Internal Medicine Resident Satisfaction with a Diagnostic Decision Support System (DXplain®) Introduced on a Teaching Hospital Service.

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Abstract

Objective:
The objective of this study was to determine whether Internal Medicine residents would find the use of an expert system (i.e. Clinical Diagnostic Decision Support System) to be a satisfactory experience when used during a clinical rotation in the hospital setting. Resident willingness to use the instrument was considered to be of particular importance because of growing concerns regarding the educational experience of residents in the hospital. Thus, our first goal was to assess resident satisfaction with the tool, prior to widespread implementation.

Study Population:
Residents on the General Medical Hospital Service at St. Mary’s Hospital, Rochester, Minnesota

Study Type:
Prospective cohort study

Method:
We provided unrestricted access DXplain, a Web-based Clinical Diagnostic Decision Support System, to five general medical teams in St. Mary’s Hospital, Rochester, MN. All residents were particularly encouraged to access the system during the evaluation of new admissions. Usage of the system was recorded electronically each time a user logged on. At the conclusion of the 2 month study period, a survey was sent electronically to each of the participating residents.

Results:
During the study period, a total of 30 residents (G1 = 20, G3 = 10) rotated on the five medical services. 29/30 residents responded to the survey. 18/29 indicated that they had used the service, while 11/29 stated that they had not accessed the system. The resident’s logged on 117 times to enter a case during the study period, with several entering more than one case per logon. The average number of log-ons per user was 2.4/week. Of the 18 who used the system, 15 found it useful (83.3%), 2 were unsure whether it was useful (11.1%), and 1 (5.6%) did not think it was helpful. However, when asked how often the system led the user to consider novel alternative diagnoses 13/18 (72.2%) responded “almost always to frequently” and 5/18 (27.8%) said “occasionally to sometimes”. None of the users felt that the system “rarely” or “never” yielded additional diagnostic considerations. Seventeen out of eighteen users (94.4%) thought the system was “easy to use”. When asked if they would like to have such a system regularly available 13/18 (72.2%) responded yes, while 4/18 (22.2%) were unsure. One resident said that they would not like to have DXplain available (5.6%).

Conclusion:
We believe the data reflect a significant level of satisfaction with the system among residents. Their recognition that it frequently led them to consider novel diagnoses suggests it had a positive educational impact.

Introduction

Currently, the practice of medicine is undergoing significant changes, perhaps nowhere more noticeably than in the hospital setting. Patients who are admitted to a hospital service, especially at a teaching institution, generally are sicker and more complex than even a decade or two ago. Economic factors constrain resources and time available for hospital evaluations and therapeutics. As a result, residents, perhaps more acutely than anyone, have been sensitized to the need to rapidly diagnose, treat, and dismiss patients from the hospital setting. One of the consequences of this approach to medicine is that there is often little time for reflection or contemplation regarding a newly admitted patient. The goal is to determine a working diagnosis and proceed with haste to confirm the diagnosis, treat the patient and return the patient to the outpatient setting. This becomes a risky strategy when applied to elderly, complex patients, with multi-organ system dysfunction, whom are currently being seen with increased frequency on our teaching hospital service.
In particular, the diagnostic data from the last two years indicates that the average number of significant diagnoses per patient is greater than four. As a result, these increasing demands on the practice may truncate attempts at generating a differential diagnosis, and can often lead to misidentification of the problem or elimination of secondary diagnoses from the problem list.

This trend is troubling because the utility of the differential diagnosis is multifold. First, the clinicians' differential provides other physicians with insight into what the admitting resident was thinking at the time of admission. This can help provide the attending physician with insights into deficits in the resident's approach to the case. The differential diagnosis list also helps promote educational efforts on rounds, as other care providers mentally must consider each stated potential diagnosis, and measure its fit with the case, as presented. Third, a robust differential diagnosis helps keep the care team alert to the potential for a change in diagnosis. When working with a solitary diagnosis early on, the tendency is often to make the data fit the diagnosis, which has already been "chosen" (the "anchoring and adjustment phenomenon"). Maintaining a viable differential diagnosis helps keep the medical team alert to the possibility of a change in the diagnostic focus of the care team, with potential for change in therapeutics, prognosis, etc.

