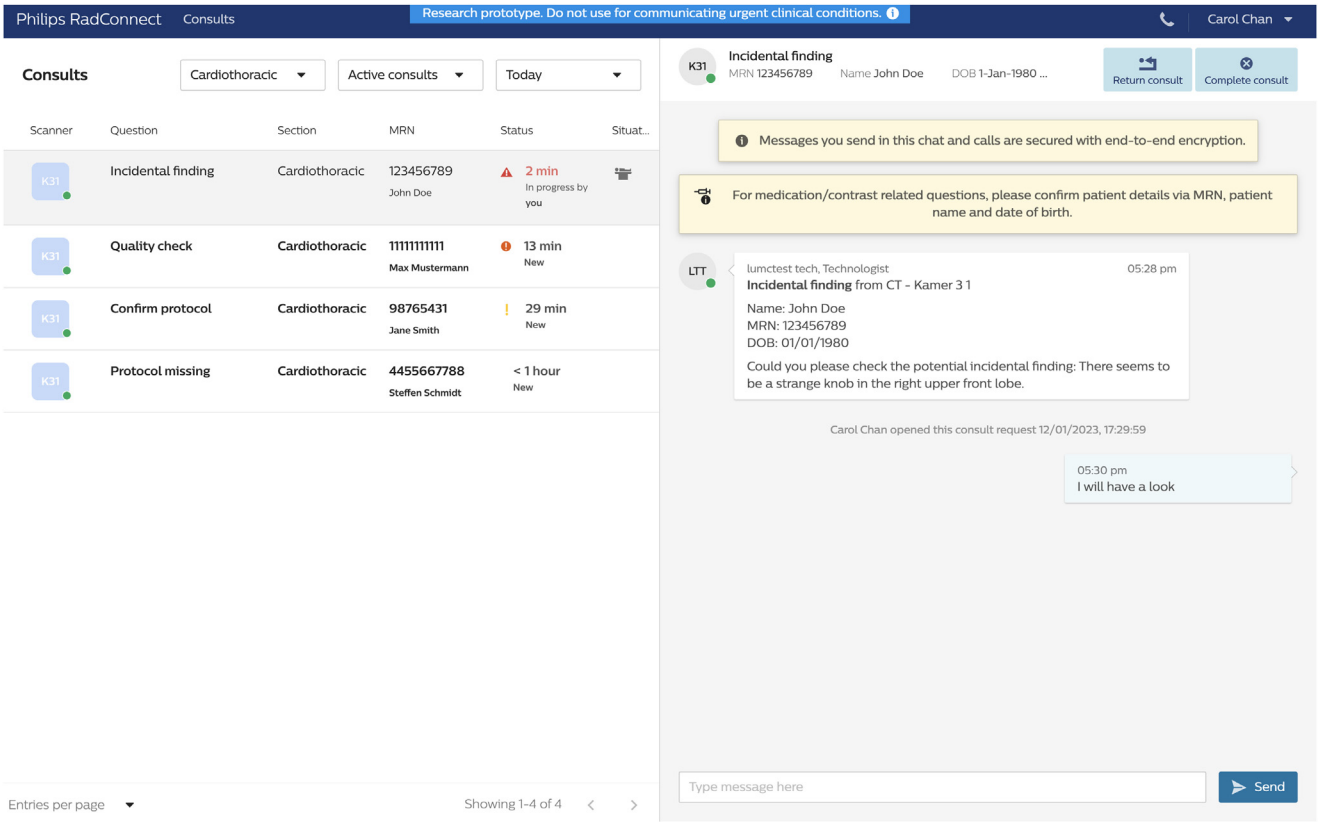

FIG. 2. The radiologist worklist is shown on the left, filtered by thorax tickets. The worklist has one ticket in progress and three pending tickets. The exclamation marks indicate the urgency as determined by the technologist. The time indicators are set at the requested response time and count down as time passes. The right side shows a chat channel where the radiologist can send and receive chat messages. Multiple chat channels can be active at the same time. Patient and user information in this illustration is synthetic.

