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Andon Interface for Healthcare Triage

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ABSTRACT

An Andon interface was developed at a level one healthcare system OR department. The interface is a standalone design, which will not require access to the software core, and all clients and data can be added and modified using the UI interface on the cloud. The system is capable of capturing and documenting defects along with the ability to present emergency and urgent situations to members of the management for triage or making final decisions. The Andon system will allow for notification and alarming needed to tackle and resolve all types of problems or incidents using problem swarming. It will also allow for cataloging defects and their severity and indexing that severity based on patient care requirement. The system is able to escalate a low severity index defect to a higher severity index defect based on patient care requirement and the impact on the patient.

Keywords: *Andon system, interface design, triage management*

1. INTRODUCTION

The Andon interface was developed for healthcare triage situations with the ability to present emergency and urgent situations to members of the management for making final decisions. The interface system also captures and documents defects. Patient Safety continues to be a national challenge for healthcare providers. This project focuses on efforts for reducing and preventing harm to patients. This includes, but is not limited to, developing a culture of safety and utilizing a system-based approach to target and eliminate system vulnerabilities related to patient safety.

A strategy for implementing and sustaining emphasis on patient safety could be implementation of system requirements and compliance with ISO/OHSAS 18001, which could provide a framework to the effective management of patient's health and safety. It provides the organizations with the elements of an effective health and safety management system that could be integrated with other management systems. The Andon interface will bring the requirements and importance of patient safety and wellbeing to the forefront of clinical operation.

Andon is a Japanese term for a visual production control. Andons have been used in manufacturing since implementation initially by Toyota Production System. Various type of Andons used include hand written Andons, electronic Andons, color lighting systems, and auditory Andons. Andons could be used in a healthcare setting to not only provide a common mode of communicating patient status and various treatment, tests, and medication schedules, but to highlight and specify delays, unusual or critical conditions, and group notification in case of emergencies.

Andon is a Lean tool which allows instant notification and broadcast of nonconformity in the process. Andon will also bring the nonconformity to the attention of the people who could address the nonconformity in the most efficient and effective way. In Health care, an Andon system will have to be designed to the specifications of the users to get buy-in of the system to start with. The Andon interface must be easy to use and effective and must be value added and not just another system to respond to or report to generate.

The prototype testing demonstrates the value of Andon interface in healthcare, which makes it a tool indispensable to the operation of the medical center. The system engages all necessary parties to swarm a problem or incident and reports are gathered on incidents resolved, time to resolution, resources called on, and the outcome.

The social barriers to implementing Andon are just as important to the successful implementation of the Andon system as the technology itself. In its most simple usage, Andon is a simple visual or auditory signal that indicates something is wrong in a process. When adopted in the healthcare setting such as a medical center, it becomes a communication system whereby frontline staff could communicate the abnormal situations, emergency, or nonconformity with the managers. Healthcare delivery is notorious for its propensity to work around process problems rather than addressing them. Similar problems and defects could be addressed on hourly basis or on case-by-case situations without any motivation to address the root cause. Furthermore, when catastrophic failure does occur, almost without exception, the contributing factors to the failure were well known to staff. Therefore, there is a need in healthcare for a systematic approach to capturing data on defects, errors, and nonconformities with little burden on the staff and resolving problems at the point of care.

There are many reported barriers to a voluntary system for documenting and recording defects and nonconformities. Most have to do with the organization culture and whether or not a protocol has been tested and implemented and if the system was accepted by the staff and employees who are supposed to be using it.

Considering that nurses could have thousands of medicine administration and physicians oversee hundreds

of patients annually, the opportunities for errors are so prevalent. The literature indicates that less than 3% of medication incidents are actually documented and reported and many other errors go unreported [1]. In the cases where nonconformities are viewed or identified, in many cases data is not collected and reports are not filed and defects are not documented.

