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Reducing patients' falls rate in an Academic Medical Center (AMC) using Six Sigma "DMAIC" approach

Reducing patients' falls rate in an AMC

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Abstract

Purpose – The purpose of this paper is to evaluate the impact of adopting the Six Sigma define, measure, analyze, improve and control (DMAIC) approach in reducing patients fall rate in an Academic Medical Center, Saudi Arabia.

Design/methodology/approach – A prospective study design was adopted and this study was conducted at King Fahd Hospital of the University (KFHU) during the year 2014. Based on the historical data of the patients' falls reported at KFHU during the year 2013, the goal was fixed to reduce the falls rate from 7.18 to < 3 (over 60 percent reduction) by the end of December 2014. This study was conducted through the five phases of "DMAIC" approach using various quality tools. Three time periods were identified, namely, pre-intervention phase; intervention phase; and post-intervention phase. Appropriate strategies were identified through the process of brainstorming and were implemented to study the potential causes leading to the occurrence of falls.

Findings – The pre-intervention falls rate was reported as 6.57 whereas the post-intervention falls rate was measured as 1.91 (demonstrating a 70.93 percent reduction) after the implementation of improvement strategies. The adherence rate toward the practice of carrying falls risk assessment and hourly rounding was observed to be high where 88 percent of nurses are regularly practicing it. A control plan was also executed to sustain the improvements obtained.

Originality/value – The Six Sigma "DMAIC" approach improves the processes related to the prevention of falls. A greater reduction in patients falls rate (over 70 percent) was observed after the implementation of the improvement strategy.

Keywords Six Sigma, Healthcare quality, Academic Medical Centers, DMAIC approach, Falls rate, Patients safety

Paper type Research paper

Introduction

The Academic Medical Center (AMC) or University Medical Center is not a single institution, but a constellation of functions and organizations committed to improve the health of patients and populations through the integration of its roles in research, education and patient care (Kohn, 2004). The occurrence of falls in AMCs is a significant patient safety issue and reducing such risks and ensuring patients safety are the most important challenges faced by the hospitals. Specifically in acute care hospitals, falls rate ranges from 1.3 to 8.9 per 1,000 inpatient days, of which 30 percent leads to serious injury (Oliver *et al.*, 2010; Stevens, 2005). It is estimated that the annual total cost of fall-related injuries could increase to \$34.4 billion by the year 2020 (Bonuel *et al.*, 2011). Among all the anticipated risks in the healthcare industry, the occurrence of falls is widespread and poses a serious threat to patient safety (Oliver *et al.*, 2010; Cameron *et al.*, 2010).

A fall is defined as "inadvertently coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects" (WHO, 2007).

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Generally, falls are precipitated by intrinsic or extrinsic factors. Intrinsic factors are those that have a physiologic origin, and extrinsic factors are those precipitating from environmental or other hazards. In addition to these, falls may also occur due to various causes and often represent an interaction among intrinsic factors (i.e. individual – weakness, impaired gait, impaired vision and impaired cognition), extrinsic factors (i.e. environmental – poor lighting, slippery floors and cluttered pathways) and, other situational activities (e.g. bending, reaching up and bed/wheelchair transfer) (Tinetti and Speechley, 1989). Organizational factors such as available policies, staff and equipment are considered to influence its occurrence in healthcare settings (Currie, 2008; Dykes *et al.*, 2010; Oliver *et al.*, 2010).

Further extensive research was carried out by Morse who classified inpatient falls into three categories, namely, accidental falls, which are derived from extrinsic factors, such as environmental considerations; anticipated physiologic falls, which are derived from intrinsic physiologic factors such as confusion and; unanticipated physiologic falls, which are derived from unexpected intrinsic events such as a new onset syncopal event or a major intrinsic event such as stroke (Morse, 1997). Among these classifications, approximately 78 percent of the falls were related to anticipated physiologic events which could have been identified earlier and could have been prevented by the adoption of appropriate safety measures. In addition, accidental falls are among the most common incidents reported in hospitals, complicating approximately 2 percent of hospital stays (Morse, 2002; Rubenstein and Josephson 2002; Agostini *et al.*, 2001). Specifically, neurosurgery, neurology, and medicine units tend to have highest falls rate, while surgical and intensive care units (ICUs) reported to have lowest falls rate (Hitcho *et al.*, 2004; Fischer *et al.*, 2005; Quigley *et al.*, 2009; Chelly *et al.*, 2008). This might be due to the fact that the patients in ICUs are less likely to be ambulatory, contributing to lowest falls rate (Chelly *et al.*, 2008). Other patient-related factors known to be associated with falling includes age, mental status, illness severity and the use of ambulatory aids which might differ across units contributing to these differences in falls rate (Hitcho *et al.*, 2004; Fischer *et al.*, 2005; Chelly *et al.*, 2008).

