

# MRI Ferromagnetic Detector System: Fatigue Study

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## EXECUTIVE SUMMARY

- Ferromagnetic detectors capable of alerting MRI operators to potentially lethal projectile risks have been proven to increase patient safety. What is less well known is how such benefits may change over time.
- The staff was involved in the whole study as they were trained on the use of the system, asked to record events that alerted the detector, and participated in follow up conversations about the impact of the systems and concerns or questions.
- While a metal detection system is capable of reducing the number of incidents in which metal objects are brought into the MRI suite, technologists do become fatigued with the alarms in an MRI system and do not always consciously hear it.

**The MetroHealth** System in Cleveland, OH is a county hospital and an academic level 1-trauma hospital system with over 700 registered beds affiliated with Case Western Reserve University. It performs over 12,000 exams per year on four MRI systems. All of the MRI locations have implemented the “4 zone” system as recommended by the American College of Radiology. The 4 zone system has defined four safety zones within MRI facilities. These are denoted Zones I through IV and correspond to levels of increasing magnetic field exposure with Zone 1 being open to the public and Zone 4 being the most restrictive. Ferromagnetic detectors capable of alerting MRI operators to potentially lethal projectile risks have been proven to increase patient safety. What is less well known is how such benefits may change over time. To study this question we proposed to measure, over a two month study interval:

1. The number of alarm activations per day
2. The ratio of alarm activations logged by technologists to total number of alarm activations
3. Durability of any beneficial effect

## Study Design and Methods

Prior to this study and the installation of a new ferromagnetic detector system, no

MRI installations were equipped with an electronic magnetic alarm system. The new system used in this study (Figure 1) was placed at the MRI door and was a 3.0 T system unit to be equipped with an incident log manager. It is a device that continuously records images of all personnel who pass through the system into the MRI suite from 5 seconds before the incident occurs until 15 seconds after the incident. This allows identification of persons and objects that are determined to be ferromagnetic and determines whether the effectiveness of such a system would degrade over time due to alarm fatigue in the MRI scanning environment.

The 3.0 T system is one of two MRI devices in the department. Each of these two units is approximately 50% of the MRI scans done in the hospital. This unit was chosen as a matter of convenience with present electrical outlets and services that would require the least amount of improvements.

The staff was involved in the whole study as they were trained on the use of the system, asked to record events that alerted the detector, and participated in follow up conversations about the impact of the systems and concerns or questions. They were engaged in the project and were encouraged by the increased awareness of metallic objects entering the MRI room. The reasoning for this study was not prompted by any events



Figure 1 • New Ferromagnetic Detector System

or concerns, but from the department's increased concern about the MRI environment. The study was possible due to a grant from the AHRA & Toshiba Putting Patients First program, which allowed MetroHealth to purchase the system.

The reason for this study is the phenomena of alert fatigue. The term "alert fatigue" describes how busy workers (in the case of healthcare, clinicians) become desensitized to safety alerts, and as a result ignore or fail to respond appropriately to such warnings.<sup>1</sup> Many healthcare individuals are affected by this phenomenon including MRI technologists. The metallic testing devices were created to screen individuals walking into an MRI area. An alert is emitted when a piece of metal goes past these

devices. Therefore, the purpose of this study is to review the alarm fatigue in relation to the metallic alarm devices such as the one used in the study.

### Methods

For all MRI examinations performed in the scanner equipped with the new system, the technologist was requested to log each incident in which the detector alarmed. Data was collected daily from the detector system in the incident log manager to determine both the alarm activation and logging rates. Both qualitative and quantitative analysis was employed. Interviews were conducted with the MRI staff regarding the use of the alarming system to establish whenever possible the nature

of the material/item responsible for the alarm activation. The pictures from the incident log manager were also reviewed and analyzed in a randomized order. Also tested were correlations between the days of the week and the number of incidents utilizing the F-test and ANOVA testing. Both tests indicated that there was no correlation between these two factors. In regards to the technologist writing down when incidents occurred—this also had no correlation to the number of incidents or the day of the week.