RadConnect play the role of on-call radiologist for their section, hence "role-based".

The ticket has fields for entering patient identifying information, which are optional but mandatory when the questions are related to medication or contrast use to reduce the risk of patient identity mix-up.

Every radiologist user has a personal account that contains the radiologist's subspecialty section(s). Submitted tickets appear on the radiologist worklist, which can be filtered by section, see Fig. 2. By default, the radiologist worklist is filtered so that only tickets are shown that were sent to the radiologist's section, but the filter can be adapted to show all tickets.

The radiologist worklist is prioritized by ticket urgency. Time to requested response time counts down in the worklist user interface, visually marking tickets that are overdue.

The radiologist clicks a ticket to open it, creating a chat channel between the radiologist and the technologist in which they can send text messages back and forth. When the question has been answered satisfactorily, either user can complete the ticket. Completed tickets disappear from the worklist but remain accessible. Chat content (of in-progress or completed tickets) is accessible to users that did not engage in the chat themselves, as the contents might be relevant for other staff.

Usability Study and Questionnaire

A total of 17 participants agreed to take part in the study, of which 8 radiologists and 9 technologists (called radiographers in the UK). Eight participants were employed by Institution 1, five by Institution 2 and four by Institution 3. All participants were able to complete the usability script, questionnaire and structured interview within the allotted time slot.

Out of the participants, 65% (11/17) indicated that they would like to use RadConnect frequently and the same percentage believed it would help them in their daily workflow, see Table 1. A small majority of participants (53%, 9/17) agreed that RadConnect reduces phone traffic >80%. A majority would prefer to use RadConnect for protocolling questions (94%, 16/17) and image quality review questions (65%, 11/17) instead of the phone.

Participants (88%, 15/17) believed RadConnect has added value compared to general-purpose chat solutions. Only one participant (6%, 1/16) was concerned that RadConnect would be a new source of interruptions.

Participants from Institution 1 more strongly agreed that they would use RadConnect often compared to the other Institutions: 4.5 versus 2.8 (Institution 2) and 3.5 (Institution 3). Participants from Institution 1 also believed more strongly that it would reduce phone calls >80%.

Discussion

Radconnect

RadConnect has three features that differentiates it from general-purpose enterprise chat solutions, like Zoom (Zoom Video Communications, San Jose, US), Teams and Skype (both Microsoft, Seattle, US). First, the radiologist worklist prioritizes tickets by urgency level to differentiate between questions that need immediate versus those that do not. Many questions, e.g., missing protocols, do not require an instant response. In the questionnaire,

TABLE 1
Distribution of responses to the questionnaire by the 17 participants, and average responses for all participants and by Institution. Average scores were computed using 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree. One participant did not respond to two questions.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Average all	Average Institution 1	Average Institution 2	Average Institution 3
I think that I would like to use RadConnect frequently	6% (1/17)	12% (2/17)	18% (3/17)	29% (5/17)	35% (6/17)	3.8	4.5	2.8	3.5
I expect that RadConnect will support me in my daily work	0% (0/17)	6% (1/17)	29% (5/17)	47% (8/17)	18% (3/17)	3.8	4.3	3.4	3.3
I expect that by implementing RadConnect more than 80% of phone calls will be avoided	0% (0/17)	29% (5/17)	18% (3/17)	29% (5/17)	24% (4/17)	3.5	4.3	2.6	3.0
I would prefer asking questions and/or being consulted via RadConnect than via the phone for questions related to protocolling	0% (0/17)	0% (0/17)	6% (1/17)	41% (7/17)	53% (9/17)	4.5	4.9	4.4	3.8
I would prefer asking questions and/or being consulted via RadConnect than via the phone for questions related to image quality review	12% (2/16)	8% (1/16)	12% (2/16)	44% (7/16)	25% (4/16)	3.6	3.8	3.2	4.0
I expect that RadConnect will help me to answer questions faster than over the phone/get an answer to my questions faster	0% (0/17)	12% (2/17)	47% (8/17)	24% (4/17)	18% (3/17)	3.5	3.5	3.4	3.5
I believe that RadConnect has added value compared to communication platforms	0% (0/17)	0% (0/17)	12% (2/17)	47% (8/17)	41% (7/17)	4.3	4.1	4.8	4.0
I expect that technologists will choose the appropriate urgency level	6% (1/17)	6% (1/17)	12% (2/17)	29% (5/17)	47% (8/17)	4.1	4.1	4.4	3.5
I am concerned that incoming consults via RadConnect will interrupt my workflow	12% (2/16)	56% (9/16)	25% (4/16)	0% (0/17)	6% (1/17)	2.3	1.7	2.8	2.8

