Abstract

Clinical Decision Support Systems (CDSS) have the potential to help physicians overcome their own limitations in terms of information processing and decision making to create an outcome that is most beneficial to patients. While the impacts of CDSS have been shown to increase efficiency in a number of clinical trials, the results of these trials is varied and the manner in which CDSS affects outcomes is still not well understood. This study aims to increase the body of knowledge regarding factors that may influence the impact that a CDSS has on efficiency. The study uses efficiency measures made available by the Center for Medicare and Medicaid Services to study the relationship that CDSS has on these measures. The focus of this study is the extent to which the level of adjustment required by a physician to alter choices impacts the effectiveness of CDSS on efficiency. Results show that CDSS has a greater impact on decisions that require lower levels of adjustment than on those that require higher levels of adjustment.

Keywords

Clinical Decision Support, Decision Support, Clinical Efficiency

Introduction

Physicians are faced with decisions each day regarding the treatment of patients including fitting a patient’s symptoms to a particular diagnosis, which tests should be ordered for patients, and what treatments should be given. For many years, physicians had only their own judgement and training on which to rely to make such decisions. This judgement could be influenced by history with other patients, exposure to medical research literature, conversations with colleagues, medical school and continued education. As with any decisions, the decisions required of a physician are subject to bounded rationality, cognitive biases, and heuristics (Dawson and Arkes, 1987).

Clinical Decision Support Systems (CDSS) have the potential to help physicians overcome their own limitations in terms of information processing and decision making to create an outcome that is most beneficial to patients. Much of what clinical decision support systems are intended to do is to create alerts and reminders for physicians to help them to make decisions that are in line with clinical practice guidelines (Hoyt and Yoshihashi, 2014; Kohn, Corrigan, and Donaldson, 2000). In this way, CDSS provides what is known as suggestive guidance (Silver, 1991). Clinical practice guidelines can involve guidelines on ordering tests, medication, surgery, and other procedures for a patient with a given condition (Wager, Lee and Glaser, 2009). These guidelines are put in place to ultimately increase the efficiency with which care is provided. That is, to provide the best outcome at the lowest cost. Hence, there is an expectation that comes with the implementation of a CDSS that it will increase efficiency. While the impacts of CDSS have been shown to increase efficiency in a number of clinical trials, the results of these trials is varied and the manner in which CDSS affects outcomes is still not well understood.

This study aims to increase the body of knowledge regarding factors that may influence the impact that a CDSS has on efficiency. The study uses efficiency measures made available by the Center for Medicare and Medicaid Services to study the relationship that CDSS has on these measures. The focus of this study is the
extent to which the level of adjustment required by a physician to alter choices impacts the effectiveness of CDSS on efficiency.

**Literature Review**

The relevant literature for this study originates from two different areas: decision support systems literature within the information systems discipline, and clinical studies related to CDSS.

**Decision Support Systems**

Decision makers often begin the decision making process from a starting point, adjusting the starting based on some feedback or guidance (Tyersky and Kahneman, 1974). For example, it has been shown that individuals who are asked to estimate a specific real world number, without strong knowledge of what the actual number may be, are biased towards a random number presented to them before estimating the number (Tyersky and Kahneman, 1974). In a healthcare context, a physician who is making a decision about what type of test to order for a patient may have a predetermined idea about what type of test a patient needs, and will adjust preferences based on feedback regarding that decision. The random number, or predetermined idea represent anchors. The anchor is the starting point from which decisions are made (Tyersky and Kahneman, 1974).

The anchoring effect in decision making has been well studied and can be applied to many different domains regarding numeric estimates (Epley and Gilovich, 2011), and also in legal judgements (Mussweiler, Strack, and Pfeiffer, 2000), purchasing decisions (Wansink, Kent, and Hoch, 1998), forecasting (critcher and Gilovic, 2008), negotiation (Galinsky and Mussweiler, 2001), and self-efficacy (Cervone and Peake, 1986) These and other studies related to anchoring and adjustment are well summarized in a 2011 literature review of the anchoring effect (Furnham and Boo, 2011).

Decision support systems have been shown to have an effect on the anchoring and adjustment bias. Warnings from decision support systems have been shown to reduce the effect of anchoring on estimation of list prices for homes (George, Duffy and Ahuja, 2000) and to “debias” individuals with respect to internet-buying attitude and purchase intention (Cheng and Wu, 2010), as well as making investment decisions (Bhandari, Hassanein, and Deaves, 2008).

