Spring 2020

Can the Kanban Technique Reduce Medical Errors?

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Submitted in partial fulfillment of the requirements for the
Masters Degree in Healthcare Informatics

HCIN 699 Professor Glenn Mitchell

17 April 2020

Abstract

This study discusses common medical errors and the extent of harm caused in the United States and explores the application of the Kanban technique of Lean Management in the healthcare industry to reduce medical errors. It also describes various scenarios of how the visual scheduling/ signaling system has been incorporated for continuous process improvement in the clinical and non-clinical sectors of the industry based on several review articles. Furthermore, a survey study was performed in order to assess whether 'Kanban Visual Management System' utilization in healthcare has the ability to reduce medical errors. A convenience sample of healthcare providers was recruited to obtain an anonymous, online exploratory survey of current awareness of Lean management and Kanban techniques. The results suggest further investigation into Kanban's applications for reducing healthcare errors is warranted.

INTRODUCTION

Medical Errors:

   Medical errors are described as preventable adverse effects of medical care, that might or might not be evident or harmful to the patients (Hofer, Kerr & Hayward, 2000). A recent study by Institute of Medicine shows that 210,000 to 440,000 iatrogenic deaths occur per year in the U.S, that makes it the third leading cause of death, following heart disease and cancer (Brennan, Leape, Laird, Hebert, Localio, Lawthers, Newhouse, Weiler & Hiatt, 1991). The most frequent medical errors in the United States in 2014 were recorded as follows: adverse drug events, catheter-associated urinary tract infections (CAUTI), central-line associated bloodstream infection (CLABSI), injury from falls and immobility, obstetrical adverse events, pressure ulcers, surgical site infections (SSI), venous thrombosis/ blood clots and ventilator associated pneumonia (VAP) (Brennan, Leape, Laird, Hebert, Localio, Lawthers, Newhouse, Weiler & Hiatt, 1991).

   According to an article from NIH, one of the main reasons for medical errors is diagnosis related inaccuracies like failure to diagnose, delayed diagnosis or an incorrect diagnosis (Andrews, Stocking, Krizek, Gottlieb, Krizek, Vargish & Siegler, 1997). Other issues involve failure to consult and premature discharge from the ED. Some other contributing factors are failure to order appropriate tests and non-adherence to treatment plans and follow up appointments. Communication issues include failure to communicate among providers, poor professional rapport, insufficient communication between providers and patient's family (Carver & Hipskind, 2019). A study by Sklar, D. P., et al., suggested that "there were 30 deaths per 100,000 discharges, half of which were unexpected and related to ED care, 60% of which involved a possible error". One of the most recurring observations was that vital signs were abnormal at discharge for nearly

all of those unexpected deaths, and the most common was tachycardia (Sklar, Crandall, Loeliger, Edmunds, Paul & Helitzer, 2007).

With the advent of the electronic heath record system (EHR), three main phases of malpractice were hypothesized (Mangalmurti, Murtagh & Mello, 2010). Inadequate training during the implementation phase can give way to numerous error pathways. The transition from paper to electronic system can cause downtimes, which are not often planned well for, causing health information to be divided, leading to gaps in documentation and other error possibilities. Systemwide bugs and failures can occur during the mature phase and if this happens at times when tech support is not readily available, there can be disruption and interferences in routine processes, opening the error doorway.

The Institute of Medicine mentions that errors occur most commonly due to faulty systems, processes and conditions that lead people to make them or fail to prevent them (Hofer, Kerr & Hayward, 2000). Health Lean management (HLM) is one of the proven ways to work on process improvement (Crema & Verbano, 2015). It is important to understand that designing a safer health care system means to make it harder for providers to make mistakes and easier for them to do it right. Of course, accountability is essential but blaming an individual does little to improve the system that allowed that mistake.

Healthcare Lean Management and Kanban Visual Signaling System:

Lean Management can be defined as a managerial method of eliminating wastes to improve flow of activities and increase value to customers. It was first introduced in Japan by the Toyota Company in the 1950s (Tarne, 2011). Similarly, health lean management is a way to standardize and specify work flows, in order to avoid unexpected adverse events or to deploy activities that

identify and fix mistakes in the healthcare industry (Crema & Verbano, 2015). In a complex

industry such as healthcare, errors may not be prevented completely. Therefore, all possible

interventions should be employed to control risks. Although Six Sigma tools also help reduce

errors, the method is not necessarily acceptable when dealing with human lives (Crema &

Verbano, 2015).

   The Kanban system was first integrated into the Toyota production system's lean

management methods and it literally translates to 'single card' in Japanese (Tarne, 2011).

The name refers to the cards workers used to identify the process steps in a workflow. It is

a visual system that manages workflow and is based on the concept of Just-In-Time (JIT).