However, the very time constraints which have given rise to the concerns mentioned above, also make residents justifiably wary of any new demand on their time. Thus, before we proceeded to widespread implementation of a new tool (which we perceived to be easy to use and time efficient) we wanted to test it on a small sample of the intended users. We reasoned that even if the tool was helpful, residents would still be dissatisfied if it was cumbersome or slow or otherwise contributed disproportionately to their workload. Thus, we set out to evaluate the perceptions of residents actually using the system in the clinical setting.

**Preliminary Work**

**Diagnostic Decision Support Systems**

DXplain, a computer-based medical education, reference and decision support system, was developed by the Laboratory of Computer Science (LCS) at Massachusetts General Hospital (MGH). DXplain has the characteristics of an electronic medical textbook, a medical reference system and a decision support tool. In the role of a medical textbook, DXplain can provide a comprehensive description and selected references for over 2,000 different diseases, emphasizing the signs and symptoms that occur in each disease, the etiology, the pathology, and the prognosis. As a decision support tool, DXplain uses its knowledge base of the crude probabilities of approximately 5,000 clinical manifestations (History, PE findings, Lab data, Xray data and elements of the PMHx) and generates from it a differential diagnosis associated with individual diseases. The system uses an interactive format to collect clinical information and makes use of a modified form of Bayesian logic to produce a ranked list of diagnoses which might be associated with the clinical manifestations. DXplain uses this same knowledge base and logic to list other findings that, if present, would support a particular disease, and also lists what findings entered by the user are not usually found in a particular disease. The system also provides references and disease descriptions for each of the diagnoses in its database.

Over the past fifteen years ago DXplain has been used by thousands of physicians and medical students. Five years ago, LCS began to make DXplain available over the Internet to hospitals, medical schools, and medical organizations.

**Methods**

We provided unrestricted access to DXplain to five general medical teams in St. Mary's Hospital, Rochester, MN (Mayo Foundation's largest teaching hospital). Each service takes call every other day, with an average of 4 admissions per day. Teams are comprised of two First Year residents, a Third Year resident and a staff physician. Each team was provided with a one-hour introductory session in which basic features of DXplain were reviewed. All residents were particularly encouraged to access the system during the evaluation of new admissions. A special link was created on the Residency home page to allow easy linkage to the Web site containing DXplain. Usage of the system was recorded electronically each time a user logged on. Reminders of the system's availability were sent out via e-mail every two weeks. A survey (Figure A) was sent electronically to each of the participating residents at the conclusion of their rotation on the service.

Data analysis was performed using the Binomial Exact Test to compare the response rates with a rate
of 50% to determine whether or not the results could be explained by a random effect.

**Figure A: Survey for Resident Staff after using DXplain**

1. Did you find the program Helpful? Y, N, Undecided, Did not use
2. Please comment on your answer in #1.
3. How many times a week did you use the program?
4. Was the program more useful on your admitting days or other days?
5. Was the program easy to use? Y, N, Undecided, Did not use
6. Was the program as easy to use as you expected? Easier, Just as Easy, Harder to use, Undecided, Did not use
7. Would you like a program such as this one to be available routinely to Internal Medicine Residents at Mayo? Y, N, Undecided, Did not use
8. If there was a feature of the program which was particularly helpful please comment.
9. Did the DXplain program help you think of diagnoses, which you thought reasonable to consider for your patient’s presentation? (Always, Almost Always, Frequently, Sometimes, Occasionally, Rarely, Never)