The purpose of this research was to explore this socio-behavioral phenomenon in the context of using an Andon system with the understanding of the barriers and obstacles to reporting defects and nonconformities. The Andon system as an anonymous reporting and recording system allows the users to partially or fully accept the premise that the institution is not after pointing blames and is only concerned with improved quality of care. This will bring about a change in the culture, which will take place after the system is trusted and users realize that the improvements are made because of management actions based on the data analysis using data collected by the Andon interface. Only then, the Andon interface becomes a useful tool to resolve issues and tackle problems and at the same time trusted to be valuable in collecting data related to defects and nonconformities and effective in their resolution.

The Andon interface was designed to meet the following criterions:

- To be used by mobile devices
- To be used by clinical staff at the point of care
- To communicate abnormal state/defective state to charge nurses, supervisors and managers
- To enable severity triaging
- Identifying defect and uploading it to Andon
- To enable problem swarming if needed

2. LITERATURE REVIEW

The Andon philosophy has been widely used in manufacturing specifically in automobile industry. Many automobile manufacturers have adopted the use of Andon for building in quality. Analytical models to study the performance of a transfer production line featuring Andon developed in [2]. An Andon system was set up in [3] for patient arrival registration system. [4] mentioned that Andon concept as an important concept most commonly associated with lean manufacturing have not yet been tested in healthcare or if used, it has not been published.

There have been numerous publications of various research studies addressing barriers to voluntary reporting of incidents and mishaps in healthcare organizations and nursing homes. A study conducted to describe the reporting rate of Medication Administration Errors (MAE), patient falls, and occupational injuries [5]. In a national survey of 25 hospitals with 1105 subjects responding to the survey, which addressed voluntary reporting of incidents, work environment factors, and reasons for not reporting were questioned. More than 80% of the respondents indicated that all MAEs should be reported and only 36% indicated that near misses should be reported. Actual rate of reporting for various incidents are 47% (MAE), 77% (Patient Falls), 48% (Needle Sticks), 22% (Exposures to Body Fluids), and 17% (Back Injuries).

Reasons for not reporting included: personal fears, the quality of management and the management response to the report.

Vincent and Stanhope [6] in a study titled Reasons for not reporting adverse incidents: an empirical study, administered a questionnaire to 42 obstetricians and 156 midwives in two obstetric units. Most staff knew about the incident reporting system but did not know how to find a list of reportable incidents. Recommendations made to increase incident reporting rate and the reporting reliability included clear definition of incidents, make reporting simple and easy, designate staff who need to be reporting and provide feedback and be clear about the nature and purpose of incident reporting system.

Wakefield and Wakefield [7] used a survey in understanding why medication administration errors may not be reported. They determined 15 potential barriers which were then combined into 4 subscales. These were: Disagreement over Error, Reporting Effort, Fear, and Administrative Response.

To increase error proofing, a better understanding of healthcare provider's perspective regarding MAE reporting and its barriers could improve incident reporting rates. Jeffe and Dunagan [8] used focus groups to understand physicians' and nurses' perspectives on MAE in hospitals.

The common theme in all of these studies include: a blame culture, a lack of time, training and coordination, lack of understanding the importance, fear of punitive culture continue to be the major barriers to reporting. Learning from errors and having a non-punitive approach to reporting were thought to be the most critical features of an incident reporting systems.

Carleen Hawn [9] presented a Web-based social media tools which allows the patients and providers to interact as a way of using social media tools to improve patient-doctor communication.

Firat Alagöz and André Calero Valdez [10] presented some strategies in monitoring and enforcing therapy compliance to improve quality of care.

Mirela Prgomet and Andrew Georgiou [11] evaluated the use of cellular and hand-held devices by hospital staff and physicians and its impact on improving patient care. They identified thirteen studies that demonstrated the ability of personal digital assistants (PDAs) to positively impact on areas of rapid response, error prevention, data management and accessibility.

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Liza Heslop and Stephen Weeding [12] developed a project which brings patient information and medical records to the point of care. As a decision support tool, the use of wireless devices was evaluated and reported.