In the project management world, the JIT concept means that items are produced only on

demand to avoid wastage instead of producing them in advance and storing them as

inventory (Tarne, 2011). This should help us understand that Kanban is also used as a

scheduling/signaling system that tells you what to do, when and how to do it and in the

process, so that many procedural errors can be avoided.

   Kanban first started being used in healthcare in the 1980s with the 2-bin system for

inventory (Aguilar-Escobar, Bourque & Godino-Gallego, 2015). Both bin A and bin B

were filled with the same inventory. The nurses used bin B once A was empty (Figure 1).

This would be updated in the Kanban cards for the material suppliers instead of requiring

individuals from different departments to physically inspect the bins in order to replenish

them. In the recent years, scanning processes or RFID-enabled Kanban cards are being

used (Aguilar-Escobar, Bourque & Godino-Gallego, 2015). This process improvement

method also helps reduce material management workload on nursing staff, thus improving

nursing personnel satisfaction (Aguilar-Escobar, Bourque & Godino-Gallego, 2015). A

similar example was depicted in a picture as shown below, in a research paper by Abouhenidi in 2014, published by the International Journal of Scientific & Engineering research in 2014 (Abouhenidi, 2014).

FIGURE 1:
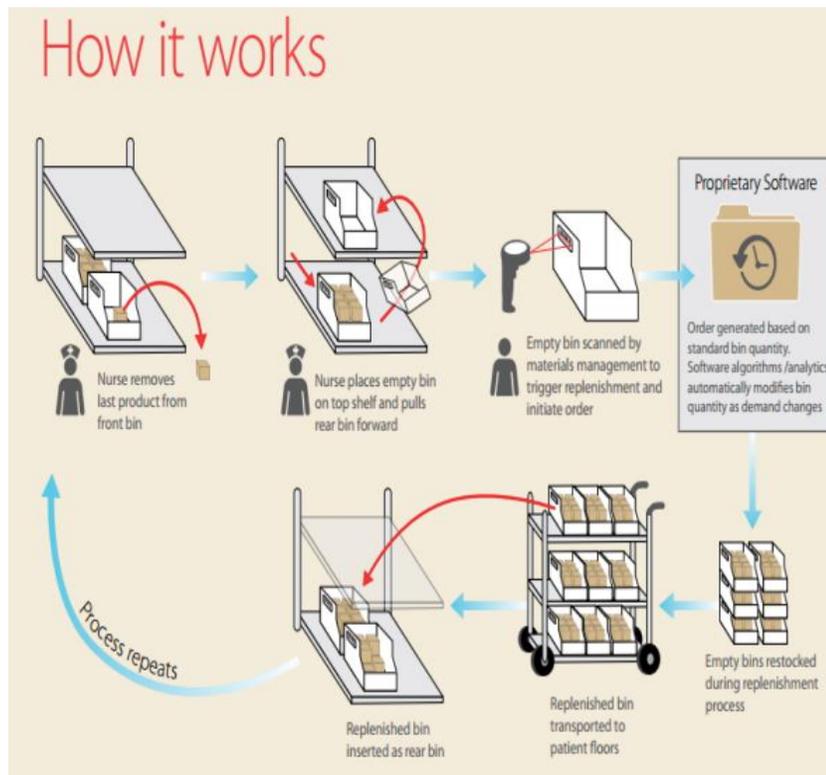
Utilization of Kanban in hospital inventory also helps in reduced chances of disruption in clinical activities. This is because the material handlers spend less time in the nursing units with reduced product handling because of kanban system. This means that the clinical staff are less intervened during their time with patients reducing chances to error (Aguilar-Escobar, Bourque & Godino-Gallego, 2015).

Khrishnayer and Chen talk about utilizing Kanban in a cloud-based decision support system for resource and schedule management (Krishnaiyer, & Chen, 2017). According to them, their research helped eliminate many spreadsheets that were used to monitor

production and instead, a single database was used to store and view all information. This helped managers and front-line employers use the cloud-based Kanban Decision Support system (CKDSS) to calculate the hours needed to complete tasks and manage resources more scientifically, which also resulted in collection of more accurate data. Therefore, CKDSS combined with robust continuous improvement methodologies have proven managers to make better decisions (Krishnaiyer, & Chen, 2017). With more structure to the non-clinical sector of healthcare comes a more mistake-proof clinical sector.