94% (16/17) of participants responded that they would rather use RadConnect for protocoling questions than the phone. For image quality review questions, which may be more time sensitive when a patient is waiting to be released, 65% (11/17) of participants indicated they would rather use RadConnect than the phone. Second, tickets are role-based and can be sent to a section account, instead of an individual radiologist. This way, the technologist does not need to know who the active contact person for a radiology section is. This contact person may change throughout the day and it is therefore challenging to identify the right person. Third, communication is initiated through tickets with pre-determined categories and built-in questions tailored to the radiology workflow.

Usability Study and Questionnaire Response

Perceived value

Technologist participants recognized the value of the worklist as a means to keep track of open consult requests. They also appreciated the section role-based model as it obviates the need to "track down" a radiologist. They found the urgency prioritization to be particularly useful: "It looks like a 911 call list, where the question is ranked with an urgency, which creates a prioritized list. This is the future." Radiologist participants recognized the value of the ticket categories in the worklist. Possibly because it helps radiologists to estimate the time and effort that is required to answer a ticket, without engaging with the sender and tacitly committing to a timely response. Overall, they found the worklist feature to be "handy" and "much more efficient than the telephone" and appreciated the urgency prioritization.

Technologist participants expressed concern that RadConnect only works if radiologists actively monitor the worklist and respond within the requested response time. They also remarked that they would resort to calling or walking over if the recipient account does not respond. Radiologist participants expressed concern that RadConnect could increase the number of consultations, if technologists experience that RadConnect is an efficient mechanism for answering their questions. They indicated that this side effect of RadConnect should be studied in clinical practice and that it could be remedied by changing standard operating procedures.

Local Workflow Factors

Participants shared their thoughts on how RadConnect fits in with their local workflow. In Institutions 1 and 3, one radiologist answered all questions for one section. In Institutions 1 and 3, radiologists worked in reading rooms that are physically separated from the acquisition rooms. Institution 2 utilized a different approach where radiologists work with the technologists at the modality or at another modality in the same physical workspace. These radiologist(s) were solely responsible for supervising the acquisition process and were not involved in image interpretation. The proximity of radiologists and technologists in Institution 2 may explain why participants from this Institution were least likely to believe that they would use RadConnect frequently, compared to participants from Institutions 1 and 3.

Communication Alternatives

All three institutions used chat solutions for communication between technologists and radiologists, but the specific solutions varied. Institution 1 utilized phone and the chat functionality of a general-purpose communication platform (not its audio and video capabilities). A radiologist from Institution 1 compared RadConnect to phone-based communication: "[RadConnect] will save a lot of phone calls that you don't have to answer immediately but can answer at a time when you think you have to. Over the phone it must be handled directly or you will forget it". The vast majority of participants preferred RadConnect over general-purpose communication solutions.

In Institution 2, where technologists and radiologists were co-located at a scanner, face-to-face was the primary mode of communication. When face-to-face was not possible, Institution 2 used phone and the chat functionality of a general-purpose communication platform (not its audio and video capabilities). Technologist participants from Institution 2 recognized the issue of non-responding radiologists and believed that RadConnect would be useful in that respect.

