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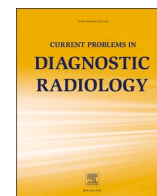
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Original Article

Sustainable reduction of phone-call interruptions by 35% in a medical imaging department using an automatic voicemail and custom call redirection system

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ABSTRACT

Background: : Have you ever been in the trenches of a complicated study only to be interrupted by a not-so urgent phone-call? We were, repeatedly– unfortunately.

Purpose: : To increase productivity of radiologists by quantifying the main source of interruptions (phone-calls) to the workflow of radiologists, and too assess the implemented solution.

Materials and methods: : To filter calls to the radiology consultant on duty, we introduced an automatic voicemail and custom call redirection system. Thus, instead of directly speaking with radiology consultants, clinicians were to first categorize their request and dial accordingly: 1. Inpatient requests, 2. Outpatient requests, 3. Directly speak with the consultant radiologist. Inpatient requests (1) and outpatient requests (2) were forwarded to MRI technologists or clerks, respectively. Calls were monitored in 15-minute increments continuously for an entire year (March 2022 until and including March 2023). Subsequently, both the frequency and category of requests were assessed.

Results: : 4803 calls were recorded in total: 3122 (65 %) were forwarded to a radiologist on duty. 870 (18.11 %) concerned inpatients, 274 (5.70 %) outpatients, 430 (8.95 %) dialed the wrong number, 107 (2.23 %) made no decision. Throughout the entire year the percentage of successfully avoided interruptions was relatively stable and fluctuated between low to high 30 % range (Mean per month 35 %, Median per month 34.45 %).

Conclusions: : This is the first analysis of phone-call interruptions to consultant radiologists in an imaging department for 12 continuous months. More than 35 % of requests did not require the input of a specialist trained radiologist. Hence, installing an automated voicemail and custom call redirection system is a sustainable and simple solution to reduce phone-call interruptions by on average 35 % in radiology departments. This solution was well accepted by referring clinicians. The installation required a one-time investment of only 2h and did not cost any money.

Abbreviations

AI Artificial Intelligence
WHO World Health Organization

Introduction

Medical Error is the third leading cause of death in the USA.¹ Further,

the WHO recently pointed out that most people will likely suffer from a diagnostic error during their lifetime.² A diagnostic error can emerge when a diagnosis is wrong, missed or delayed.^{2–5} It is estimated that more than 3.6 billion diagnostic images are generated annually in radiology departments worldwide⁶ with an estimated daily error rate in image-interpretation ranging from 3 to 5%.⁷ To reduce the error-rate in medicine and medical imaging, a multitude of complex proposals have been made^{8–10}. They range from the implementation of AI to the

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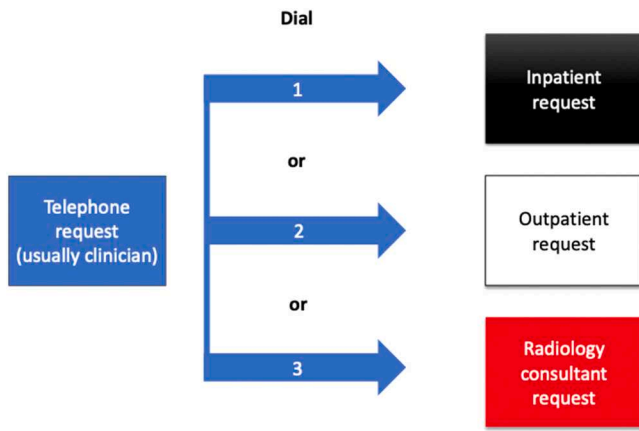


Fig. 1. Set-up of the automated voicemail and custom call redirection system. Incoming telephone requests (usually by clinicians) were categorized into three themes as shown. Telephone requests were registered 24/7 for an entire year (12 full and continuous months). The results were recorded in 15-minute increments.

formation of a new medical specialty. What they all have in common is that they are either very complex, that no encompassing legal framework exists, or they simply are not ready-to-use in a reasonable time-frame. Thus, in addition to these important albeit more mid- to long-term solutions, radiologists currently practicing require near-term solutions for current problems. As radiology is becoming more important globally with the demand for radiological imaging projected to rise sharply in the next years¹¹ the current allotted time of 3 - 4s per image¹² will likely shrink. Many employees have reported that work interruptions have increased in recent years.¹³ The advent of technology-driven interruptions sets a limit to the output of knowledge

workers (such as radiologists) in that they introduce the potential to severely hinder their workflow.^{14,15} Phone call interruptions are among the most common and most pressing challenges to the workflow in radiology departments.¹⁶⁻¹⁸

In the department of Neuroradiology at the University Hospital Zurich, a consultant radiologist is designated daily for the role as MR-Officer during working days. In addition to image-interpretation, the MR-Officer is also responsible to answer the dedicated MRI-telephone. The MRI-telephone is typically the first point of contact for all incoming calls regarding MRI studies. The phone hinders workflow greatly through frequent calls (and concomitantly raises the potential for errors due to these interruptions) to MR-Officers as they simultaneously read MRI studies and write reports. Furthermore, many requests do not actually need the input of a consultant level radiologists.