This study explores the effects of decision support systems on the anchoring and adjustment of clinical decisions which impact efficiency.

**Clinical Studies Related to CDSS**

Medical research has also studied the effects of anchoring and adjustment. The effect has been discussed as an important one in influencing medical decisions in descriptive literature (Elstein, 1999; Dawson and Arkes, 1987). In addition, a number of studies have measured the impact of CDSS on efficiency outcomes (Chaudhry et al, 2006; Garg et al, 2005). Of particular relevance to this study is a study conducted at a single hospital which showed that CDSS use contributed to lower utilization of redundant imaging tests (Blackmore, Mecklenburg, and Kaplan, 2011). While studies measuring the impact of CDSS on various measures of efficiency exist in clinical literature, there is acknowledgement that the results of these studies are varied and that more research is required to understand the factors involved in influencing the impact of CDSS (Chaudry et al, 2006).

From the literature review conducted, there appears to be little research attempting to explain why CDSS is successful in impacting some measures but not others. This study adds to the literature by providing insight into this question and by applying prior knowledge from other domains on the impact of CDSS to the healthcare domain.

**Research Questions and Hypotheses**

The goal of this study is to provide insight into how CDSS impacts efficiency. Efficiency is viewed as the absence of waste. In a medical setting this involves avoiding unnecessary tests or procedures. As CDSSs are designed to provide alerts to physicians regarding the necessity of specific procedures or tests, it is expected that a CDSS will aid in identifying redundant or unnecessary tests, thereby increasing efficiency. This has
been supported by clinical trials conducted in single hospital settings (Chaudhry et al, 2006; Garg et al, 2005). Consistent with the reasoning presented and prior results, the first hypothesis is:

**H1: Level of use of clinical decision support systems by a hospital will have a positive effect on efficiency**

The impact of CDSS on efficiency does not always yield the same results. As will be shown in this study, the impact may vary depending on the efficiency outcome of interest. The aim of this study is to help explain this variation. Why does CDSS impact one efficiency measure but not another? To explain this, the concept of anchoring and adjustment is used. Physicians, because of their training and expertise, nearly always have self-generated anchors regarding what tests should be conducted or what treatments should be performed (Eraker and Politser, 1982). CDSSs provide alerts to physicians, recommending a change from the physician’s original intent. Consistent with theory regarding anchoring and adjustment, the greater the change, the less likely a physician will be to adjust an original decision to align with that which the CDSS recommends (Tversky and Kahneman, 1974). Consistent with this reasoning, the second hypothesis is:

**H2: Use of clinical decision support systems will have a larger impact on decisions that require smaller adjustments from an anchor than those that require larger adjustments**

**Method**

Two data sources were used in this study: the 2013 Health Information Management Systems Society (HIMSS) Dorenfest data and the 2013 CMS Hospital Compare dataset. Each year, HIMSS conducts a survey among hospital executives throughout the country pertaining to various aspects of information technology implementation and use at a hospitals. Survey items include estimates of the percentage of physicians using different IT components. Among the components included in the survey is clinical decision support. The CMS Hospital Compare Dataset contains results of various outcomes measures reported by hospitals to CMS. Among these measures are measures of clinical efficiency.

**Efficiency Measures**

CMS collects data from hospitals as part of the Hospital Outpatient Quality Reporting Program. This program requires hospitals to submit data on quality measures related to providing care in the outpatient setting. Many of the measures fall into the three Donabedian dimensions of quality: structure, process, and outcomes (Donabedian, 1966). Structural measures involve physical or governance artifacts that the hospital uses during the course of care. An example of a structural measure includes a hospital’s ability to track lab results electronically. Process measures involve the manner in which care is provided in the hospital. Many process measures involve adherence to specific care protocols. An example of a process measure is the percentage of patients admitted to a hospital with a heart attack that receive aspirin at discharge. Outcomes measures involve what happens to a patient once they leave the hospital. Many outcome measures involve mortality measures, such as the percentage of patients that die after a specific procedure is performed.

In addition to measures which fall into one of the three Donabedian dimensions, CMS collects data on efficiency measures. These measures are designed to determine the extent to which hospitals are eliminating waste and reducing unnecessary tests or procedures. Currently, the efficiency measures CMS tracks are related specifically to imaging efficiency. CMS collects data from hospitals on 6 different imaging efficiency measures. A list of the measures, their names, and descriptions as reported by CMS are provided in Table 1.