Institution 3 utilized phone and chat functionality in their Radiology Information System (RIS) for communication between

technologists and radiologists. In this application, a chat conversation could be started from the context of a study order, presenting relevant information to sender and receiver. This might explain why participants from Institution 3 believed that RadConnect has added value compared to a general-purpose chat application and would rather use RadConnect than using the phone for protocolling and image quality review questions, but were neutral if RadConnect would support them in their daily work. A radiologist from Institution 3 stated: "As a standalone messaging system, I would not want to use it. What you want to have is a seamless workflow. It is a good system, but you need it to be integrated."

Extensions

RadConnect was developed as a minimal viable product for communication between technologists and radiologists for use during regular working hours. The version of RadConnect evaluated in this paper can be extended technically. It can also be used in different settings than normal working hours and by other users than were in the scope of this study.

Participants emphasized the importance of integration in workflow solutions, such as the Radiology Information System (RIS), modality console, Electronic Medical Record (EMR) and Picture Archiving and Communication System (PACS). This has the dual benefit of reducing the number of software applications that technologists and radiologists need to navigate and of sharing relevant workflow information that is managed by the solution to pre-fill ticket forms with state information.[13] Tight integration in existing workflow solutions requires that the chat functionality be embedded in the solutions' user interface and that state information be accessible, for instance, through an application programming interface (API). Third-party workflow solutions may not necessarily meet both requirements.

RadConnect facilitates communication from technologists to radiologists. It does not allow radiologists to contact technologists, but this would be a plausible extension of the solution.

During the design phase with technologists and radiologists from Institution 1, it was discovered that coordinating technologists from this institution would also benefit from RadConnect. These technologists handle the day-to-day operations. Participants also saw value in expanding the user base to include referring physicians, especially from the Emergency Department who typically rely on the radiology assessments for expedited care decisions.

During the usability study, some participants indicated that RadConnect's functionality would also be useful outside normal working hours, when fewer radiologists are available for answering imaging questions and the proportion of urgent questions is typically higher. This leads to hectic situations and RadConnect could help to organize open questions and rank them by urgency.

Comparison to Other Tools and Approaches

Ticket-based communication tools have been described in the literature to report image quality issues. Ong et al.[13] describe a system that allows radiologists provide image quality feedback to technologists. One of the user needs addressed by their system was tight integration with PACS to capture relevant context information in the ticket, to minimize the data entry burden for the radiologist. A similar approach was taken in,[14] describing a PACS-integrated communication tool.

In the literature various other approaches have been reported to improve the communication experience, such as a telephone triaging system,[15] implementing organizational changes[16,8] and streamlined imaging request pathways.[17]

Limitations

Our study was conducted at three academic institutions in Europe with a limited number of participants that were willing and able to participate, potentially causing self-selection bias. Participants interacted with a functional solution, but in an artificial setting, not in the clinical workflow. The perceived value of and attitudes towards RadConnect may have been different if used for an extended period in combination with alternative communication methods. The added value of RadConnect and its ability to reduce interruptions will be investigated in a clinical evaluation.

Conclusion

Involving future end users, an asynchronous software solution was developed for communication between technologists and radiologists that is ticket and role based. The solution was evaluated by 17 technologists and radiologists from three academic hospitals in Europe, with varying workflow settings. The majority of participants (65%) would like to use it frequently in their workflow and the vast majority of participants (88%) believed it adds value compared to general-purpose enterprise chat solutions. Technologist-radiologist proximity, the number of scanners overseen by a single radiologist and communication alternatives were factors that may have influenced the perceived value of RadConnect. Participants recommended tight integration in existing workflow solutions.

Chat-based asynchronous communication might be a viable mode of communication between technologists and radiologists to reduce avoidable interruptions. Tailoring the chat solution to the needs of and tightly integrated with the radiology workflow is valued by future end users after exposure to the tool in a simulated environment.

Acknowledgements

The authors gratefully acknowledge Thomas Anten, Jimi Ashford, Paul Haima, Jaap Knoester and Carol Lane for their contributions.

