Caring is Sharing – Exploiting the Value in Data for Health and Innovation
M. Hägglund et al. (Eds.)

doi:10.3233/SHTI230195

The Effect of Physicians' Acknowledgement of Clinical Decision Support Systems Generated Alerts on Patient Diabetes Management in a Primary Care Setting

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Abstract. The purpose of the study is to evaluate whether clinician's acknowledgement and adherence to Clinical Best Practice Advisories (BPA) system's alerts improves the outcome of patients with chronic diabetes. We used deidentified clinical data of elderly (65 or older) diabetes patients with hemoglobin A1C (HbA1C) >= 6.5 that were extracted from the clinical database of a multi-specialty outpatient clinic that also provides primary care services. We performed paired ttest to evaluate whether clinician's acknowledgement and adherence to BPA system's alert has any impact on patients' HbA1C management. Our findings showed that the average HbA1C values improved for patients whose alerts were acknowledged by their clinicians. For the group of patients whose BPA alerts were ignored by their clinicians, we found clinicians' acknowledgement and adherence to BPA alerts for chronic diabetes patient management did not have a significant negative effect on improvement in patient outcome.

Keywords. Clinical Decision Support System, CDSS and Diabetes Management, Acknowledgement of CDSS alerts

1. Introduction

The use of Clinical Decision Support System(CDSS) tools in primary care settings has increased dramatically in recent years, especially for the use of managing patients with chronic conditions [1]. CDSS are computer based information systems that help physicians, nurses and other healthcare professionals with medical decision making. CDSS has been found to have a profound impact on improving physician behavior and doctor performance [1]. A team-based care for diabetes management using CDSS for Medicaid patients showed a significant reduction in patients' HbA1C [2]. A systematic

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review and meta-analysis on the effect of CDSS on cardiovascular risk factors revealed that complying with CDSS generated guidelines resulted in significant clinical benefits among patients with type 2 diabetes in attaining target low density lipoprotein cholesterol (LDL-c) [3]. A comparative study examining the effectiveness of team-based care with and without a CDSS for diabetes management showed a significant reduction in the cardiovascular risk factors in diabetes patients when the team-based care employed and used a CDSS [4]. Another study explored the use of CDSS for diabetes management in Scotland and found CDSS to have positive impact on improving patients' HbA1C [5]. A systematic review by Sly et al. found CDSS to have a significant positive impact on safety and quality of inpatient diabetes management [6]. However, numerous studies investigating the efficacy of CDSS at improving patient outcome, safety and cost of care are lacking positive findings [1, 7-8].

Studies that target specific diseases (e.g., diabetes; hypertension) have been sparse and the limited results have been equivocal in nature. There have been a few studies that have found CDSS to be effective in managing and improving the process of care for type 2 diabetes mellitus [9-10]. In a recent systematic review that investigated the effects of CDSS in individuals with type 2 diabetes mellitus, Clevering and colleagues concluded that CDSS was effective in improving the process of care, adding feedback on performance and/or case management [10]. However, this systematic review found equivocal results in regard to it effect on decreasing glucose levels. It should be noted that Tsai, Wang, Hsu & Li [11] conducted a study to investigate false positive alerts and whether they affect outcomes when investigating CDSS's effectiveness. They concluded that most studies do not differentiate the true positive and false positive alerts, and therefore, the effects of true positives and false positive alerts will be mixed. The implication of this is an underestimation of how effective CDSS is in reducing the negative effects of type 2 diabetes. This also increases the likelihood of Type II error when investigating CDSS.

The purpose of the study is to evaluate whether clinician's acknowledgement and adherence to Clinical Best Practice Advisories (BPA) system's alerts, a type of CDSS, embedded within an electronic health record (EHR) system improves the outcome of patients with chronic diabetes. The alert logic was designed in a way that it fired an alert based on a patient's condition to help the provider to acknowledge and review the patients chronic care plan for that year. The BPA's criteria were built for patients that had a chronic condition of diabetes or chronic heart failure and had not been seen for evaluation during the encounters. We hypothesized that the greater use of the BPA system by practitioners, the better the outcome for the patient suffering from chronic diabetes, as demonstrated by lower HbA1C levels.

2. Methods

For this retrospective study, deidentified clinical data for one month of elderly (65 or older) diabetes patients with hemoglobin A1C (HbA1C) >= 6.5 were extracted from the clinical database of a multi-specialty outpatient clinic that also provides primary care services. Average age of patients was 79 with a standard deviation 8.9. The dataset consists of 64% female and 36% male patients.

The dataset was collected from a multidiscipline outpatient practice. The practice served the population within the boroughs of New York City excluding the Bronx. It included a team of 100 primary care physicians and an estimated 4 support staff per

provider that comprised of a clerk, a medical assistant, a nurse and a mid-level provider such as a physician assistant or a nurse practitioner. The primary care physician along with support staff support a model called a provider care team. This model aligned in line with Patient Centered Medical Home (PCMH). PCMH is a model that has been created to allow organizations to structure their healthcare delivery system to best suit the healthcare providers and the patients. This model was geared to allow primary care facilities to provide efficient and cost effective care without compromising the quality and coordination of care a patient received.