Thus, the aim of this work was:

1. To find a sustainable and cost-efficient method to increase productivity thus concomitantly reducing the potential for errors for reporting radiologists.
2. To quantify the main source of interruptions (phone calls) to the workflow of Neuro-radiologists in a university hospital for 12 continuous months.
3. To assess the implemented cost-effective solution and demonstrate its potential to avoid interruptions.

Materials and methods

The local ethics boards waived the requirement for informed consent as no patients were involved in the study at hand. The study was prospective. An automated voicemail and custom call redirection system was installed to answer each incoming call to the MR-Officer. In the recorded greeting message, the caller is asked to categorize the call before being able to directly speak with the MR-Officer. The caller is

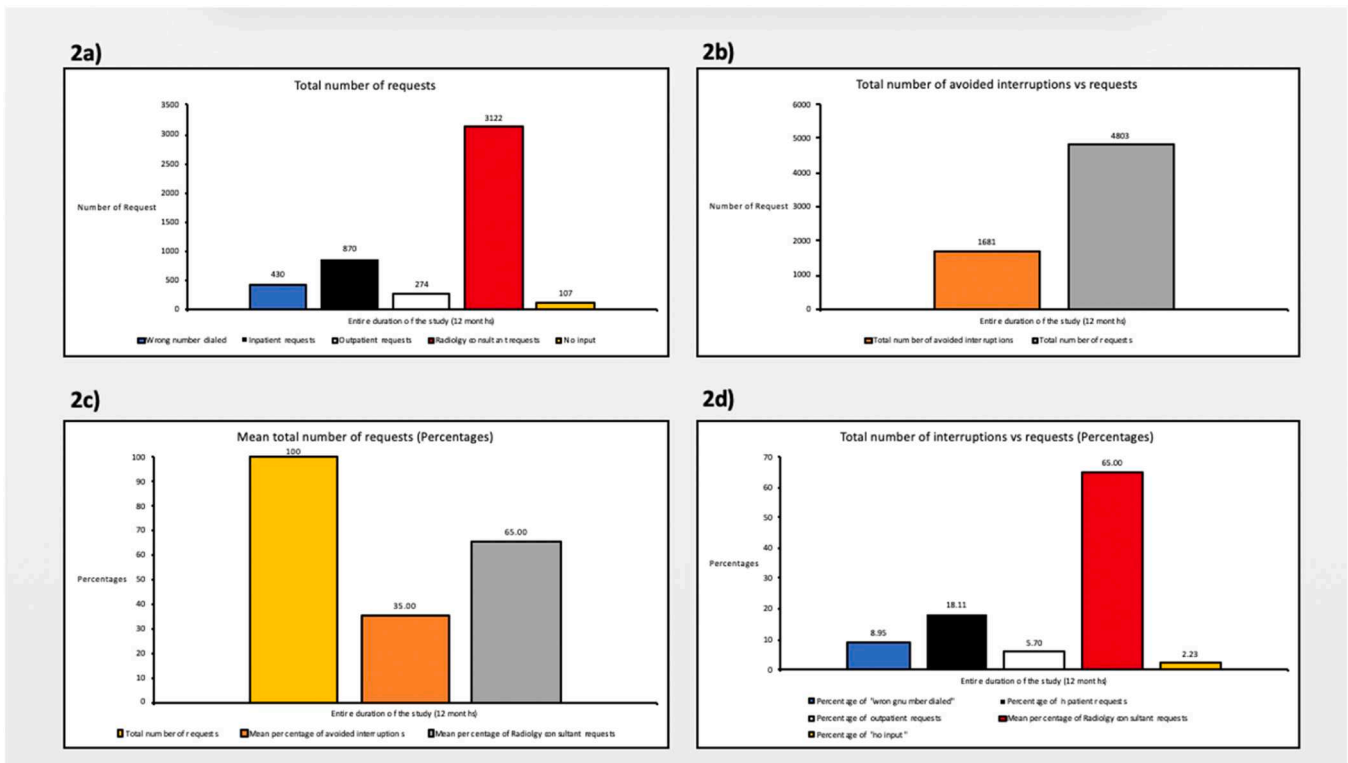


Fig. 2. a) Total number of requests and b) total number of avoided interruptions vs requests received during the entirety of the study (12 continuous months); c) mean number of requests (percentage) and d) total number of interruptions vs requests (percentage). These figures show that a total of 4803 telephone requests were registered during the entire duration of the study and how they were comprised.