Prior studies have shown that fall-related fractures treated in hospital emergency departments and hospitalizations for fall-related injuries are increasing among older adults in developed countries (Orces, 2013; Hartholt *et al.*, 2011; Hartholt *et al.*, 2010). Specifically, 5 percent of falls result in injury and 2 percent result in fractures among hospitalized patients (Rubenstein and Josephson, 2002). The occurrence of falls among older adults is especially dangerous because of their increased causation of morbidity and mortality (Tinetti and Speechley, 1989; Currie, 2008; Oliver *et al.*, 2010). This is a critical issue in hospitals since older adults over and above 75 years constitute 22 percent of total hospital admissions (Wier *et al.*, 2010). It is clear, therefore, that falls and related injuries are associated with the quality of healthcare services.

The occurrence of patient falls in the hospital could lead to many consequences and it can result in injuries, death, additional medical cost, increased length of stay (LOS) and poor patient satisfaction. Previous studies also indicate that the occurrence of falls in hospital increases the cost of patient care. It was concluded that the patients who sustained a fall injury spent \$4,333 higher charges and longer LOS (i.e. 12.3 days) which equates to a 61 percent increase in charges and a 71 percent increase in LOS (Bates *et al.*, 1995; Hendrich, 1988). Recent studies also concluded that in patients who sustained a serious fall-related injury had higher total operational costs and longer LOS than non-fallers (Morello *et al.*, 2015; Wong *et al.*, 2011).

As a measure to reduce the occurrence of these falls in hospitals, several causative factors were identified. These include: inadequate staff communication; incomplete orientation and training; incomplete patient assessments and reassessments; environmental issues; incomplete care planning and unavailable or delayed care provision; and inadequate

organizational culture of safety (The Joint Commissions, 2005). These factors need to be explored by conducting a root cause analysis so as to implement an appropriate falls prevention program to prevent and reduce falls rate in hospital settings (National Quality Forum, 2004). It had been previously observed that several falls prevention strategies are in place for patients who have high risk of fall. These strategies include increased observation, systematic assessment, bed alarms, devices to assist with ambulation, patient education, active prevention and treatment of post-operative complications (Stenvall *et al.*, 2006; Lane, 1999; Roberts, 1993). Other interventions focusing on patient education, ergonomic improvements such as no-slip mats, bed exit alarms, and volunteers to assist with surveillance demonstrated a reduction in falls from 12.5 to 10.1 per 1,000 patient days (Fonda *et al.*, 2006). Besides these, individual lifestyle modifications such as regular exercise, reduction of alcohol intake, cessation of smoking and ensuring a balanced diet would reduce the risk of falls and osteoporosis (Pluijm *et al.*, 2006). Utmost care needs to be taken while choosing an appropriate falls prevention program that focuses on standard assessment of risk factors, universal fall precautions including scheduled rounding protocols, post-fall procedures such as clinical review and its root cause analysis.