References

1. Donnelly L, Strife J. Establishing a program to promote professionalism and effective communication in radiology. Radiology 2006;238(3):773–9.
2. Voutsinas N, Sun J, Chung M, Jacobi A, Genes N, D N, B HKD. Improving Communication Between the Emergency Department and Radiology Department With a Novel Web-Based Tool in an Urban Academic Center. Curr Probl Diagn Radiol 2021;50(3):293–6.
3. Murphy D, Singh H, Berlin L. Communication breakdowns and diagnostic errors: a radiology perspective. Diagnosis (Berl) 2014;1(4):253–61.
4. Ratwani RM, Wang E, Fong A, Cooper C. A Human Factors Approach to Understanding the Types and Sources of Interruptions in Radiology Reading Rooms. J Am Coll Radiol 2016;13(9):1102–5. Sep.
5. Kansagra A, Liu K, Yu JP. Disruption of Radiologist Workflow. Curr Probl Diagn Radiol 2016;45(2):101–6.
6. Yu JPJ, Kansagra AP, Mongan J. The Radiologist's Workflow Environment: Evaluation of Disruptors and Potential Implications. J Am Coll Radiol 2014;11(6):589–93.
7. Sabat S, Kalapos P, Slonimsky E. Quantifying disruption of workflow by phone calls to the neuroradiology reading room. BMJ Open Qual 2019;8(3).
8. Shah S, Atweh L, Thompson C, Carzoo S, Krishnamurthy R, Z NA. Workflow Interruptions and Effect on Study Interpretation Efficiency. Curr Probl Diagn Radiol 2022;51(6):848–51.
9. Degnan A, Ghobadi E, Hardy P, Krupinski E, Scali E, Stratchko L, Ulano A, Walker E, Wasnik AA, A WF. Perceptual and Interpretive Error in Diagnostic Radiology-Causes and Potential Solutions. Acad Radiol 2019;26(6):833–45.
10. Balint BJ, Steenburg SD, Lin H, Shen C, Steele JL, Gunderman RB. Do Telephone Call Interruptions Have an Impact on Radiology Resident Diagnostic Accuracy? Acad Radiol 2014;21(12):1623–8.
11. Wynn R, Howe J, Kelahan L, Fong A, Filice R, Ratwani R. The Impact of Interruptions on Chest Radiograph Interpretation: Effects on Reading Time and Accuracy. Acad Radiol 2018;25(12):1515–20.

12. Dickerson J, Koch B, Adams J, Goodfriend M, Donnelly L. Safety coaches in radiology: decreasing human error and minimizing patient harm. Pediatr Radiol 2010;40(9):1545–51.
13. Ong L, Elnajjar P, Nyman C, Mair T, Juluru K. Implementation of a Point-of-Care Radiologist-Technologist Communication Tool in a Quality Assurance Program. Am J Roentgenol 2017;209(1):W18–25.
14. Glazer DI, Zhao AH, Lacson R, Burk KS, DiPiro PJ, Kapoor N, Khorasani R. Use of a PACS Embedded System for Communicating Radiologist to Technologist Learning Opportunities and Patient Callbacks. Curr Probl Diagn Radiol 2022;51(4):511–6.
15. Bell L, James R, Rosa J, Pollentine A, Pettet G, Mccoubrie P. Reducing interruptions during duty radiology shifts, assessment of its benefits and review of factors affecting the radiology working environment. Clin Rad 2018;73.
16. Watura C, Blunt D, Amiras D. Ring Ring Ring! Characterising Telephone Interruptions During Radiology Reporting and How to Reduce These. Curr Probl Diagn Radiol 2019;48(3):207–9.
17. Watura C, Kendall C, Sookur P. Direct Access and Skill Mix Can Reduce Telephone Interruptions and Imaging Wait Times: Improving Radiology Service Effectiveness, Safety and Sustainability. Curr Probl Diagn Radiol 2022;51(1):6–11.