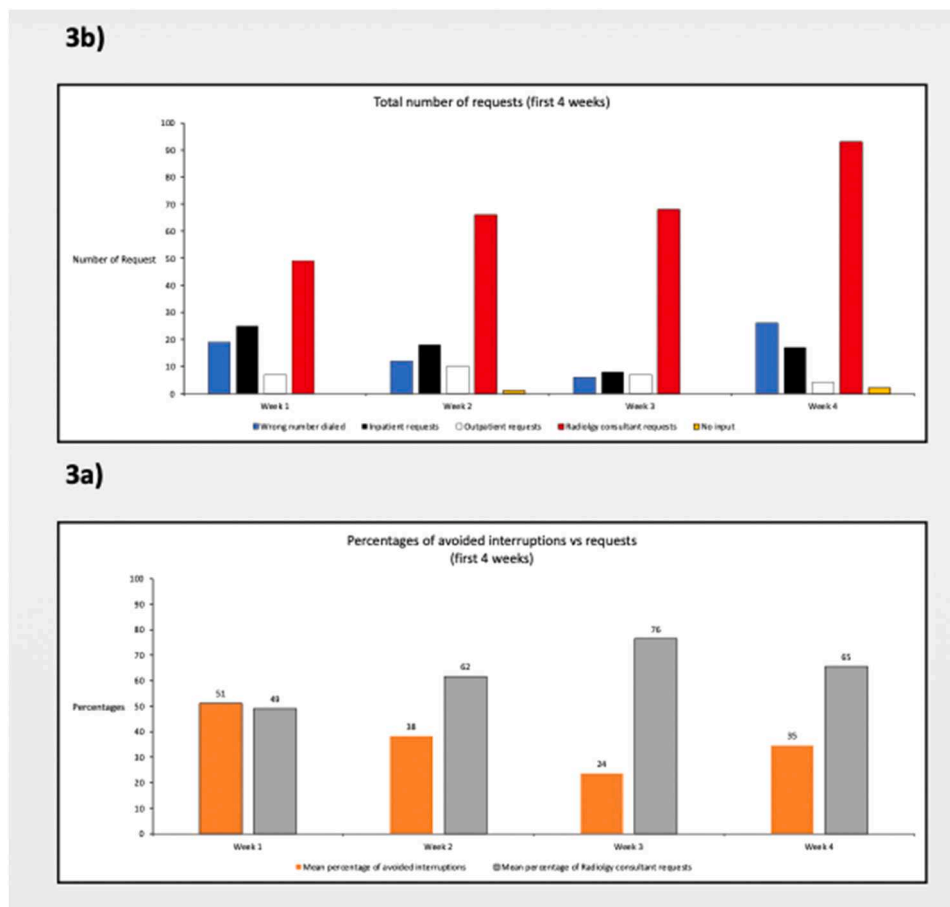


Fig. 3. a) Total number of requests during the first 4 weeks and b) percentage of avoided interruptions vs requests during the first 4 weeks.

asked to dial and choose between the following options Fig 1: If the caller had a request regarding an inpatient ‘one’ was the proper number to dial. These calls were generally to ask for or organize an MRI timeslot for inpatients, such as those on the ICU which required co-ordination between multiple parties. Similarly, ‘two’ dealt with outpatient requests. These calls were generally to ask for or prioritize an outpatient MRI timeslot. If the caller wanted to speak with a consultant radiologist, the MR-Officer of the day, they had to dial ‘three’. These calls were generally to discuss the results of an MRI exam. If the calling person hung up before all options were read out and no decision was made, the call was categorized as “wrong number called”. If the calling person did not make any input after all options were read out, the call was labelled “no input” and the options were read out again starting with one, “Inpatient request”. All incoming calls were monitored in 15-minute increments. Subsequently, we assessed both the frequency and category of requests.