Lean management consists of identifying and eliminating eight wastes: overproduction, over-processing, unused skills, unnecessary motion, inefficient transportation, unwanted inventory and defects (Satyadi, 2013). The different types of medical errors can be compared to these wastes. For example, non-consulted discharges causing adverse effects can be avoided by having some kind of a signaling system that tells you if and when you can discharge a patient, perhaps a Kanban system. An article by NIH talks about a lean management concept called 'Poka Yoke', also called as 'mistake proofing' is better accomplished with a visual coding point or Kanban system. This demonstrated that Kanban has a direct correlation with defect prevention (Grout, 2006).

Lean thinking also helped improve the outcome of fracture patients in a district general hospital (Yousri, Khan, Chakrabarti, Fernandes, & Wahab, 2011). This was one of the largest studies conducted by the National Health Service used a system of utilizing resources efficiently whilst eliminating wastes. Statistically significant difference in outcomes were noted in a 30-day period, including overall mortality rates and early discharge from hospitals.

One of the best advantages of waste elimination through lean thinking is to help reduce patient wait times. A more customer-focused lean effectiveness approach is illustrated by a case study in which heart attack patients were transported to a central treatment hospital in a system wide, highly coordinated quick response program (Schonberger, 2017). This article demonstrates that Lean thinking and Kanban may not only be used in scheduling, inventory or resource management, they can also be used in an orderly way to reduce patient wait times and in more critical situations to help save lives through concentrated responses.

Kanban and Medical Errors:

With these correlations of Kanban with healthcare and its potential to avoid defects, we need more understanding about whether better comprehension and implementation of Kanban in healthcare can significantly reduce medical errors. As a healthcare management worker, this topic should not only aid my performance efficiency in the industry, but also uncover innovative ways to Kanbanize my workplace to reduce potential errors.

METHODS

The study of this topic began with literature searches in PubMed about medical errors and the history and extent of harm to patients in the U.S (Hofer, Kerr & Hayward, 2000). By using a snowball approach, the articles were picked from the reference list of each reviewed article from then on, following the same order as cited, for further study. Similarly, Health Lean Management and Kanban articles continued with the same approach, followed by article searches about their

utilization in healthcare. The articles for literature search were extracted from sources such as PMC-NIH (Pub Med Center and National Institute of Health), ScienceDirect, PMI (Project Management Institute) and the Library of Harrisburg University of Science and Technology.

An exploratory study was conducted to study the extent of understanding of Kanban in healthcare and its possible benefits to reduce medical errors. The method used an anonymous online survey using the tool SurveyMonkey to administer the survey questions. The target population was a convenience sample of clinical and non-clinical healthcare providers of any age, gender and ethnicity. Necessary Institutional Review Board approvals were obtained to protect respondents' privacy and rights. A poster was designed and displayed in various California hospitals such as Kaiser Permanente and Stanford Healthcare to encourage the healthcare provider population to take the brief survey. The questions included a fusion of likert, ipsative, yes and no, and true-false based response scales to judge the reliability in responses and avoid socially desirable responding. The Likert scales included four values only, to avoid both choosing a mean response and the reduce respondent fatigue. The 10 questions were reviewed by focus groups to make sure they are accurate for the target population and meet the goals of the survey. Convenience samples were ideal for this survey and the minimum sample size was 30. The survey was open for a period of one month and the data collected remained anonymous and confidential.

Hypotheses: -

Null Hypothesis: There is no significant effect between Kanban technique and medical errors.

Research Hypothesis: There is a significant effect between Kanban technique and medical errors.