<table>
<thead>
<tr>
<th>Measure ID</th>
<th>Measure Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP 8</td>
<td>MRI Lumbar Spine for Lower Back pain</td>
<td>Outpatients with low back pain who had an MRI without trying recommended treatments first, such as physical therapy (If a number is high, it may mean the facility is doing too many unnecessary MRIs for low back pain)</td>
</tr>
</tbody>
</table>
Impact of Adjustment Level on CDSS Effectiveness

The measures were used as indicators of efficiency. One can see from looking at each measure, that they all involve a decision which must be made by a physician with respect to ordering radiology tests. Each outcome is a measure of the extent to which physicians made a decision that aligned with increasing efficiency. The OP 8 measure, for example, involves a decision of whether or not to conduct an MRI. In a CDSS system, a recommendation would be made to a physician recommending other treatments before conducting the MRI (Blackmore, Mecklenburg, and Kaplan, 2011). Likewise for OP 9, which requires a decision of whether to conduct a follow-up radiology test (mammogram, ultrasound, or MRI) if the test was within 45 days after a screening. Measures OP 10 and 11 involve a decision to conduct a single scan versus a double scan. It is important to note that the difference between a double and single scan involves the use of what is called a contrast material. This is a substance taken orally or intravenously that contain a radioactive material that can enhance the quality of the image of certain organs in the CT scan. Measure OP 13 involves conducting cardiac stress test before outpatient surgery. Measure OP 14 involves a decision to conduct a brain CT scan if a sinus CT scan has already been performed, or vice versa.

**Adjustment Level**

To look at effects of CDSS on different types of decisions, those involving greater adjustment levels and those involving less, each measure above is associated with a level of adjustment based on the difference between an assumed anchor position of a physician, and a guided recommendation provided by a decision support system. The assumptions of anchor positions by physicians and likely guidance of a clinical decision support system are listed in Table 2.

<table>
<thead>
<tr>
<th>Measure ID</th>
<th>Anchor Position</th>
<th>CDSS Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP 8</td>
<td>Patient needs an MRI</td>
<td>Patient does not need an MRI. Try recommended treatments first.</td>
</tr>
</tbody>
</table>
Table 2. Measure Anchors and CDSS Guidance

While this study does not collect information on a physician’s anchor position or opinion regarding the necessity of a certain test, the assumed positions above can be supported by sound reasoning. Each of these measures has in the denominator a count of the total number of a specific test (MRI, CT, mammogram, ultrasound) and in the numerator a count of the total number of these tests that met a certain criteria (no prior alternative therapies, other test conducted within the past 45 days, etc). Since all measures involve the number of tests performed, it is fair to assume that the anchor position of physicians ordering these tests was that the patients in question needed them. It is also fair to assume, since CMS guidelines are incorporated into CDSS alerts (Romano and Staffor, 2011), that CDSS guidance would recommend to physicians to hold off or change the types of tests being performed.

In looking at the anchor positions, and the CDSS guidance related to each measure, an observation is made that there are two types of recommendations. One is to avoid a test altogether, and one is to change something about a test being performed. Specifically, measures OP 10 and OP 11 involve recommending a different type of test be performed (CT with or without contrast), whereas the remaining measures involve a recommendation to avoid a test completely (at least momentarily). Given that the anchor positions associated with each measure is that a test be performed, it seems that the largest contrast to this would be a recommendation to not perform a test, and a smaller contrast to this would be to change the nature of the test. Therefore, measures OP 10 and OP 11 can be associated with lower levels of adjustment from an initial anchor position, and the remaining measures can be associated with higher levels of adjustment.