### Results

During the two month study interval, the system recorded 3161 alarm activations as someone entered or exited the MRI

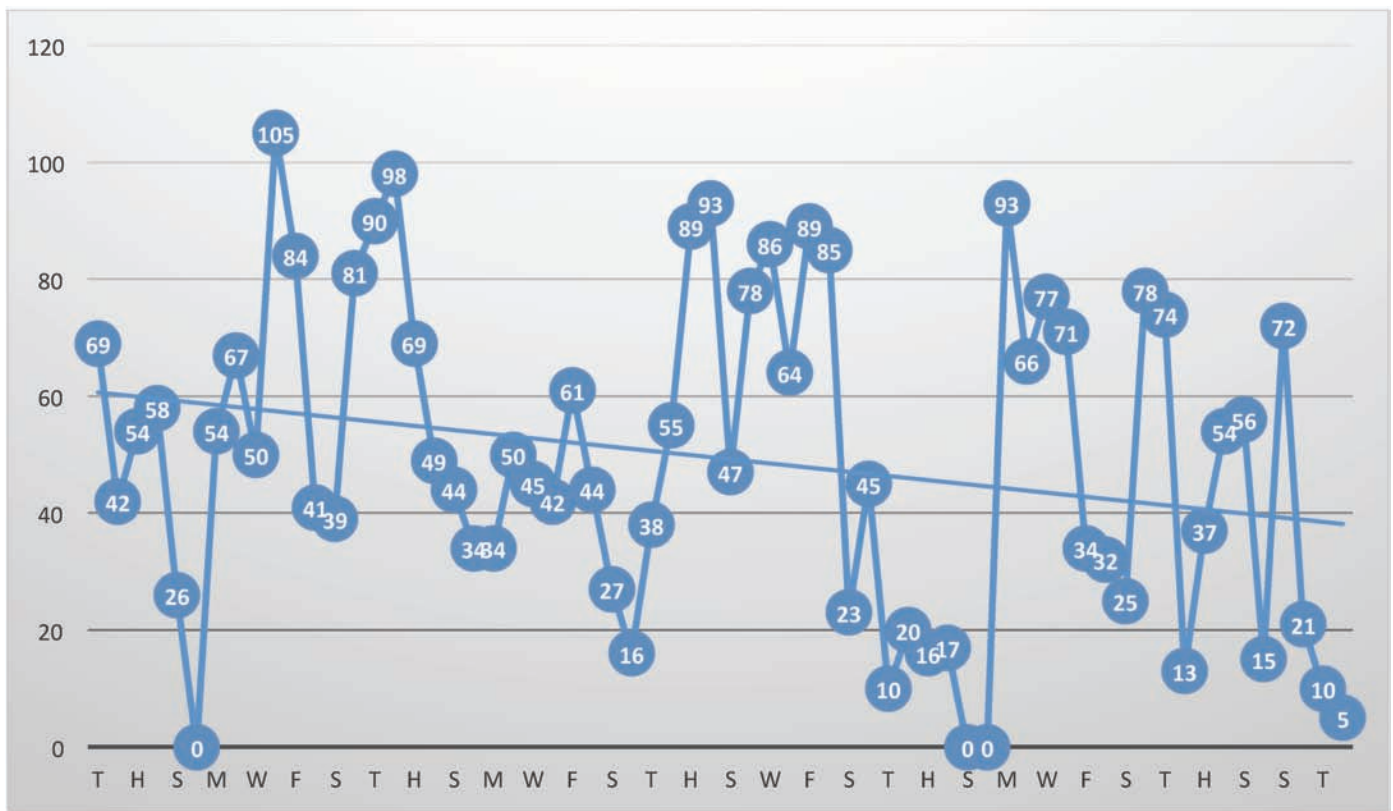


Figure 2 • Number of Incidents Per Day

room. This was shown to be an average of 49 alerts per day with the highest number being recorded of 105 incidents or events in a day. The weekend numbers were at a much lower incidence of magnetic detection than weekdays since the volume of procedures was decreased. The average number of incidents in the first week of study was 60 per day and at the end of two months the average dropped to 40 incidents per day as shown in Figure 2.