Analysis: -

Refer to Appendix-1 for the survey questions. The questions focused on understanding the following checkpoints:
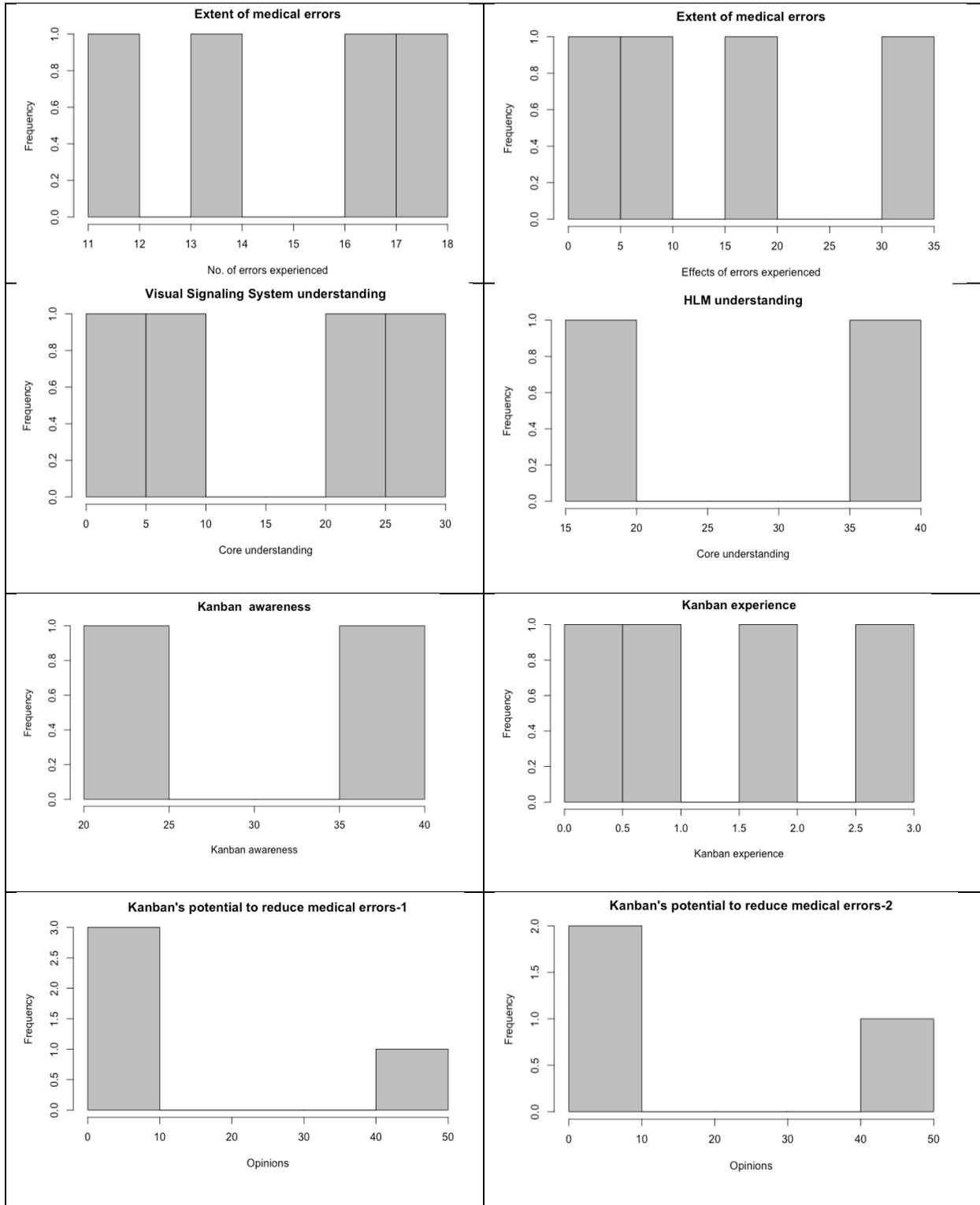
1. Extent of medical errors in the community.

2. HLM's and Kanban's level of comprehension and utilization in the community.

3. Kanban's potential to reduce medical errors.

4. Necessity of future work and study.

Responses were scanned for accuracy, missing data and outliers, and cleaned thoroughly once the survey was complete. The formatted dataset was then analyzed using Descriptive Analysis to check the distribution of data wherever applicable. With the help of R Studio, histograms for the responses of 10 questions were generated to review their data distribution. Chi Square test was conducted to check the goodness of fit. Microsoft Excel was the stage used for the same. Edward Tufte's Data visualization principles have been considered to display the results of this survey using bar plots (Guidelines for Good Visual Information Representations).

RESULTS

All 61 respondents were healthcare professionals. The survey had 10 questions and took the respondents on an average of 2 mins and 30 seconds to understand and finish the survey questions. The responses to the 10 questions show a normal distribution as seen in table 1. This makes the responses more reliable and easier to comprehend.