Results

During the entire study (12 continuous months) from March 2022 until March 2023 we recorded a total of 4803 requests (see Fig. 2). Of these 4803 requests, 3122 were directed at the MR-Officer, while 1681 did not need the input of a specialist trained radiologist. Since these 1681 calls, before the implementation of the automated voicemail, would have still interrupted MR-Officers in their reporting duties, we collectively labelled these requests (successfully) avoided interruptions. Over 12 continuous months the average percentage of successfully avoided interruptions was 35 % vs 65 % of requests that indeed needed the input of the MR-Officer. The 35 % of avoided interruptions were further subdivided according to number the caller dialed: 430 requests

(8.95 %) were terminated without any input and before the entire voicemail was played. 870 requests (18.11 %) were inpatient requests, and 274 requests (5.7 %) were outpatient requests. Finally, during 107 requests (2.23 %) no number was dialed. During the first week the percentage of successfully avoided interruptions (51 %) exceeded the percentage of MR-officer requests (49 %) (Fig. 3a). In the subsequent 3 weeks the percentage of avoided interruptions decreased and the percentage of requests to the MR-Officer increased.

The absolute numbers (as opposed to percentages) in Fig. 2b. show an even more pronounced trend: During the first 4 weeks, a drastic increase of MR-Officer requests was recorded, 49 in week 1 vs 93 in week 4. It must be noted however, that the overall number of calls (including in- and outpatient requests) in week 4 was higher than in week 1 as Fig. 3b depicts. We consider week 4 as an outlier, likely due to expected changes to the roster (beginning of 2nd Quarter of 2022). After week 4, the total amount of calls as well as the number of calls that were labeled as “wrong number dialed” decreased (Fig. 4b). The total number of requests to the MR-officer fluctuated during the first 12 months. Fig. 4a illustrates the percentages of successfully avoided interruptions vs MR-officer requests. From week 3 to 5 and again from week 7 to 12, the percentage of avoided interruptions increased almost steadily. This increase does not correlate with the fluctuation in total number of calls to the MR-officer. Week 7 (together with week 35, not shown) was the week with the lowest percentage of interruptions at 19 % vs actual requests for the MR-officer. Next, the percentages of successfully avoided interruptions were analyzed on a monthly basis for 12 continuous months (see Fig. 5a).

This analysis revealed that the percentage of interruptions usually fluctuated between the high 20 % range (the lowest value was recorded in month 9 at 29.0 %) and the low 40 % range (the highest value was