**Results**

During a two-month period, a total of 30 residents (G1 =20, G3= 10) rotated on the five medical services. During the two-month study period the residents had 117 logons to DXplain where clinical cases were entered (multiple cases may have been entered per logon). 29/30 (96.7%) residents responded to the survey. 18/29 (62.1%) indicated that they had used DXplain, while 11/29 (37.9%) stated that they had not accessed the system. The average number of log-ons per user was 2.4/week. Of the 18 who used the system, 15 (83.3%) found it useful, 2 (11.1%) was unsure whether it was useful, and 1 (5.6%) did not think it was helpful (Mean 94.4% with lower confidence interval of 64% (p=0.03, Compared with a coin flip, Method Binomial Exact Test)). However, when asked how often the system led the user to consider novel diagnostic ideas, 13/18 (72.2%) responded “always to frequently” and 5/18 (27.8%) said “occasionally to sometimes”. None of the users felt that the system “rarely” (0/18) or “never” (0/18) yielded additional diagnostic considerations. 100% of the respondents felt that DXplain yielded additional diagnostic possibility at least “Occasionally” (with lower confidence interval of 78% (p=0.003) Compared with a coin flip, Method Binomial Exact Test). Seventeen out of eighteen users thought the system was “easy to use” (94.4% with lower confidence interval of 72% (p=0.004 Compared with a coin flip, Method Binomial Exact Test)). When asked if they would like to have such a system regularly available 13/18 (72.2%) responded yes, while 4/18 (22.2%) were unsure. 1/18 (5.6%) responded that they would not want to have DXplain available to their practice (94.4% did not say no (with lower confidence interval of 72% (p=0.004) Compared with a coin flip, Method Binomial Exact Test)).

**Did you find the program Helpful?**

<table>
<thead>
<tr>
<th></th>
<th>Useful</th>
<th>Not Useful</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident Responses</td>
<td>15</td>
<td>1*</td>
<td>2</td>
</tr>
</tbody>
</table>

* To rule out that the system was “not useful” we reported a mean rate of 17/18 (94.4%) with lower confidence interval of 64% (p=0.03) Compared with a coin flip, Method Binomial Exact Test

**Did the DXplain program help you think of diagnoses, which you thought reasonable to consider for your patient’s presentation?**

<table>
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<tr>
<th></th>
<th>Almost always-frequently</th>
<th>Sometimes - Occasionally</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>13</td>
<td>5*</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

*100% responded at least Occasionally with lower confidence interval of 78% (p=0.003) Compared with a coin flip, Method Binomial Exact Test.

**Was the program easy to use?**

<table>
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<th></th>
<th>Easy</th>
<th>Not easy</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident Responses</td>
<td>17</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

94.4% responded that DXplain was easy to use, with lower confidence interval of 72% (p=0.004) Compared with a coin flip, Method Binomial Exact Test.
Would you like a program such as this one to be available routinely to Internal Medicine Residents at Mayo?

<table>
<thead>
<tr>
<th>Resident Responses</th>
<th>Yes</th>
<th>No</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13</td>
<td>1*</td>
<td>4</td>
</tr>
</tbody>
</table>

*72.2% yes, 94.4% did not say no with lower confidence interval of 72% (p=0.004) Compared with a coin flip, Method Binomial Exact Test.

Conclusions

Residents were generally satisfied with the use of DXplain as an adjunct to their usual evaluation of new admissions onto a hospital service. 83.3% of the respondents felt it was useful and 94.4% felt it was easy to use. Also of importance, every respondent (100%) felt that the use of the system at least “occasionally” led to contemplation of previously unconsidered diagnoses. Even more impressive, 72.2% felt that it “almost always or frequently” led to new diagnostic considerations.

The strengths of this study include our ability to electronically monitor each time the system was accessed. Thus, we did not have to rely on resident recall of their usage of DXplain. Anecdotally, the residents said that they felt that DXplain was useful in recommending truly novel diagnoses. For example, one resident identified a case of “Inclusion Body Myositis” after it was suggested by DXplain.

A weakness of this study was its small sample size. Survey response rates are notoriously low, especially among physicians. Our response rate of 96.7% from busy residents covering a rapidly changing hospital practice was an excellent response rate.

An intriguing finding is that 17 of 18 respondents felt that the system was easy to use and brought new diagnoses into consideration. We recognize that individual resident exposure to the tool was limited and it is certainly possible that application to an increasing number of clinical cases would lead to recognition of DXplain’s greater utility, especially if a novel diagnosis suggested by DXplain turned out to be correct.

It is also disturbing that only 18 of the 29 survey responders actually tried the system. This may reflect that time has become so constrained on Internal Medicine residency hospital programs that residents cannot even take the time to experiment with a new tool that could potentially increase their effectiveness as physicians. The authors conclude that residents on the Saint Mary’s Hospital General Medical Service generally found DXplain easy to use and useful for expanding their differential diagnoses.

Future research should seek to determine what factors lead to greater utilization of diagnostic decision support systems.

Acknowledgments

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References


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