Table 1:
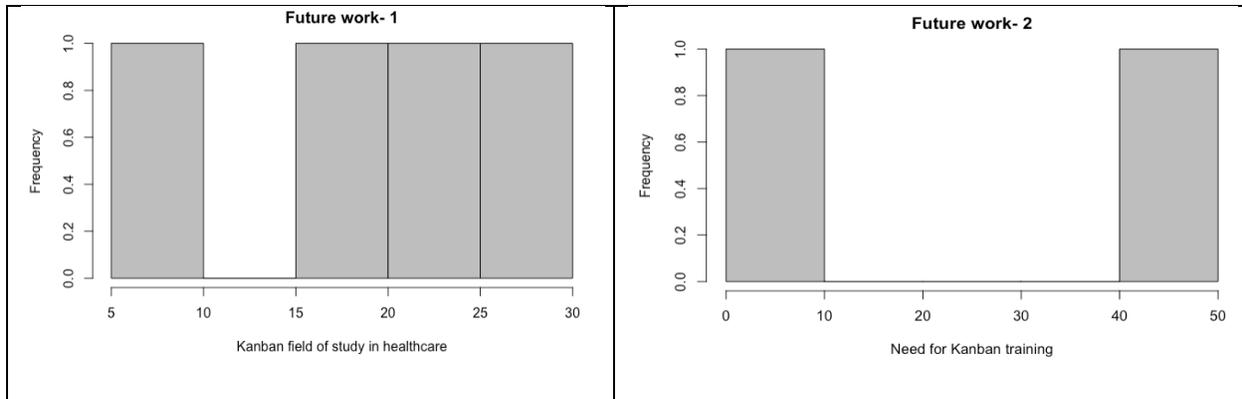
The first two questions revolved around understanding the extent of medical errors in the community. The first question tried to gauge the number of medical errors each respondent has experienced. The data received are numerical and descriptive analysis showed an even distribution with a confidence interval of 95%. About 70% of the respondents answered that they had experienced to one or more medical errors (Table 2). The second question targeted the extent of damage their medical error experiences had caused. Approximately 40% responded that those patients had undergone minimum to serious discomfort. One responded answered that the patient had died. One out of 61 respondents reporting a death due to medical error is a significant ratio, considering the alarming number of iatrogenic related deaths that occur per year in the U.S (Brennan, Leape, Laird, Hebert, Localio, Lawthers, Newhouse, Weiler & Hiatt, 1991).

Table 2:
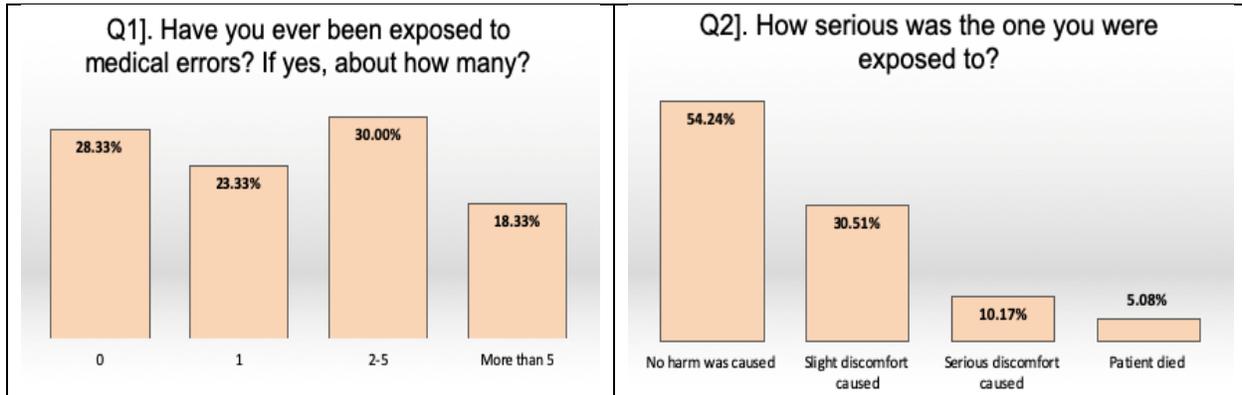
The next two questions explored the level of understanding of Lean management concepts. Question three is about Health Lean management, to which about 70% of the responses were positive to understanding the core of lean management. As we understand, Kanban is a lean management technique and is a visual signaling system. Therefore, understanding what a visual signaling system is important to move on to Kanban awareness. The results to question four showed an almost even split for visual signaling system understanding. Through question five, about 35% of them responded that they had come across a visual signaling system in their practices but not Kanban. Furthermore, only about 10% of them expressed their involvement working with Kanban. These four questions show an interesting pattern. The number of positive responses gradually decreased from HLM (question3) to visual signaling system (question 4), and then to Kanban understanding and usage (questions five & six). As the concept deepened, the magnitude of awareness and understanding reduced. This is a significant checkpoint for future study. Refer to table 3 for the visuals.