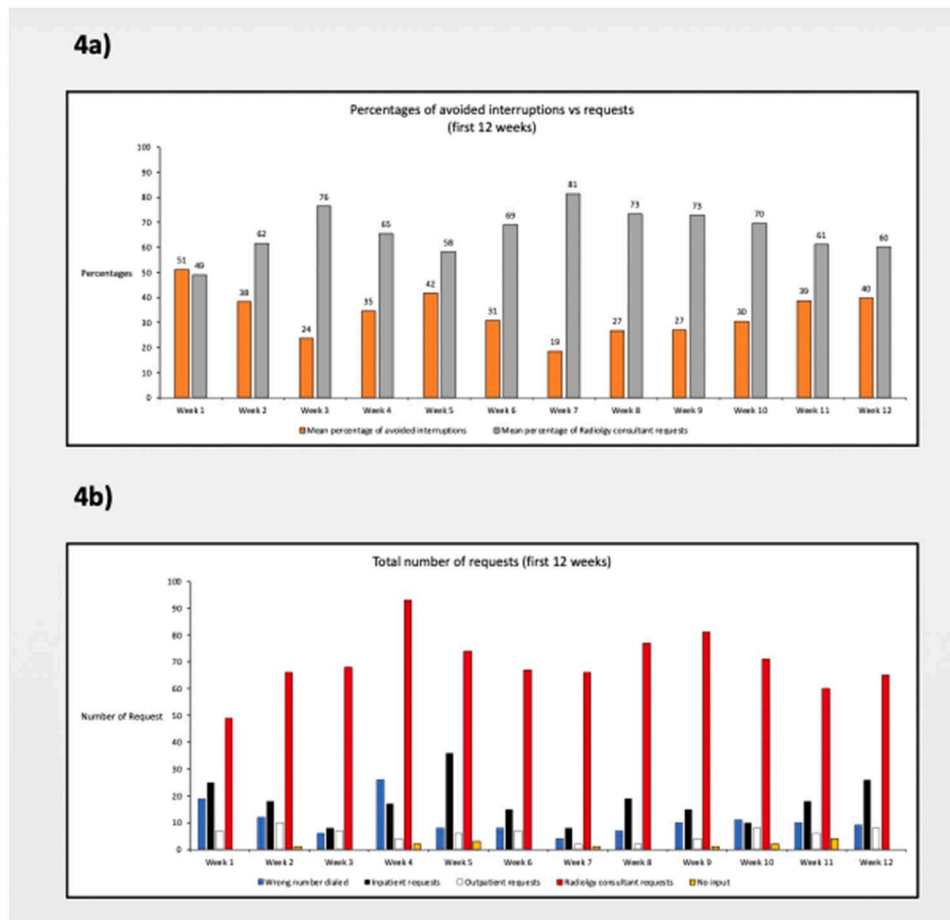


Fig. 4. a) Percentage of avoided interruptions vs requests and b) total number of requests during the first 12 weeks.

recorded in month 10 at 40.5 %). Most percentages however were in the low to high 30 % range (median value 34.54 %). Accordingly, the percentage of phone calls that indeed needed the input of the MR-officer fluctuated between 71 % (month 9) and 59.5 % (month 10). Most percentages however were in the low to high 60 % range (median value 65.46 %). For context, over the course of the study, 12,556 MRIs (Brain and Spine) were performed at our department. Fig. 5b illustrates the detailed analysis of the number of phone requests on a monthly basis. The highest number of aborted phone calls (“wrong number dialed”) was recorded in month 1. The number of inpatient requests steadily increased from month 9 until month 12. The requests for the MR-officer (with the exception of month 9) also increased from month 10 until month 12.

Discussion

We here demonstrate for the first time an analysis of phone-call interruptions to consultant radiologists in an imaging department for 12 continuous months. Additionally, we propose a sustainable and simple solution (installation of an automatic voicemail and custom call redirection system) to reduce phone-call interruptions by 35 % in a radiology department. This solution was well accepted by referring clinicians.

Workflow interruptions are known to play a pivotal role in medical error: The effect of interruptions on workplace stress and patient safety are well researched in the clinical^{19–21} and laboratory context where it was shown that stress acutely leads to reduced memory retrieval efficiency.^{22,23} The estimated rate of errors in image-interpretation is thought to be between 3 and 5 %⁷ and both physicians as well as the

public supports the view that the health care professional responsible for the medical error should be sanctioned.²⁴ The number of images has surged more than 500 % from 1999 to 2010¹² and the boom of medical imaging is expected to persist.¹¹ This boom is in stark contrast to staffing in medical imaging departments which has risen only very incrementally – if at all. As a consequence, today's radiologists have to interpret one image very 3-4 seconds in an 8h workday (excluding lunch) to keep up with demand.¹² Although the output of radiologists rose dramatically over the last decades due to the aid of technology, it is the advent of these very same technologies, the expectation of 24/7 service availability,^{25,26} omni-connectivity and reachability (e.g. via mobile phones or email)^{17,27} that proves to set a ceiling to productivity (productivity defined as output/ time) in the work environments of knowledge workers.^{28,29} Some authors even propose that productivity has in fact declined recently – at least for now.³⁰ Regarding knowledge workers (e.g. radiologists), it was pointed out that the advent of technology-driven interruptions sets a limit to their output, in that they introduce the potential to severely hinder workflow.^{14,15} Many employees have reported that work interruptions have increased in recent years.¹³ In the radiology context, phone call interruptions have been implicated as one of the biggest challenges and the main root cause of medical errors.^{16,18,31} Balint et al have suggested that a single phone call above the average baseline call volume hiked the error rate of on-call radiology residents by as much as 12 %.¹⁷ These stress-induced errors and types of forgetting occur because after the interruption, both effort and time have to be actively invested to return to the same level of concentration required for the original task at hand,^{32,33} which, for radiologists, is image interpretation. In fact, a recent study has shown that radiologists spent only 36.4 % of their time on image interpretation³⁴ thus underscoring