For each of these patients, a CDS alert based on BPA indicating elevated HbA1C was generated that required primary care clinician's attention and further clinical intervention(s). To comply with the widely used National Institute of Diabetes and Digestive and Kidney Disease (NIDDK) guidelines, the organization's protocol requires repeating HbA1C test every 3 months for diabetes patients and every 6 months for patients whose blood sugar is well-controlled. We used patient records whose alerts were acknowledged, and the records with ignored alerts to verify whether the clinician's acknowledgement to BPAs improves chronic diabetes patient outcome.

For the group whose alerts were acknowledged, we claim ed that due to clinician's acknowledgement of the alerts, average HbA1C value after alerts would be improved (lowered) compared to the average of the last HbA1C value s prior to the alerts. Our null hypothesis for this case was that the average HbA1C would remain unchanged or worsen (elevated) after clinicians' acknowledgement of the alerts. A paired ttest was performed to verify our claim. For the records whose alerts were ignored, we also claimed that the average HbA1C value after the alerts would be worsen (elevated) compared to the average of their last HbA1C values prior to the alerts due to clinicians' ignoring of the alerts. Our null hypothesis for this case was that the average HbA1C would remain unchanged or improved (lowered) before and after the alerts . We performed a paired ttest to verify our claim for this group. All the data analyses were performed, and statistical values and 95% Confidence Intervals (CI) were generated using SAS 9.4 software. This study protocol was approved by SUNY Downstate Health Sciences University's IRB.

3. Results

Out of total 264 alerts, 191 (72.3%) were acknowledged by clinicians and 73 (27.7%) were ignored. For the group whose alerts were acknowledged, the paired ttest produced a t value of 2.9 with a probability value of 0. 00 4 (p-value < 0.05) which is sufficient to reject the null hypothesis and supported our claim. It also generated a n HbA1C mean difference of 0.24 (95% CI, 0.08 - 0.41) between before and after acknowledgement of the alerts.

For the group whose alerts were ignored, the paired ttest produced a t value of 1.87 with a probability value of 0.0 7 (p - value > 0.05) which supported the null hypothesis for this group and rejected our claim that the average HbA1C value of this group after the alert would be worsen (elevated) compared to the average of their last HbA1C values prior to the alerts. This test also showed that the average HbA1C improved (lowered by 0.17) after alerts compared to the average of the last HbA1C values prior to alert (95% CI, - 0.0 1 - 0.36).

4. Discussion

As the rates of diabetes mellitus continue to increase, the financial burden of the disease is also increasing as there has been a 41% increase in the United States from 2007 to 2012 alone; costing $174 billion to $245 billion [12]. Therefore, decreasing the rate of diabetes mellitus through the use of inexpensive interventions is warranted and can help to mitigate or even prevent other chronic illnesses. One such possible intervention is CDSS, as it has been demonstrated to be cost-effective and can be used to serve a large number of individuals with a generally low cost. Technology vendors, healthcare organizations and researchers have been working collaboratively to identify effective use of CDSS for chronic disease management. Our study finding has shown that clinicians' acknowledgement of CDSS alerts (BPA alerts) for diabetes patient management has a positive impact on patients' diabetes improvement (lower average HbA1C value) which is consistent with findings from recent literature review [9].

On the other hand, our study has also revealed that the group of patients whose BPA alerts were ignored by their clinicians did not have their average HbA1C value increase after the alerts were ignored. This could be due to improper labeling of BPA alerts in the system or false alerts or alert fatigues that caused the clinicians to ignore the alerts. This could also be due to clinicians ignoring the alerts because they were false alarms and just treating the patients based on standard protocol set forth by the organization without acknowledging them in the system.

5. Limitations

Our study had some limitations and some of the findings sound inconsistent with findings from current literature. For example, our study showed clinicians' ignoring of BPA alerts did not have any significant negative effect on the improvement in patient outcome which contradicted some of the findings from current literature [13]. The dataset lacked information on patient demographics such as race and ethnicity, clinician's expertise and training such as whether a clinician were properly trained on how to use the CDSS and take appropriate actions based on the system generated BPA alerts. Due to sensitivity of practice related business protocol, organizational requirement on BPA alerts and how these CDSS tools governed the clinical practice protocol to improve patient outcome were not available in the dataset.

The authors plan to explore comprehensive data that include patient level information, detailed information on clinicians, and clinical practice settings to address these limitations of this study and to identify factors associated with clinicians' ignoring CDSS generated alerts that could have clinical impact on the management of chronic conditions in primary care settings. However, knowing the reasons behind clinicians' lack of willingness to adhere to the CDSS generated alerts or ignoring the alerts in the primary care clinical settings can have profound impact on designing and optimizing CDSS tools that could potentially meet end user clinicians' needs and improve adherence to clinical protocols for chronic diabetes management in technology-enabled clinical settings.

6. Conclusion

The study has shown that the average HbA1C values improved for patients whose alerts were acknowledged by their clinicians. This finding aligns with findings from most of the studies that focused on CDSS and diabetes management [13]. The group of patients whose BPA alerts were ignored by their clinicians, our analysis showed that clinicians' acknowledgement and adherence to BPA alerts for chronic diabetes patient management did not have any significant negative effect on the improvement in patient outcome. This could be due to the study dataset's lack of detail information on clinicians' adherence to organizational protocols. The authors would like to explore this in the future to address this issue using larger datasets from multiple clinical sources that include both patient and physician level information.

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