Table 3:
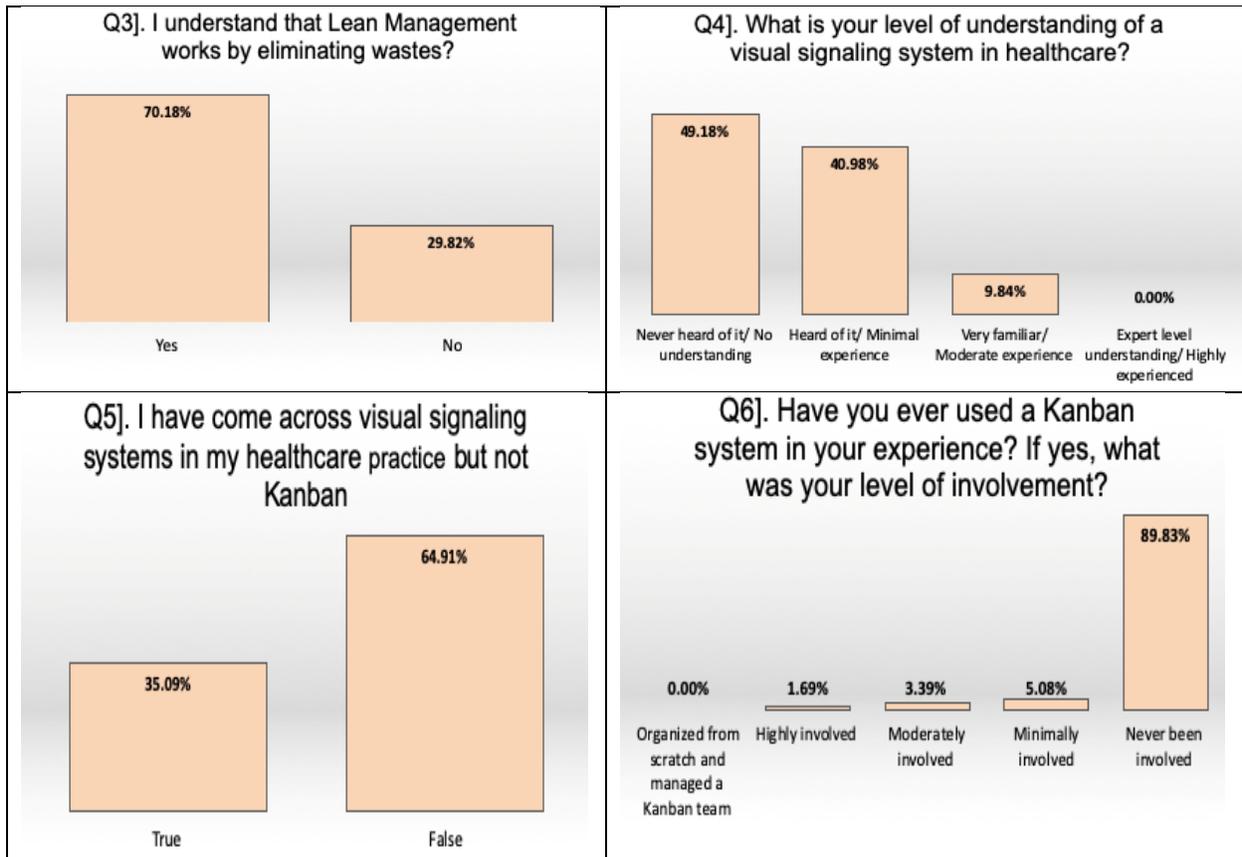
The next two questions target the real deal of this survey. Kanban's potential to reduce medical errors were paraphrased as question seven and eight to combat socially desirable responding possibilities. Question 7 aimed more at achieving a straightforward and broader understanding of Kanban's benefits, to which although only 15% of them vouched to Kanban's potential to reduce errors, none of the respondents strongly committed to Kanban making no appreciable difference in healthcare. Question 8 was paraphrased to ask more directly about Kanban's benefits specifically towards medical errors. To this, about 70% of them replied that Kanban has a good potential to reduce errors as shown in table 4. Chi Square tests were conducted for question 7 and 8 to check the goodness of fit as these questions are directly related to the hypotheses of this research study. The expected responses were set according to the null hypothesis. The p values

came out to be less than 0.05, making the study more significant with a definite effect of Kanban

technique on medical errors.

Table 4:
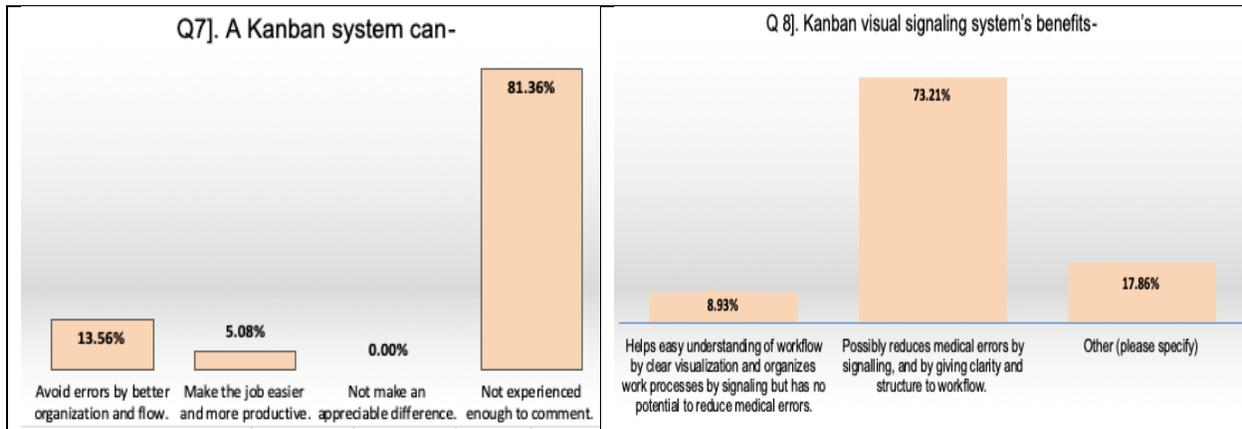
The final two questions revolve around the future research needed for this topic. According to