Maged N Kamel Boulos [13] evaluated the use of smart phones in healthcare and discussed new technologies and trends.

3. ANDON INTERFACE

The Andon Interface was developed for notification and triage in healthcare emergency situations. Amazon EC2 cloud hosting was used to deploy it over the cloud for general audience.

3.1 Client Page

Client Page is used by staff to input defects and messages related to them. The OR room, defect type, defect description, and the type of message is either selected or written into this page. The recipients of the message are added or selected from previously added members. Previous messages and their status are also displayed. The Client interface is separated into three parts: the Defect Display, Defect Input and Contact List. Defect Display shows the messages in the system. The "OR" is for the OR room number, "time posted" is to show the time that the message has been posted. "Message Status" shows the status of the message with three options of OPEN, ACTIVE and CLEAR. OPEN means the message has been posted. ACTIVE means they started working on it (In Process). CLEAR means it has been resolved.

Message Type could vary for INIT, NORMAL, URGENT and EMERGENCY and will be highlighted in white, blue, yellow and red respectively. INIT stands for the initialization and it is the default type of a message. Normal type means there is no emergency or urgent situation present and it is for data collection purposes. Urgent is for the high priority situation with no warning alarm. Emergency is the highest priority with warning alarm. After a defect has been resolved the color of message will change into green. The Defect Display contains the messages and description of the situation. The Client page is shown in Figure 1.

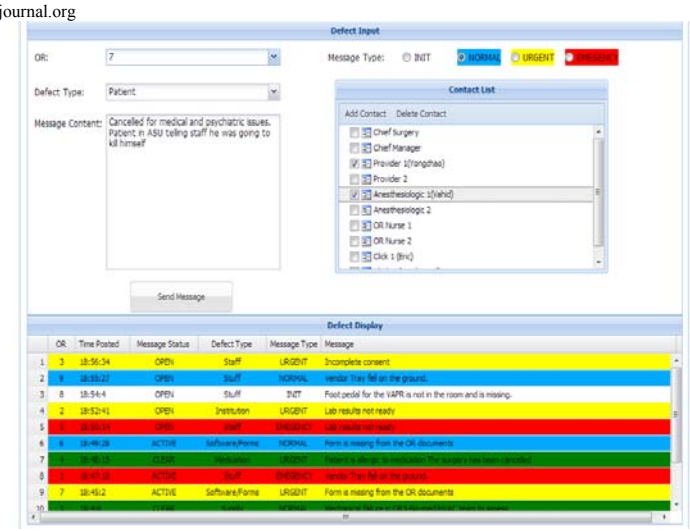

Fig 1: Client Interface Page

3.2 Server Page

Server Page is used by managers (chief of surgery, nurse manger, etc.) to review the defect message and to respond and modify if needed. The Nurse manager or staff responsible to monitor the server will be checking the messages any time to either confirm, update or change a message types specified by client. Time to resolution is displayed to show how long it took until the case was cleared (Green). The Server page is shown in Figure 2.