CDSS Use

The HIMSS Dorenfest database contains a dataset labeled UseOfITComponent. This dataset contains information on IT components that are used by physicians within a hospital, and an estimate of how many physicians use those components. Each hospital provides a separate estimate of the percentage physicians that use each component. The estimated percentages are recorded as ranges and can fall into one of four categories: 1%-25%, 26%-50%, 51-75%, and 76-100%. Use of systems for order entry is one of the components tracked in this dataset. In addition, the database contains information on whether or not hospitals have CDSS integrated into workflows. An order entry system in a hospital with CDSS integrated into workflows would provide physicians with decision support upon entering orders. Thus, in this study, the estimated percentage of use of the order entry component among hospitals indicating that CDSS is integrated into workflows is the element used to represent the use of clinical decision support. Because this study is looking to measure the effects of increased use of CDSS on efficiency, the percentages were converted to an ordinal variable ranging from zero to 3, with zero representing 1-25% use and 3 representing 76-100% use.
Covariates

Two variables are used as covariates in this study: size and Medicare Spending Per Beneficiary (MSPB) achievement points. Size could have an impact on efficiency as larger hospitals may have more resources to invest in making efforts to achieve efficiency. The number of beds of a hospital, taken from the HIMSS Dorenfest Database, was used as a proxy for size. To avoid having coefficients that are difficult to interpret, the raw number of beds was not used, but rather size was represented as a number from 0 to 3, representing the quartile into which each hospital’s size fell. The ranges for the quartiles were: 0-182, 183-300, 301-483, >483.

The MSPB achievement score is Medicare’s overall estimate of a hospital’s efficiency. This was used as a covariate because it is likely that a hospital that is more efficient overall, is likely to have higher imaging efficiency scores. The MSPB achievement score is derived from a raw MSPB score, which Medicare calculates for each hospital. The raw MSPB score is calculated by first taking the average amount of money spent for each Medicare episode of care, and then dividing this number by the average spending per episode of care across all hospitals. The raw number is thus standardized based on an expected spending. The MSPB achievement score is a score that Medicare uses to indicate how efficient a hospital is in providing care relative to other hospitals. The achievement score is a rating that ranges from zero to 10, with zero representing poor efficiency and 10 representing high efficiency.

Model

To test the effects of CDSS Usage and the covariates size and MSPB, a regression model was used. The regression model is as follows:

\[ \text{Efficiency} = \beta_0 + \beta_1 \times \text{Usage} + \beta_2 \times \text{Size} + \beta_3 \times \text{MSPB} \]

Since there were six different outcomes related to efficiency, the regression model was run 6 different times to test the effects of the variables on all six measures.

In order to test for differing impacts of the independent variables on outcomes associated with high levels of adjustment versus those associated with low levels of adjustment, a net regression was used. This technique is well documented and involves taking predicted scores from one model and subtracting them from actual scores of another variable, and using this difference as a dependent variable in a separate regression (Cohen et al, 2003). For the results to be meaningful, all variables must be standardized. In this study, the steps for the net regression model were done as follows:

1) All variables were standardized
2) Regression coefficients of the independent variables against OP10 and OP11 were calculated
3) Predicted values of OP10 and OP11 were obtained using the coefficients calculated above.
4) The difference between the predicted values of OP10 and OP11 and all of the independent variables were calculated as follows:
   a. \( \text{Diff}_{OP8,OP10} = OP8 - OP10_{pred} \)
   b. \( \text{Diff}_{OP9,OP10} = OP9 - OP10_{pred} \)
   c. \( \text{Diff}_{OP13,OP10} = OP13 - OP10_{pred} \)
   d. \( \text{Diff}_{OP14,OP10} = OP14 - OP10_{pred} \)
   e. \( \text{Diff}_{OP8,OP11} = OP8 - OP11_{pred} \)
   f. \( \text{Diff}_{OP9,OP11} = OP9 - OP11_{pred} \)
   g. \( \text{Diff}_{OP13,OP11} = OP13 - OP11_{pred} \)
   h. \( \text{Diff}_{OP14,OP11} = OP14 - OP11_{pred} \)
5) The dependent variables were then regressed on the Diff variables above to obtain the results in Table 5 and Table 6.
Results

The UseOfITComponent dataset from the HIMSS Dorenfest database contains information on 5,467 hospitals. The datasets from the hospital compare dataset contain information on a total of 4,122 hospitals. To conduct a proper analysis, a hospital was only included in the final result set if a match could be found between the HIMSS and CMS data, if the hospital indicated that it included CDSS into its workflow and also if the hospital had a recorded value for each of the 6 imaging efficiency measures as well as a MSPB Achievement Score. This narrowed the final dataset to 391 hospitals. To ensure that the independent variables were not heavily correlated with one another, a correlation analysis was conducted, yielding the results presented in Table 3.