question nine, about 50% of the responses say that Kanban can be most utilized in the clinical

sector of healthcare. Question ten depicts close to 90% of the respondents calling for more

education, awareness and research necessity for kanban to be more creatively implemented in the

healthcare industry to reap its benefits to the fullest. Please refer to table 5 for statistics.

Table 5:
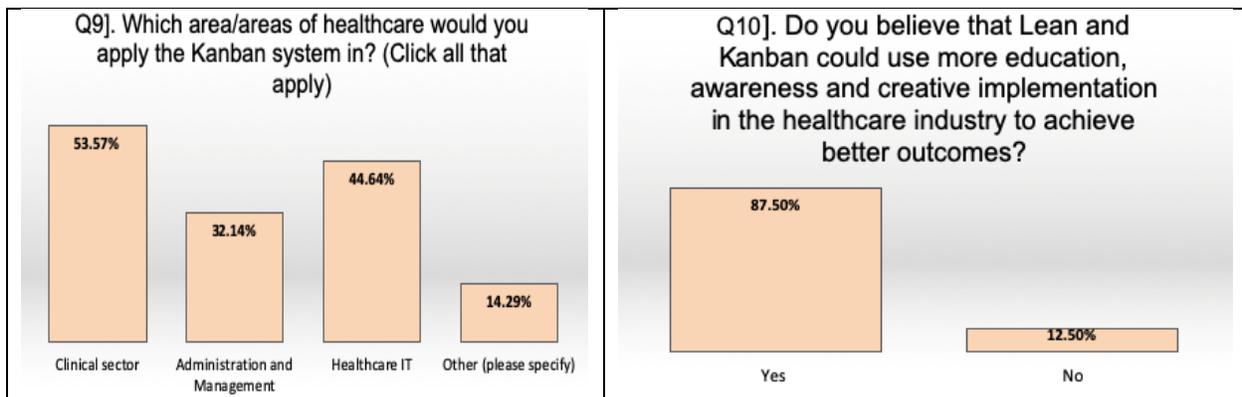
DISCUSSION

The survey respondents were all physicians and nurses whose responses indicate that the Kanban technique has a significant potential to impact the extent of medical errors in the healthcare industry. Approximately 400,000 hospitalized patients each year experience some type of preventable harm (Rodziewicz & Hipskind, 2020). Based on an article by National Institute of Health, medical errors account for over $4 billion per year (Rodziewicz & Hipskind, 2020). According to Table 2, 70% of the survey responses depict medical error experience. With such an immense trend in errors, a fix is in order, needless to say. Solutions can come as different techniques and methodologies. But any solution at any point is worth the research to reduce harm to the community. One such method is the incorporation of a better management system.

Health Lean Management is a proven method that has shown promising effects in bringing value to the patients since many years through its techniques of Kaizen, Continuous Improvement, Value Stream Mapping and many more (Lawal, Rotter, Kinsman, Sari, Harrison, Jeffery, Kutz, Khan, Flynn, 2014). Apart from the obvious financial outcome benefits, HLM has a track record to enhance patient and employee satisfaction and productivity, decrease mortality rates, readmission rates, length of stay and many more (Lawal, Rotter, Kinsman, Sari, Harrison, Jeffery, Kutz, Khan, Flynn, 2014). But one such HLM approach called the Kanban technique seems not explored enough. Literature search results also conclude that there are not too many articles about Kanban's visual signaling technique and its utilization in healthcare. This confirms the survey results in table 3, which shows that about 70% of the respondents are aware of HLM and its usage. However, their responses start to show diminished understanding and utilization when asked about visual signaling approach and Kanban in healthcare.