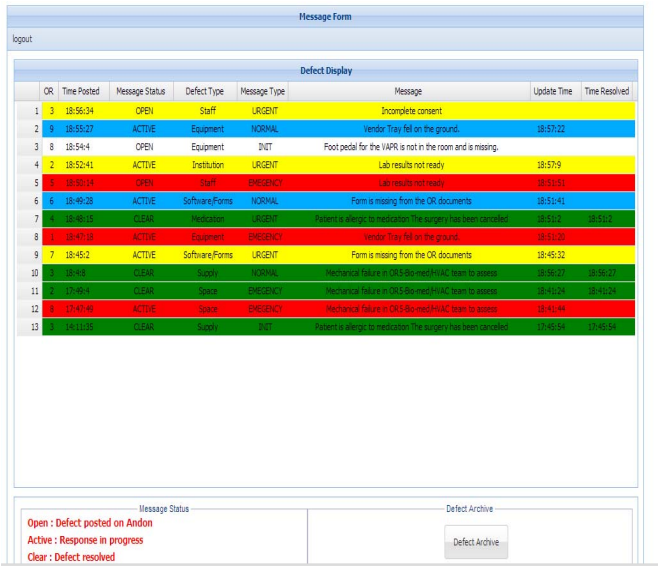

Fig 2: Server Interface Page

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3.3 Archive Page

Archive Page organizes and archives all defects by the defect type and keeps data for statistical analysis and decision making process. After a message is cleared all information plus the date posted and response times will be send to the archives. The messages in the archives will be categorized based on defect type. Corrective actions are taken based on the severity and frequency of a defect and its impact on patient care. Figure 3 shows the Defect Archive page.

Fig 3: Defect Archive Interface Page

3.4 Andon Display Page

Andon Display Page shows all emergency and urgent messages on a display board for all staff. Figure 4 shows the Andon Display.

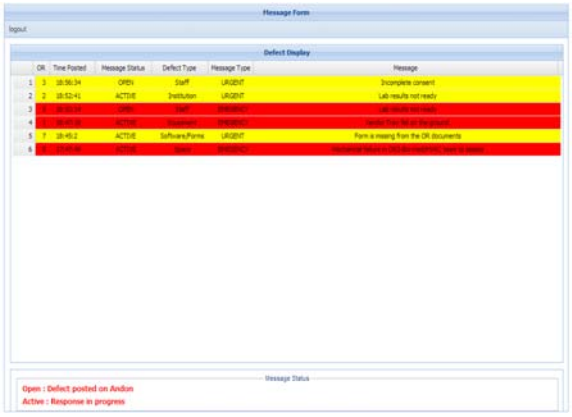

Fig 4: Andon Display

The emails sent to the individuals selected in the contact list contains: operating room number, message status, defect type and the message content with the Andon alert Message as Subject. This email is formatted as shown in Figure 5.

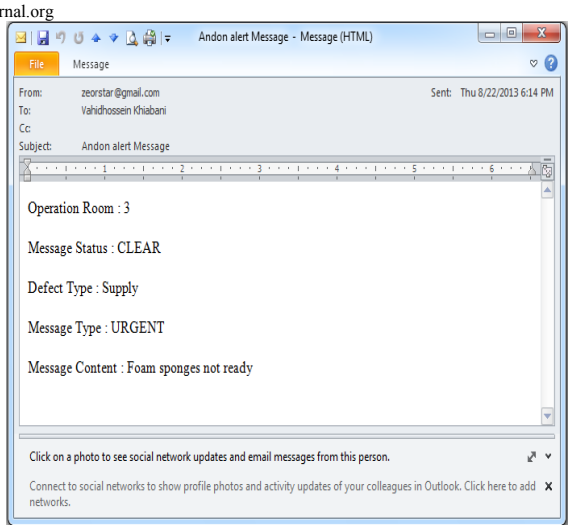

Fig 5: Email Messages

3.5 Sustainment Plan

In order for the Andon system to remain a viable tool in healthcare, it would have to be sustainable from all aspects of criticism and user interactions. The Andon will also bring value to the entire defects reporting, resolving, documentation, and archiving. This will be just the initial input process. All other interaction and information transfer and storage are value-added and make the defect reporting and archiving painless.

Some of the reasons expressed in earlier reports for not documenting and reporting defects include:

- The incident reporting system is not anonymous
- Fear of punitive action
- Poor safety culture in the organization
- The report could self-incriminate the individual
- When incidents are reported, there are no action plans and subsequent corrective/preventive actions implemented and actions are not visible to the work force
- Managers and decision makers are reluctant to swarm the problem or their efforts in tackling the problem are not adequate
- Lack of understanding of what needs to be documented and reported
- Lack of understanding who should be reporting the incidents
- Lack of understanding of how the data will be analyzed
- How the data is ultimately used
- After an emergency or problem swarming, staff are not inclined to report short-comings or incidents whether the outcome was positive or negative

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Almost all of the reasons presented here had been addressed using the Andon system in healthcare. Given the anonymous nature of the Andon system along with the focus of safety and patient care by minimizing the frequency and effect of defect in the day-to-day operation of the OR it becomes easier for the clients and users to understand and accept the system as part of a new institution/managerial culture of the hospital/healthcare system to maneuver away from the culture of blame towards a culture of quality improvement. The interface makes it clear what information is needed and who should be reporting the data and who will be responding and controlling the data and for what purpose.