<table>
<thead>
<tr>
<th>MSPB</th>
<th>Size</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSPB</td>
<td>1</td>
<td>-0.266 -0.140</td>
</tr>
<tr>
<td>Size</td>
<td>-0.266</td>
<td>1 0.198</td>
</tr>
<tr>
<td>Usage</td>
<td>-0.140</td>
<td>0.198 1</td>
</tr>
</tbody>
</table>

Table 3. Correlation Analysis

The results show that there is a small correlation between size and MPSB, but not large enough to impact the results of the study.

The regression results of the model on each of the dependent variables is given in Table 4.

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>OP8</th>
<th>OP9</th>
<th>OP10</th>
<th>OP11</th>
<th>OP13</th>
<th>OP14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>-0.403</td>
<td>-0.715*** -2.392*** -0.751*** -0.053</td>
<td>-0.102</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>0.318</td>
<td>0.114</td>
<td>-0.053</td>
<td>-0.678*** -0.051</td>
<td>0.051</td>
<td></td>
</tr>
<tr>
<td>MSPB</td>
<td>0.299*</td>
<td>-0.498***</td>
<td>-0.178</td>
<td>-0.123</td>
<td>-0.112***</td>
<td>-0.059</td>
</tr>
<tr>
<td>Constant</td>
<td>36.544***</td>
<td>11.015***</td>
<td>15.631***</td>
<td>6.109***</td>
<td>5.753***</td>
<td>2.620***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Observations</th>
<th>269</th>
<th>269</th>
<th>269</th>
<th>269</th>
<th>269</th>
<th>269</th>
</tr>
</thead>
<tbody>
<tr>
<td>R²</td>
<td>0.017</td>
<td>0.063</td>
<td>0.056</td>
<td>0.036</td>
<td>0.017</td>
<td>0.019</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.006</td>
<td>0.052</td>
<td>0.025</td>
<td>0.025</td>
<td>0.006</td>
<td>0.008</td>
</tr>
<tr>
<td>Residual Std. Error (df = 387)</td>
<td>5.691</td>
<td>4.546</td>
<td>10.019</td>
<td>5.945</td>
<td>1.683</td>
<td>1.170</td>
</tr>
<tr>
<td>F Statistic (df = 3; 387)</td>
<td>1.521</td>
<td>5.917***</td>
<td>5.246***</td>
<td>3.308***</td>
<td>1.497</td>
<td>1.677</td>
</tr>
</tbody>
</table>

Table 4. Regression Results

One can see the results provide support for H1 with respect to the regression on all outcomes except for OP8, OP13 and OP14. While the coefficients of Usage for these three outcomes are in the right direction, the results are not statistically significant. Therefore, H1 is not fully supported.

To test the second hypothesis, that the impact of CDSS Usage on low adjustment outcomes will be greater than the impact on high adjustment outcomes, the net regression was performed. The net regression tested
the difference in the impact of the model on each low adjustment outcome against each high adjustment outcome. That is, OP10 was tested against OP8, OP9, OP13, and OP14. OP11 was also tested against OP8, OP9, OP13, and OP14. The results of the comparisons to OP10 are shown in Table 5. The results of the comparisons to OP11 are shown in Table 6.

**Dependent variable:**

<table>
<thead>
<tr>
<th>OP8 vs. OP10</th>
<th>OP9 vs. OP10</th>
<th>OP13 vs. OP10</th>
<th>OP14 vs. OP10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>0.344***</td>
<td>0.207***</td>
<td>0.345***</td>
</tr>
<tr>
<td>Size</td>
<td>0.010</td>
<td>0.013</td>
<td>-0.016</td>
</tr>
<tr>
<td>MSPB</td>
<td>0.041***</td>
<td>-0.082***</td>
<td>-0.020</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.002</td>
<td>0.053</td>
<td>0.030</td>
</tr>
<tr>
<td>Observations</td>
<td>269</td>
<td>269</td>
<td>269</td>
</tr>
<tr>
<td>R²</td>
<td>0.478</td>
<td>0.079</td>
<td>0.199</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.472</td>
<td>0.068</td>
<td>0.190</td>
</tr>
<tr>
<td>Residual Std. Error (df = 387)</td>
<td>0.151</td>
<td>0.423</td>
<td>0.294</td>
</tr>
<tr>
<td>F Statistic (df = 3; 387)</td>
<td>80.779***</td>
<td>7.526***</td>
<td>21.927***</td>
</tr>
</tbody>
</table>