While implementing these falls prevention programs, hospital administrators utilize several approaches to reduce falls and enhance patient safety. One such approach is Six Sigma. Six Sigma is a very robust and validated methodology for quality improvement, cost reduction and enhancing efficiency that helps to explore potential ways to improve processes using quantitative analysis and customers' involvement (Goldsack *et al.*, 2015). It measures quality in terms of defect rates and there should not be more than 3.4 defects per million opportunities. Earlier studies demonstrated the utility of the Six Sigma approach on improving various processes in the healthcare sector, namely, surgery turnaround time (Adams *et al.*, 2004), hospital discharge process (Vijay, 2014), hand hygiene compliance (Eldridge *et al.*, 2006), antibiotic prophylaxis in surgery (Parker *et al.*, 2007), scheduling radiology procedures (Volland, 2005), catheter-related bloodstream infections (Frankel *et al.*, 2005), nosocomial urinary tract infections (Hansen, 2006) and internal processes in a hospital (De la Lama *et al.*, 2013). A few studies have also addressed the application of Six Sigma approach in reducing the patients' falls rate in hospitals (Goldsack *et al.*, 2015; Christopher *et al.*, 2014). This approach is executed in five phase, namely, defining opportunities (D); measuring performance (M); analyzing opportunities (A); improving existing performance (I); and control the improved performance (C). All the previous studies addressed the effectiveness of the Six Sigma define, measure, analyze, improve and control (DMAIC) approach to reduce patients' falls in a small clinical settings. The present study focuses on investigating its effectiveness in an AMC by involving a multidisciplinary team of healthcare professionals. To facilitate this study, King Fahd Hospital of the University (KFHU) of Dammam, Saudi Arabia was chosen.

Methodology

Study setting

A Prospective study design was adopted to reduce the risk of falls and to create a safe environment for both patients and healthcare professionals at KFHU by embracing the Six Sigma "DMAIC" approach during the year 2014 (i.e. January-December 2014). To execute the study, a multidisciplinary team was formed by involving all the relevant stakeholders. The team consisted of representatives from the risk management, nursing, physician, operations management, finance and rehabilitation units. Several approaches were explored and the Six Sigma approach was chosen to implement the falls prevention program as a measure to reduce the falls rate in KFHU. The methodological framework adopted in this study is based on DMAIC model. Various quality tools and techniques were utilized in each phase of "DMAIC" to reduce the risk of falls at KFHU.

Define phase

The precise critical issue to be investigated was clearly defined by investigators belonging to the Directorate of Quality and Safety of KFHU. The selection of the critical issue was based on two key parameters, namely, medical records showing the occurrence of falls in the hospital; previous patient complaints. From the retrospective data of the hospital pertaining to the year 2013, it had been observed that the falls rate was measured as 7.18 per 1,000 patient days and its one-year trend is shown in Figure 1. Clinically, increased falls rate has a negative impact on the average length of patient stay (Figure 2). Extended patient stays could eventually lead to an increase in the cost of patient care. From these data along with the patient satisfaction survey reports, the falls rate was identified as one of the major contributor to dissatisfaction among inpatients.

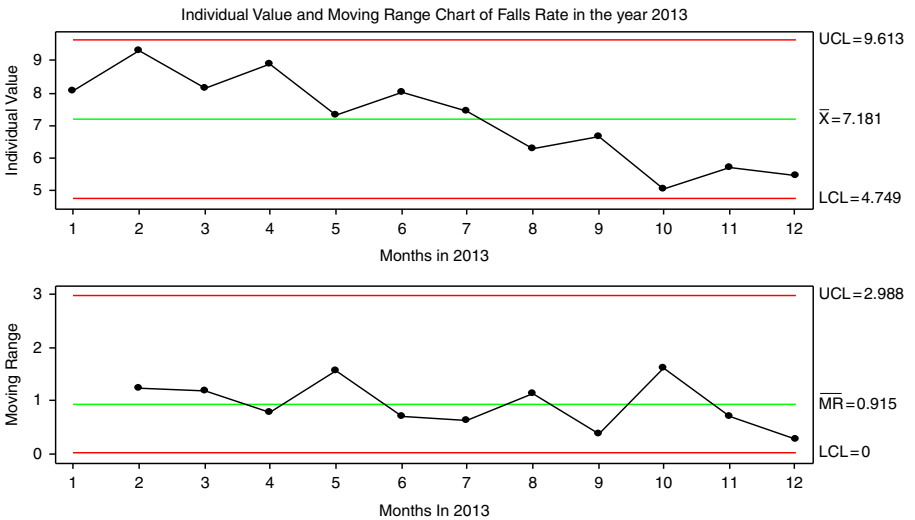


Figure 1. Control chart (I-MR chart) showing the trend of falls rate occurring at KFHU during the year 2013