Like many new systems it take a while for the user to trust and accept the system. It is up to the management to educate and train and repeatedly communicate their purpose when using the new system. What management does with the data will determine how serious they are with respect to implementation of a culture of safety?

4. DISCUSSION

A surgical department was used as the Alpha site for our team to collect defect data along with other data related to causes of delays and cancellations with the help of the hospital staff and management. Data was collected for two different procedures. The two procedures include: 1) Total Joint replacement surgery; and 2) Ophthalmology (cataracts) which provides a good contrast against procedure #1. Total joint replacement surgery is very invasive and has potential for significant harm. Ophthalmology cases are done as outpatient but still have lots of potential for defects.

The hospital has 7 operating rooms on their facility. The operations are on a block schedule for each department. Orthopedic surgery is the most back-logged department for surgery. Since the facility is a teaching hospital, in almost all cases, there are an attending surgeon, a resident, an OR nurse, a scrub nurse, a nurse technician, anesthesiologist, and an assistant in the operating room.

The hospital is a level one facility and has a very low rate of cancelation. In the past 6 months, there has been an average of 17.5 cancelations and 21.3 delays. We considered OR delays and cancelations as high priority defects in the healthcare since wasted preparations are significant waste of the resources.

Based on our observations, interviews with staff, and data collected or provided during our observation, we categorized the defects in the following categories:

- Equipment/Instrument Missing or not usable
- Supply Depleted
- Additional Equipment Needed
- Software/Forms
- Nurses/ Anesthesiologist/Surgeon/staff
- Vendors
- Medication/Drugs/Anesthesia
- Patient
- Space
- Institution

In summary, we observed an average of five defects per surgery. Defects vary from missing instrument to missing medication. Table 1 depicts the defect cost analysis. The average defect required a response time of three (3) minutes. This would be a nurse/technician/provider wasting several minutes responding to the defect in most cases. Since in average seven (7) OR rooms were operational per day and assuming an average of 5 procedures per day, then the total time wasted due to defects would turn out to be 210 minutes/day.

Considering time wasted due to defect averaging 210 hours/month, the cost associated with defects in OR (using only $35/min cost) is calculated to be $441,000 per month.

Table 1: Defect cost Analysis

Avg. # of OR defects per month	4200
Avg. time wasted per defect	3 minutes
Avg. hrs. lost/ month due to defects in OR	210 Hrs.
Avg. Cost of defects per month	$441,000

Analyzing the historic data gathered, which includes the delay and cancelations from 2009 to April 2013, also reveals an average of 36.5 minutes lost per day due to delays. In some cases defects will lead to delays, which could have significant cost associated with them.

Administrator, Anesthesia, Nursing and Instrumental delays are shown in Figure 6. The Administration and Anesthesia delays vary from 3 to 5 per month. Figure 7 shows the average minutes per delay and approximate hours lost per month. This Figure shows in average 880 hours lost in a month due to delays.