But the existence of proof to Kanban usage primarily in the supply chain department is a good start to realize that Kanban has a good potential in healthcare (Persona, Battini, & Rafele, 2008). The survey responses in table 4 also show that there is a 0% response rate for Kanban technique not making an appreciable difference in healthcare, although many responses incline towards lack of knowledge and experience. A field study by American Association for Physician Leadership mentions that the most significant benefit of Kanban was recorded as increasing patient safety by decreasing nursing logistics time (Harris, 2018). Similarly, patient safety can be achieved by using Kanban to its fullest extent to reduce medical errors and in other ways. A research article published by Science Direct talks about a case study, which shows Kanban's potential to lessen the chances of errors by organizing the workflow in a way that decreases disruptions caused during physician time for patients (Aguilar-Escobar, Bourque & Godino-Gallego, 2015). Moreover, over 70% of physicians and nurses vouch that the Kanban technique has substantial capability to reduce medical errors through the survey conducted, as shown in table 4. The Chi Square tests conducted based on the responses for the survey questions showed a p-value of less than 0.005, also indicating a definite relationship between Kanban and medical errors. With these significant findings through literature search methods and an exploratory online survey, this research study will not be accepting the null hypothesis.

There are, however, a few limitations to this research study. One of the biggest challenges was the limited time available for this study, which allowed only a month to conduct the survey. Therefore, the time available was not enough to collect a more geographically spread out and larger number of responses in order to make this research study more relatable to the community. Additionally, the Kanban technique is so minimally applied in the healthcare industry that there has not been enough research done on its utilization for medical errors. As a result, there were only

a limited number of research articles to depend on and understand the history and scope of Kanban utilization in healthcare. This must be an indication to the need for further investigation along a more effective period of time about the creative implementation of Kanban in various fields of healthcare to make the results more generalizable. Table 5 shows the responses to the last few questions of the survey, that illustrates approximately 90% of the respondents confirming to the need for more education, awareness and research of Kanban, to be able to apply it more innovatively and reap its benefits in healthcare to the fullest. In conjunction, over 50% of the respondents also suggested that kanban can be most effective if explored for benefits in the clinical sector of healthcare.

RECOMMENDATIONS

This research study has established that HLM and kanban have immense potential in healthcare, especially to reduce medical errors. However, the cumulative capabilities of lean thinking and kanban technique need more attention as suggested in the survey results. National Institute of Health confirms through a research article that operational and performance aspects of lean thinking have been looked into more thoroughly but its utilization, in healthcare have been scarcely worked on (Joosten, Bongers & Janssen, 2009). Additionally, lean concepts have several components which act independently and interdependently. For this reason, a more complex research design is needed to have more generalizable results (Joosten, Bongers & Janssen, 2009). Even if such research studies prove the effectiveness of HLM and kanban in healthcare, some changes to the current design of our healthcare system are essential. Perseverance, high quality leadership, dedicated professionals and patience are a few to mention. Organizations may resist

before embracing the change, or worse, superficially implement lean thinking, adding to existing

resistance and making it more difficult to improve health care in the long term (Joosten, Bongers

& Janssen, 2009). But with dedicated continuous improvement efforts, success is not farfetched.

In conclusion, HLM's and Kanban's potential to reduce medical errors must be a motivational

factor to propel not only more studies but also higher quality research with respect to their

application in the healthcare industry.

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APPENDIX

SURVEY QUESTIONS:

1. Have you ever been exposed to a medical error? If yes, about how many?

    1. None
    2. 1
    3. 2-5
    4. >5

2. How serious was the one you were exposed to?

    1. No harm
    2. Mild damage
    3. Severe damage
    4. Patient died

3. I understand that Lean Management works by eliminating wastes.

    1. Yes
    2. No

4. What is your level of understanding of a visual signaling system in healthcare?

    1. Expert level understanding/ Highly experienced
    2. Very familiar/ Advanced level
    3. Heard of it/Basic level
    4. Never heard of it / No understanding

5. I have come across visual signaling systems in my healthcare practice but not Kanban.

    1. True
    2. False

6. Have you ever used a Kanban system in your experience? If yes, what was your level of involvement?

    1. Organized from scratch and managed a Kanban team
    2. Highly involved
    3. Moderately involved
    4. Minimally involvement
    5. Never been involved

7. Would you say a Kanban system can-?

    1. Avoid errors by better organization and flow.
    2. Make my job easier and more productive.
    3. Not make an appreciable difference.
    4. Not experienced enough to comment.

8. Kanban visual signaling system's benefits include-

    1. Helps easy understanding of workflow by clear visualization and organizes work processes by signaling but has no potential to reduce medical errors.
    2. Possibly reduces medical errors by signaling, and by giving clarity and structure to workflow.
    3. Others (please specify).

9. Which area/areas of healthcare would you apply the Kanban system in? (Click all that apply)

    1. Clinical Sector
    2. Administration & Management
    3. Healthcare IT sector
    4. Others (Please specify)

10. Do you believe that Lean and Kanban could use more education, awareness and creative implementation in the healthcare industry to achieve better outcomes?

    1. Yes
    2. No
    3. Others (Please specify)