The technologists during this period logged 469 incidents at an average of about 8 per day. This number may seem low, but it is important to remember that many of these incident recordings are doubled as someone who walked in a room with metal in their shoes and alarmed the machine also walked out of the room and alarmed the system again. When this occurs, the technologist only noted one log for two events.

We tested for correlations between the days of the week and the number of incidents utilizing the F-test and ANOVA testing. Both tests indicated that there was no correlation between these two factors. In regards to the technologist writing down when incidents occurred also had no correlation to the number of incidents or the day of the week. It does look to be technologist dependent as far as who was working in the scanner on a given day. In reviewing the description of incidents recorded by the technologist, the following items appeared multiple times: shoes, underwire bras, and watches. There were also some “non-magnetic” equipment such as the certified non-magnetic hamper, non-magnetic carts, and non-magnetic anesthesia machines that alarmed the detector. These devices were tested with a 1.0 T magnet and still

indicated magnetic parts that alarmed the detector. Some of these devices and equipment were changed or replaced with truly non-magnetic devices over the course of the study.

## Discussion

This study was proposed to evaluate if the technologists reacted to the alarming of the ferromagnetic detector and if the presence of the detector could improve the safety of an MRI environment. The number of recorded events declined during the study due to technologists making changes in the MRI environment by replacing magnetic devices from entering the MRI room. Some of these changes were the replacement of name badge lancets worn by the technologists. The technologists also discovered equipment that was magnetic when it was previously

considered non-magnetic, and the awareness of who enters the MRI room.

The data indicated that the eight technologists only logged 15% of the alarm incidents. The rate of logging remained the same over the trial period. This statistic could represent that the technologists either did not comply with management's direction to log all events, or could represent that technologists indeed became "fatigued" at the alarm and did not notice that the alarm went off many times. After interviews with the technologists, they admitted that the alarm went off so many times in a day in reference to the same items (such as shoes or bras alarming the system) that they forgot or did not think to mark all of the alerts in the log. Ignoring the alarm can cause a safety concern for the patient and the technologist. If an alarm occurs, then the patient must be investigated for the presence of a ferromagnetic object and it should be removed (if possible). Once this has been done, the patient should be re-screened using the ferromagnetic detector system. If a ferrous object cannot be found, the screening should be repeated in case the original result was a false alarm.<sup>2,3</sup>

While there was a reduction of incidents, there is still room for improvement for a safer environment. Some suggestions for improvement include:

- Creating a policy stating that any shoes entering the MRI room be free of metal
- Creating a policy stating that any bras entering the MRI room be free of metal
- Check all designated "non-magnetic" device and equipment be free of alarm detecting parts
- Have the quality team for the MRI department review a percentage of the data from the alerts and the pictures in the incident log manager every month to determine what causes the alarms in the MRI room.

## Conclusion

MRI systems are powerful diagnostic tools that can provide information critical to the diagnosis of many disease processes.

They can, however, also be a danger to patients and employees due to the inherent magnetic field. This study has shown that a metal detection system is capable of reducing the number of incidents in which metal objects are brought into the MRI suite. A system to detect metal entering the room increases MRI staff awareness as to the devices, clothing, and equipment that have magnetic properties and are detected when entering the room. This study also has shown that technologists do become fatigued with the alarms in an MRI system and do not always consciously hear it. All departments should be extremely cautious of what and who enters the MRI room. All people and equipment entering an MRI room should be tested and determined to be magnetic or non-magnetic and safe to enter. 🚫

## References

- <sup>1</sup>U.S. Department of Health and Human Services. "Alert Fatigue." Agency for Healthcare Research and Quality. Last updated: July 2016. Available at: <https://psnet.ahrq.gov/primers/primer/28/alert-fatigue>. Accessed October 12, 2016.
- <sup>2</sup>Shellock F, Karacozoff A. Detection of implants and other objects using a ferromagnetic detection system: implications for patient screening before MRI. *American Journal of Roentgenology*. 2013;201(4).
- <sup>3</sup>Shellock FG. "Using Ferromagnetic Detection Systems in the MRI Environment." *Mrisafety.com*. Available at: <http://www.mrisafety.com/SafetyInfo.asp?SafetyInfoID=320>. Accessed November 30, 2015.

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