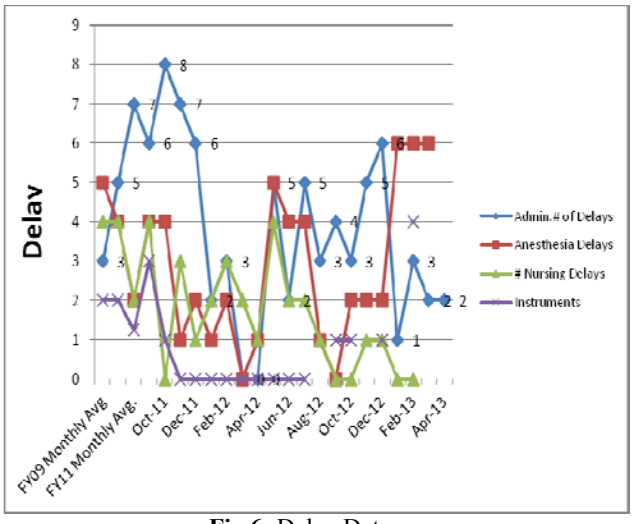

Fig 6: Delay Data

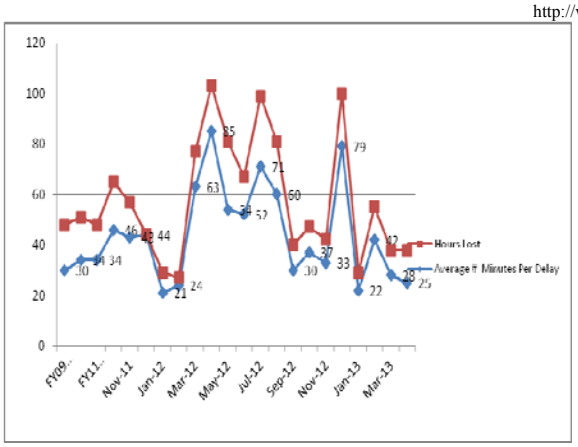

Fig 7: Delay Time

This illustrates the significance of the cost of delays or cancelations in the OR. However for more complex procedures the cost per minute can easily increase considering the overhead costs, physician fees and other fees [14]. However considering the case of multiple delays then the overtime pay also may be incurred for OR room staff [15]. Therefore we calculated the approximate cost of delay per month shown in Figure 8.

Using Andon interface system, the defect is documented and reported immediately and the computer does not keep track of who is reporting and why is it a defect. All defects will be reviewed by managers and responded to appropriately. The server will also archive the data and defect data will be available for analysis and improving quality of operation.

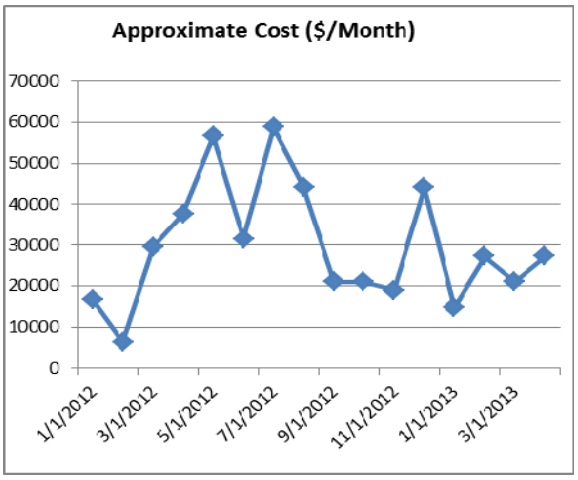

Fig 8: Cost of Delays

5. CONCLUSION

The Andon interface was designed and developed for notification and triage along with defect reporting and documenting in a healthcare setting and/or surgical operation in an OR. The interface is easy to implement and simple to use and requires minimum oversight along with the ability to notify staff for triage purposes or other emergencies. All defects reported are tracked and archived anonymously.

As part of this study, we observed an average of five defects per surgery. Defects are deviation from the established process and procedure that may have negative impact on patient safety and care that may delay and hamper the surgery. The average defect required a response time of three minutes. This would be a nurse/technician/provider wasting several minutes responding to the defect in most cases. Considering seven OR rooms operational per day with an average of 5 procedures per day, the total time wasted due to defects would be 525 minutes/day or approximately 210 hours/month.

This system is designed to be a true Andon which is a notification system along with being an easy and automated approach to collecting defect data. The cost savings along with the understanding of major defects plaguing a system will be an invaluable tool in minimizing the cost of healthcare and waste associated with it.

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