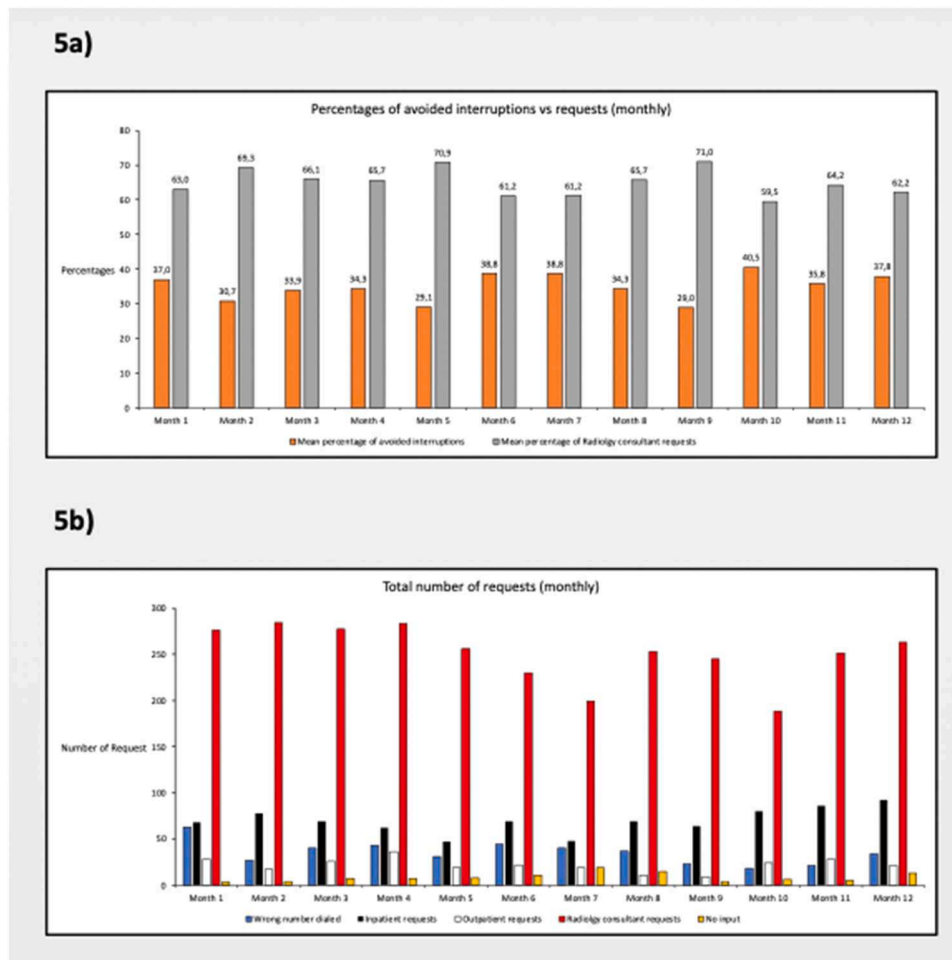


Fig. 5. Monthly analyses for 12 continuous months; a) percentages of avoided interruptions vs requests and b) total number of requests. The figures show the number of categorized requests per month. In every month, the most frequent request was to speak with the MRI-officer, followed by “Inpatient requests” and “wrong number dialed”.

the potential as well as the need for workflow optimization in modern medical imaging departments.

It is a great honor and even greater responsibility to operate in a field that is in such high demand. As the demand is projected to rise further one must therefore ask: How much time is needed to interpret an image thoroughly and comfortably without endangering patients? Or put in a more dramatic way, knowing that “To err is human”¹⁹ which percentage of error in image-interpretation are physicians and the public willing to accept?

While improving the workflow of radiologist is a noble endeavor, we must not neglect the predominant determinant of clinician satisfaction with radiology services: Reachability of the radiology department.³⁵ Fortunately, after a short adaptation phase of only a few days (see week 1 in Fig. 2b), the voicemail was well accepted and has been in use ever since. The automated voicemail and custom call direction system that we implemented needed a one-time investment of only 2 hours to install (e.g. to record the different prompts) and reduced phone call interruptions for 12 continuous months by on average 35 %. The installation did not cost any money.

The inability to track unanswered calls due to unavailability of the targeted recipient (with resulting re-call) is a limitation of this study; the data, however, represents real-world clinical routine. Second, we were not able to record the duration of phone calls to the MR-officer which would have allowed for a more precise quantification of interruption to daily routine. Third, we realize that other imaging departments have implemented strategies such as the creation of a dedicated radiology

call-center, implementation of a reading-room assistant, or designation of a clerk to filter all incoming calls, thus the results of this study will be of interest primarily to departments currently working without a dedicated solution.

We hope this study can help provide a sustainable and simple solution to advance un-interrupted workflow in medical imaging departments.

Summary Statement

Phone-call interruptions are among the top challenges to workflow-optimization. Installing an automated voicemail and custom call redirection system is a simple and sustainable way to reduce phone-call interruptions by 35 %.

Declaration of competing interest

None of the authors has any conflict of interest to disclose.

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