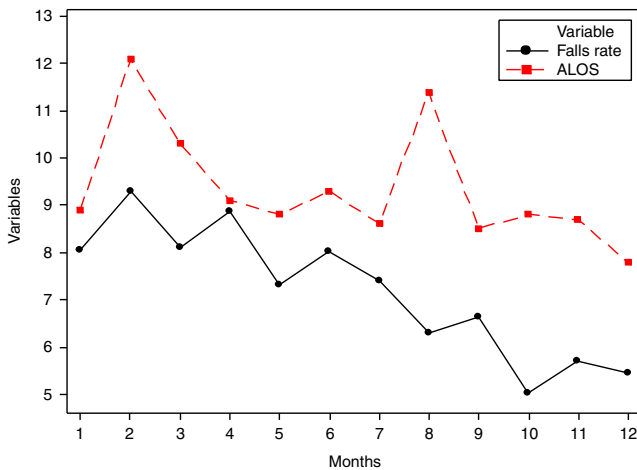


Figure 2. Time series plot showing falls rate and the average length of patient stay (ALOS) at KFHU observed during the year 2013

For the purpose of this study, falls rate is calculated by dividing the total number of falls occurring by the number of occupied bed days for each month in the hospital over a given period of time, such as one or three months.

The occurrence of falls was recorded on a monthly basis for the period starting from January to December 2014. Investigators captured the voice of the customers' by conducting direct interviews with relevant stakeholders such as nurses, physicians, unit secretaries, physical therapists, clinical technicians, patients and family members. Consequently, the opinions sought from the stakeholders were grouped using an affinity diagram and it was translated into critical to quality (CTQ) characteristics. The identified CTQs are:

- 100 percent completion of falls risk assessment on admission and re-assessment;
- 100 percent accurate documentation of patient history;
- 100 percent identification of high-risk patients;
- 100 percent access to call light system;
- 100 percent compliance with placement of trays and personal items;
- 100 percent patient education at the time of admission regarding what the patients can do to prevent falls; and
- 100 percent of compliance of healthcare workers with the falls prevention protocol.

After defining the problem and identifying the CTQs, a goal was fixed to reduce the patients' falls rate from 7.18 to < 3 per 1,000 patient days (i.e. with the aim of achieving more than 60 percent reduction) at the end of December 2014. It was anticipated that reducing falls would eventually enhance patient safety, increase patient and family satisfaction, decrease additional hospital costs and reduce LOS.

Measure phase

In this phase, the investigator developed a data collection plan and gathered data to stratify baseline performance. The initial three months (i.e. first quarter of the year 2014) is fixed as a time frame to collect data on the occurrence of falls at KFHU (i.e. pre-intervention phase). All inpatient units of KFHU were included in the study. However, several patient groups and clinical areas were excluded from the project, these being outpatients, emergency room, obstetrics, pediatrics, all procedural areas, operating room, and perioperative services. The falls rate per 1,000 patients' days reported at KFHU during the first quarter of 2014 is given in Table I.

The patients falls rate reported during the first three months of the initiation of the project (i.e. January, February and March, 2014) was measured as 7.97, 6.54 and 5.19, respectively. As a next step, the investigator utilized the stratification technique to ascertain in which locations of the hospital reported more falls.

Analyze phase

In this phase, the falls rate corresponding to each floor was calculated and it was subjected to further analysis using a Pareto chart with the aim of finding out the vital few contributing

Month of reporting	Falls rate per 1,000 patient days
January 2014	7.97
February 2014	6.54
March 2014	5.19

Table I.
Number of patients falls reported at KFHU during the first quarter of 2014

to the trivial many (Figure 3). A Pareto chart is used to highlight the most common source of defects or the most frequently seen defect in the data set (Al-Kuwaiti, 2016). From the Pareto analysis, it was observed that more falls were reported on Floor 1. Subsequently, the investigators utilized the cause and effect diagram to identify the possible causes for patient falls in that specific floor, which is here identified as a zone most prone to falls (Figure 4).