*Note:* *p<0.1; **p<0.05; ***p<0.01

**Table 5. Comparison of High Adjustment Outcomes to OP10**

<table>
<thead>
<tr>
<th>OP8 vs. OP11</th>
<th>OP9 vs. OP11</th>
<th>OP13 vs. OP11</th>
<th>OP14 vs. OP11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>0.221***</td>
<td>0.085</td>
<td>0.223***</td>
</tr>
<tr>
<td>Size</td>
<td>0.201***</td>
<td>0.205***</td>
<td>0.175***</td>
</tr>
<tr>
<td>MSPB</td>
<td>0.058***</td>
<td>-0.065**</td>
<td>-0.004</td>
</tr>
<tr>
<td>Constant</td>
<td>0.127***</td>
<td>0.182**</td>
<td>0.159***</td>
</tr>
<tr>
<td>Observations</td>
<td>269</td>
<td>269</td>
<td>269</td>
</tr>
<tr>
<td>R²</td>
<td>0.525</td>
<td>0.125</td>
<td>0.215</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.520</td>
<td>0.115</td>
<td>0.206</td>
</tr>
<tr>
<td>Residual Std. Error (df = 387)</td>
<td>0.151</td>
<td>0.423</td>
<td>0.294</td>
</tr>
<tr>
<td>F Statistic (df = 3; 387)</td>
<td>97.761***</td>
<td>12.634***</td>
<td>24.174***</td>
</tr>
</tbody>
</table>

*Note:* *p<0.1; **p<0.05; ***p<0.01

**Table 6. Comparison of High Adjustment Outcomes to OP11**
These results show a statistically significant difference between the effects of the given model on low adjustment versus high adjustment outcomes, in all comparisons with the exception of the comparison of OP9 and OP11. When taking into account that the magnitudes of the coefficients in Table 4 are larger for the low adjustment outcomes, and that the differences between these coefficients is statistically significant in all cases with the exception of the comparison of OP11 to OP9, there is support for H2.

Discussion

This study adds to information systems literature in two ways: 1) adds to an existing body of work investigating factors which may impact the effectiveness of health information technologies (including CDSS) on performance outcomes, 2) provides support for adjustment level as a factor influencing the impact of clinical decision support systems on efficiency. These findings could have potential implications for healthcare providers and designers of clinical decision support systems. As adjustment level has been shown to play a role in influencing provider decisions, it may be important for designers to set up alerts or warnings that recommend treatments which require less adjustment from an anchor point. That is to say that, although the elimination of a test may be desirable, a warning recommending such elimination may have a high likelihood of being ignored. This may mean that providers will have to re-evaluate recommendations to eliminate certain tests and favor perhaps making adjustments to existing tests that are less costly or invasive.

Although it may seem trivial to identify measures that are not likely to be impacted due to anchoring and adjustment, since operating under efficiency requires certain tests to be eliminated anyway, it may still be important to reduce the number of alerts to only those which are likely to have an impact, as alert fatigue has been shown to have an effect on a physician’s tendency to ignore all alerts.

Overall, increased understanding of the manner in which CDSS as a component of an electronic health record system, will allow providers to achieve better results from implementation. This will lead to improved outcomes among providers using electronic health records systems. This could further increase adoption levels of EHR systems, which remain low compared to expectations (Charles et al, 2014).

Limitations

This study is subject to limitations. First, the categorization of outcomes into those that are associated with low versus high adjustment from an anchor were done based on reasoning by the author and not on feedback from physicians or other providers indicating whether the recommendations to eliminate or change tests actually do represent large or small changes from an initial intent. Second, the proposed recommendations of a CDSS were not taken from data in the given sample, but were inferred from existing literature on radiology decision support systems. Third, decision support use is an estimate given by executives filling out the HIMSS survey and not based on any hard data.

Future Research

This study uses archival data to answer questions relating to the impact of CDSS. The study makes inferences about physicians’ intents and also on CDSS recommendations. A future study could involve a more controlled approach, collecting information directly from physicians regarding intent to prescribe a certain test, and offering different recommendations from a CDSS to observe changes in behavior.

The study could also be expanded to measure the impact of CDSS on other measures of efficiency to test the generalizability as imaging efficiency may be different than other types of efficiency. The impact on outcomes or process measures could also be evaluated to determine if the findings here are consistent across other clinical settings outside of radiology.

REFERENCES


