Human Outside the Loop: New Technology and Automating Compliance

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Introduction

A hardware and software system to acquire point-of-care patient photographs was deployed on portable radiography machines at a large academic hospital throughout 2018 (Fig. 1.a, b). These photographs aid in patient identification, provide image related clinical context to radiology images, and reconnect radiologists with patients. We report an enhanced feature to improve photograph acquisition rate. In the first deployment, acquisition was triggered when the X-ray technologist pressed the X-ray handswitch fitted with a force-sensing resistor rigidly suspended above the existing X-ray handswitch button (Fig. 1.c). In this instance, the photograph acquisition success rate decreased significantly during nights and weekends. To equalize and increase photograph acquisition rate, automatic triggering was achieved by adding a microphone to the camera unit. The camera controller was programmed to trigger acquisition by detecting the warning tone generated by the X-ray machine during each exposure. The goal of this study was to determine if acquisition rate was affected by automatic triggering.

Hypothesis

Low photograph acquisition rates during nights and weekends were a result of non-compliance by X-ray technologists physically bypassing the original non-automated trigger.

Methods

Photograph acquisition success rate is defined as the rate at which a photograph was successfully acquired and sent to PACS for each radiology study from a camera-equipped X-ray machine. This rate was calculated using automatically generated system logs for the latest two-week timespans for before and after the automation of photograph acquisition. This choice was made to accurately reflect the most mature and current state of each trigger method. Acquisition success rates were calculated as a function of hour of the week to observe temporal variations. Hours were classified as either routine hours (7:00am-7:00pm weekdays) or afterhours (7:00pm-7:00am and weekends)

Results

The acquisition success rate using both the original and the automated trigger are shown as a function of hour of the week in Figure 2. At baseline with the original handswitch trigger, the median and average hourly success rates were 66.7% and 56.3%, respectively (range of observations, 0-100%). During routine hours these rates were 80.9% and 78.9% (range, 37.5-100%), while during afterhours these rates dropped to 44.9% and 43.8% (range, 0-100%). After implementing the automated trigger, the corresponding rates were both significantly higher and more consistent. Overall: median and average, 100% and 95.3% (range, 50-100%), Routine hours: 100% and 95.2% (range, 71.4-100%), Afterhours/weekends: 100% and 95.3% (range, 50-100%).

Conclusion

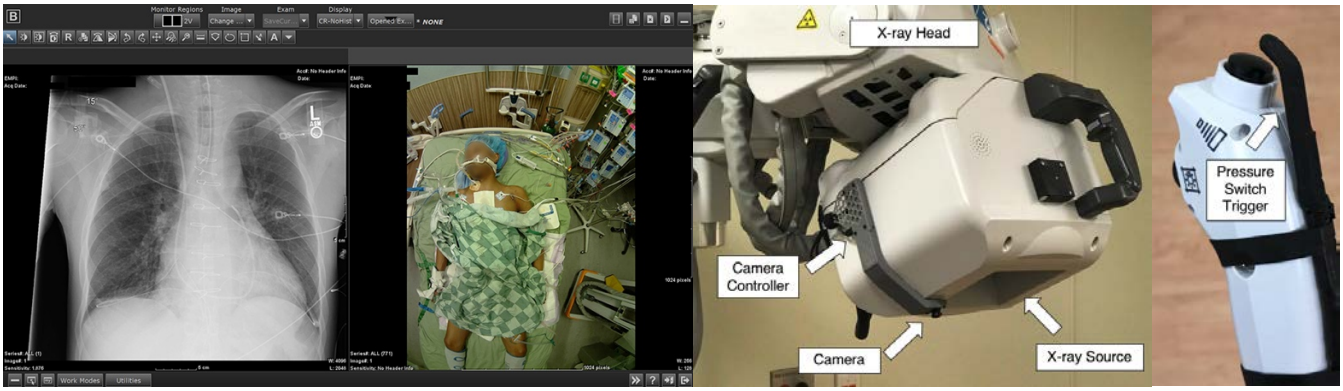
Automating photograph acquisition effectively removed variance introduced by human operators and significantly improved system performance. The hypothesis was validated by demonstrating that the acquisition success rate improved significantly, and temporal variations were greatly reduced when the potential to bypass the trigger was removed. The feedback obtained before automating acquisition, proved valuable in refining the staff education process for future deployments.

Statement of Impact

Automating the performance of a new technology is crucial to ensuring optimal performance, especially to increase compliance when human operators are involved. Patient photographs are now acquired automatically with minimized impact on technologists, and without additional augmentation to the existing X-ray handswitch.

Keywords

patient safety; visible light imaging; quality improvement



(a) (b) (c)

Figure 1: System overview showing (a) radiologist workstation display, (b) camera installed on portable radiography machine, and (c) original handswitch trigger used as baseline.

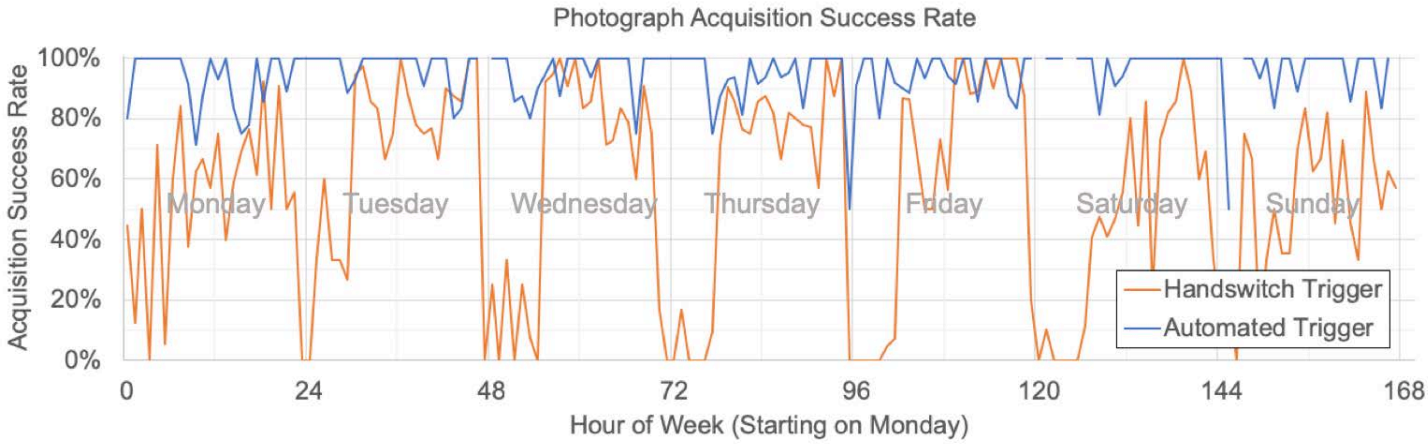


Figure 2: Plots of photograph acquisition success rates for both the original and the automated trigger shown as a function of hour of the week. Rates were calculated using the latest two-week time spans before and after trigger automation.