Based on the findings of the cause and effect diagram, the investigators found eight potential causes for the occurrence of falls. These include: details of high fall risk patients were not interchanged between nurses during hand over; orange sticker/falls risk sign was not used; staff were unaware of what to do for those who were prone to falls; power chart did not display high risk for falls in detail; fall risk assessment was either not completed or omitted at the time of admission; hourly rounding did not happen every 2 hours;

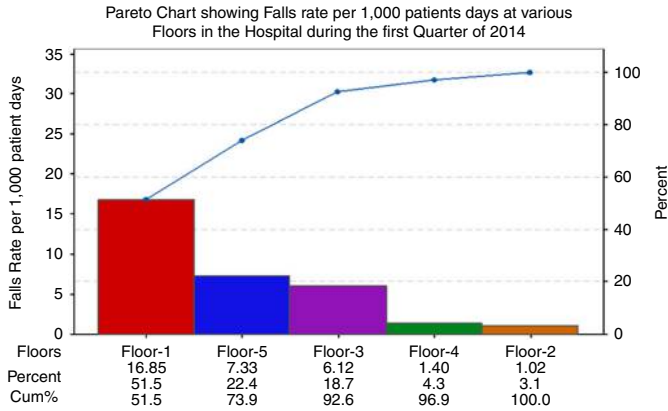


Figure 3.
Pareto chart showing falls rate observed across different floors of KFHU

Cause and Effect Diagram showing the Occurrence of Falls in the Hospital

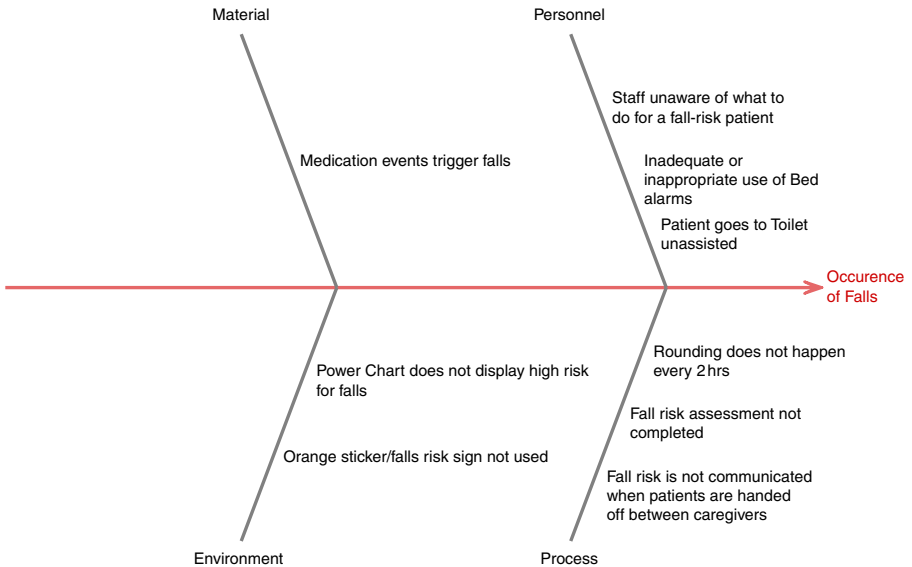


Figure 4.
Cause and effect diagram showing possible causes for patient falls in KFHU

inappropriate or inadequate use was made of the bed alarms/tab alarms/call bells; patient would go to bathroom without assistance.

All the potential causes identified during the analyze phase were taken into consideration and appropriate strategies were developed through various brainstorming session held with the relevant stakeholders of the hospital.

Improve phase

The investigators carried out a root cause analysis for each one of the factor (i.e. cause) identified during the analyze phase and developed a set of strategies for implementation. Root cause analysis is a systematic process during which all factors contributing to a sentinel event (i.e. patient falls) are studied and various ways to improve the quality of care are identified. Two kinds of root cause analyses were carried out, namely, aggregate and individual. Through aggregate root cause analysis, the investigator reviewed all the falls, or its related injuries that occurred over the previous month, quarter, or year. Further, the main causes for falls in KFHU were determined and the required changes were implemented to address each issue. Likewise, an individual-level root cause analysis was carried out by each unit head immediately after a fall. These analyses could take the form of a post-fall safety huddle, which is an informal gathering of unit staff to discuss what caused the fall and how subsequent falls or injuries could be prevented. The following strategies were suggested and had been implemented to overcome the potential causes of falls among the patients at KFHU for a period of three months:

- Consistent reinforcement of information about the current fall risk status of patients to all staff involved in their care was found to be an effective tool and it was implemented across the hospital. This reduced not only the falls in the first seven days of admission, but also in the overall number of falls in the hospital.
- Created awareness among all healthcare providers and visitors about patient's fall risk by displaying an orange sticker/falls risk sign in the common fall risk zones in the hospital.
- Trained all the relevant healthcare workers in the strategies to be adopted both to prevent falls from happening and also to handle the situation when it occurs.
- Displayed fall status clearly and obviously on power chart and appropriate personnel were assigned to accomplish this task.
- Developed a system to ensure that fall risk factor assessment is being performed within 24 hours of admission. Further to gain uniformity, all the patients were scored for fall risk by using the Morse Fall Scale, a standard scale for risk assessment.
- Implemented "Rounding protocol" for all staff nurses, nursing assistants, and the unit manager to ensure that universal fall precautions were put in place. Hourly rounds are being carried out to ensure that universal fall precautions are implemented and the patients' needs are being met. These rounds integrate fall prevention activities along with the rest of a patients' care.
- Installed bed alarm system to alert the healthcare providers when a patient rises from a chair or bed and are intended to prevent falls.

After implementing the improvement strategies, the research team members conducted an audit across the nursing units. Team members examined the case sheets or medical record for completion of the Morse fall scale (fall risk assessment tool) and also ascertained how each staff adhered to the rounding protocol. Accordingly, a sample of 100 case sheets from all nursing units was examined. While screening those samples, it was observed that

88 percent of case sheets showed completion of fall risk assessment and a proper execution of hourly rounding protocol by nurses; 9 percent of case sheets were observed with incomplete fall risk assessment and irregular hourly rounding protocol and 3 percent of case sheets showed negligence of fall risk assessment and hourly rounding protocol by nurses. Nursing staff not conforming to the execution of falls risk assessment and the rounding protocol were identified and advised to strictly adhere to these protocols in their respective units.

Control phase

After the process was stabilized, the control phase was initiated to sustain the improvement obtained. A control plan was developed to statistically monitor the process as well as to observe how regularly the fall debriefing tool was utilized by the staff. Accordingly, a control chart was developed to monitor the reported falls rate during the fourth quarter 2014 and the data indicates what is observed within the upper and lower control limits (Figure 5). A control chart is used for distinguishing between the common causes of variation and special causes of variation for a CTQ element (Al-Kuwaiti *et al.*, 2016). A proper communication plan was also developed to monitor the training schedules and assign responsibility to the team members in order to make the staff aware of the implemented changes.

Results and discussion

This study is the documentation of the effect of utilizing Six Sigma “DMAIC” approach as a measure to reduce patient falls rate at KFHU, Saudi Arabia. In order to execute this study, a multidisciplinary team covering all the relevant stakeholders at KFHU was formed and it was carried out through five stages of “DMAIC.” During the define phase, the problem was defined based on the historical patients falls rate, which was reported as 7.18 in the year 2013. From this data, the senior management realized that there was a high in patients’ falls rate which might negatively impact patient satisfaction, LOS and cost. Accordingly, a goal was fixed to reduce the falls rate from 7.18 to < 3 per 1,000 patient days (i.e. anticipating 60 percent reduction) by the end of December 2014. By analyzing the voice of customers,

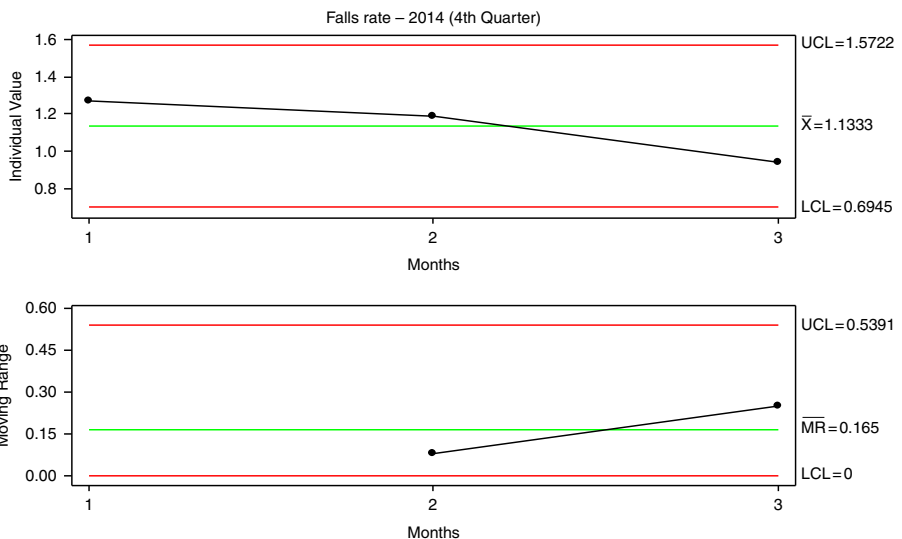


Figure 5. Individual moving range (IM-R) control chart showing a falls rate observed during follow-up phase (fourth quarter of 2014)

a CTQ characteristics was developed. During the measure phase, falls rate in the first three months (First quarter of 2014) was measured and reported as 7.97, 6.54 and 5.19, respectively. Further analysis was carried to find out the locations in the hospital where high incidences of falls were reported. In the analyze phase, Pareto analysis was carried out to find out which floor/location of the hospital contributed to higher falls rate. From the Pareto analysis, it was observed that the incidence of falls was higher on Floor 1 than elsewhere and the investigator applied cause and effect diagram to identify the possible causes for each patients' fall on Floor 1.

Based on the findings of the cause and effect diagram, eight potential causes were identified. All the identified causes were carefully studied and appropriate strategies were framed through various brainstorming sessions with the stakeholders of the hospital. Following this, strategies planned for the identified causes were efficiently implemented throughout the hospital. Rounding protocol, risk factor assessment of falls, bed alarm systems, power chart displaying fall status, orange sticker/fall risk sign, training staffs, and information about current fall risk status to staffs were implemented to overcome the potential causes. After implementing the above strategies, the research team screened the case sheets for assessing the adherence of staff in carrying out falls risk assessment and execution of rounding protocol. About 88 percent of case sheets showed completion of fall risk assessment and proper execution of hourly rounding protocol by nurses. However, incomplete fall risk assessment as well as improper and negligence of hourly rounding protocol by nurses were also identified and those nurses were advised to subsequently follow the strategies implemented in their respective units. As a result, the falls rate per 1,000 patients was reduced from 6.57 during the pre-intervention phase (first quarter of 2014) to 1.91 during post-intervention phase (third quarter of 2014). As a result, the implemented strategies led to 70.93 percent of reduction in falls rate at the end of December 2014. This improvement achieved using Six Sigma "DMAIC" approach is found to be higher than the initial goal fixed (i.e. > 60 percent). The results of this study were validated by previous studies, namely, incorporating hourly rounding into an already-established fall prevention program has been shown to strengthen the program and decrease fall rates (Dacenko-Grawe and Holm, 2008); hourly rounding was also observed to reduce call-bell usage; call-bell usage is associated with patient falls (Olrich *et al.*, 2012; Meade *et al.*, 2006); and implementation of patient-centered, pro-active hourly rounding program demonstrated a significant reduction in the fall rate and the initial team goal of a 30 percent reduction was surpassed to 65.64 percent (Marandola, 2014). In this study, "DMAIC" approach was adopted to create an awareness which made all the hospital employees to involve in the process. Using Six Sigma tools, areas with high occurrence of falls were identified and potential causes for falls were analyzed. As a result, appropriate strategies were developed using brainstorming sessions and implemented successfully to overcome the occurrence of falls at selected locations in KFHU. Also, a control plan was developed to sustain the gains or bring about further improvements to the process. In the present study, the impact of the falls rate on the cost of patient care is not addressed since the cost of patient care at AMCs is entirely managed through government funding in Saudi Arabia. Future research work should focus on studying the impact of falls rate on the cost of patient care in AMCs by devising suitable measures.

Conclusion

The application of Six Sigma "DMAIC" approach is found to be effective in implementing falls prevention program across KFHU, Saudi Arabia. Through the application of Six Sigma approach, the patients fall rate was reduced from 6.57 to 1.91 per 1,000 patient days establishing a 70.93 percent drop. Six sigma tools assisted in identifying the areas with increased number of falls and their causes. It was also observed that the majority of nurses

adhered to falls prevention measures and rounding protocol following the implementation of the improvement strategy. The results demonstrated a positive impact of the Six Sigma approach on reducing patients fall rate after application of the suggested recommendations for the period of three months. This study helped the hospital administrators and quality management personnel to understand how the Six Sigma methodology could be implemented to reduce patients falls rate in an AMC, Saudi Arabia.

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