Employing Electronic Health Records To Influence Care of Diabetic Patients:

A Report of HEALTHeWV Health Outcome Project Research

Prepared by Wheeling Jesuit University
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INTRODUCTION

HEALTHeWV is an electronic health records-based disease management and health promotion program designed to improve health care quality, patient outcomes, and patient safety. Based at the Robert C. Byrd National Technology Transfer Center (NTTC), on the campus of Wheeling Jesuit University (WJU), HEALTHeWV was inaugurated in 2005 with funding from the National Aeronautics and Space Administration (NASA) to improve the health of West Virginia’s rural communities by linking national health care advancements with the expertise of health care professionals to fulfill community health care needs.

A component of the HEALTHeWV project funding has been devoted to investigating the significance of utilizing electronic health records within clinical settings to effect modifications in health outcomes for diabetic patients. To date, the majority of HEALTHeWV projects have been undertaken within the confines of the state of West Virginia.

Employing Electronic Health Records To Influence Care of Diabetic Patients: A Report of HEALTHeWV Health Outcome Project Research details the specifics of this project and reports the results of the research. The project and compilation of this report are funded by NASA Grant Number NNX08AP69G. Project staff members are enumerated in Appendix 1.

BACKGROUND AND SIGNIFICANCE OF RESEARCH

The Centers for Disease Control and Prevention note that “Diabetes is a group of diseases marked by high levels of blood glucose resulting from defects in insulin production, insulin action, or both. Diabetes can lead to serious complications and premature death, but people with diabetes can take steps to control the disease and lower the risk of complications.” (http://www.cdc.gov/diabetes/pubs/pdf/ndfs_2007.pdf) The prevalence of diabetes in the United States continues to grow steadily each year. Nationally, the American Diabetes Association reports:

- Diabetes affects 23.6 million children and adults in the United States (8 percent of population)
- Nationally, approximately 17 million persons are diagnosed with diabetes, 5.7 million are undiagnosed, and 57 million are pre-diabetic
- One in seven Americans either has diabetes or is at high risk for developing diabetes (Agency for Healthcare Research and Quality, 2004)
- In 2007, the national cost of diabetes exceeded $174 billion ($116 billion in excess medical expenditures as well as $58 billion in reduced national productivity)
- People diagnosed with diabetes, on average, have higher medical expenditures that are approximately 2.3 times higher than expenditures in the absence of diabetes
- Approximately $1 in every $10 health care dollars is attributed to diabetes

In West Virginia, the West Virginia Health Statistics Center reports:

- West Virginia has the highest prevalence of diabetes in the U.S. (2006 data)
- In West Virginia, 12.1% of the population is diagnosed as diabetic
- Approximately, 256,000 West Virginians are considered to be diabetic (171,000 diagnosed, 85,000 undiagnosed)
- During the past 13 years, diabetes prevalence among West Virginia adults doubled
- The oldest adults (65 and older) had the highest diabetes prevalence among all age groups in West Virginia – 23.5% in 2006
In addition to diabetes, West Virginia leads the nation in the incident of other chronic diseases such as cancer and heart disease. The state’s residents also experience higher prevalence rates of co-morbid conditions such as obesity, physical inactivity, and hypertension.

Within the state, access to diabetes education, care, and management is limited or non-existent in many rural regions. With an aging and predominantly poor citizenry, West Virginia must often cope with the devastating consequences of chronic diseases such as diabetes. The disease’s social, psychological, physical, and economic costs create significant burdens for individuals, families, and society as a whole.

Therefore, the primary significance of this project lies in the measurement of potential positive health outcome impacts upon the population surveyed. According to the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), studies in the United States and abroad have found that improved glycemic control benefits people with either type 1 or type 2 diabetes. In general, every percentage point drop in A1C blood test results—for example, from 8 to 7 percent—can reduce the risk of microvascular complications—eye, kidney, and nerve diseases—by 40 percent.” (http://diabetes.niddk.nih.gov/dm/pubs/statistics/index.htm)

Additionally, White (2002) reports that economic savings from a 1 percent reduction in A1c levels can be as much as $4,000 in patients with a combination of diabetes, heart disease, and hypertension, which are common comorbidities of diabetes. In 2008, Wyne extrapolated a 3-year period savings from patients who reduced their A1c levels by one percent:

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Standardized Per-Patient Cost of Care Differentials for 1% Changes in A1c Levels for 1,694 Adults With Diabetes Over a 3-Year Perioda</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1c Level</td>
<td>10% to 9%</td>
</tr>
<tr>
<td>Diabetes with heart disease and hypertension</td>
<td>$2675 ± 1164</td>
</tr>
<tr>
<td>Diabetes with heart disease</td>
<td>$2078 ± 900</td>
</tr>
<tr>
<td>Diabetes with hypertension</td>
<td>$1130 ± 498</td>
</tr>
<tr>
<td>Diabetes without heart disease or hypertension</td>
<td>$805 ± 353</td>
</tr>
</tbody>
</table>


Clearly, then, there is potential benefit in identifying the role that an electronic health records-based disease management and health promotion program can fulfill in improving patient well-being.

HEALTHeWV Program Configuration

In 2005, the U.S. Congress directed the Robert C. Byrd National Technology Transfer Center to adapt and implement the Walter Reed Army Medical Center’s HEALTHeFORCES electronic health records system to benefit rural, medically underserved areas of the nation. The pilot geographic region chosen for implementation was the state of West Virginia and the program was called HEALTHeWV.
The HEALTHeWV program is a full-featured, user-friendly program with system functionalities that include:

- **HEALTHeNOTES** – outpatient medical record documentation that incorporates data from a variety of sources, such as HEALTHeSURVEYS, patient registries, laboratory/radiology results, notes from previous visits, prescription information, master problem list, medications, surgeries, and family history.
- **Prescription Order Entry (POE)** - includes robust features for writing, renewing, printing, or e-faxing patients’ prescriptions.
- **Disease Registries and Reporting** – allows tracking of patient data, setting of specific goals for self-care, and comparison of patient data against national norms.
- **HEALTHeSURVEYS** - 15 disease-specific and general health patient surveys currently available in the system. Customized clinic surveys can also be developed.

HEALTHeNOTES Features

![HEALTHeNOTES Features Diagram](image)

The HEALTHeWV project and its staff (based at the NTTC) have adopted the application service provider (ASP) model for hosting electronic health records and their software applications. ASPs host, manage, and deliver applications to multiple entities from a remote data center across a wide area network.

At the on-site medical clinics, providers are prompted by the registry information that is a component of each patient’s record.
A typical HEALTHeWV patient display demonstrates graphically whether or not the patient has met the LDL and/or A1c goals:

Other displays are utilized by healthcare providers to counsel the patient or to serve as reminders to place orders for diagnostic testing (see Appendix 2). Thus, the HEALTHeWV system provides tools to identify at-risk patients; collect and synthesize patient population data; individualize patient health status; and assist with patient education with the goal of improving medical care (Wyne, 2008).

**RESEARCH PROCESS**

**Hypothesis**

The research project utilized the following hypothesis:

The usage of the HEALTHeWV electronic health records-based disease management and health promotion program (with chronic disease registry evidence-based guidelines) will result in enhanced health outcomes for diabetic patients as measured by hemoglobin (A1c), low-density lipoprotein cholesterol (LDL), and hypertension (blood pressure) levels.
Creation of the Data Pool and Selection of the Sample

The Data Pool and Data Collection Procedures

Population of the potential HEALTHeWV research project data pool began in 2010 when records from the previous 4 years were evaluated for potential selection. Data was collected from onsite charting and by electronically polling the HEALTHeWV diabetic registry for each healthcare clinic.

Clinics participating in the potential pool during the 4 previous years totaled:

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Participating Clinics</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2007</td>
<td>5</td>
</tr>
<tr>
<td>2007-2008</td>
<td>16</td>
</tr>
<tr>
<td>2008-2009</td>
<td>8</td>
</tr>
<tr>
<td>2009-2010</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
</tr>
</tbody>
</table>

The 14 clinics used in the study were of similar rural settings and patient populations. In addition, primary care providers across all clinics were trained in the same manner and relied upon similar treatment guidelines for diabetic care. Training was delivered in a consistent format to comprehensively cover the proper use of the EHR, implementation, and go-live support.

Previous to 2008 (and prior to implementation of the electronic records module), information from a 12-month data set of paper-based charts was considered for inclusion in the data pool. Because of varying and staggered implementation dates, the 3-year window of record collection for each clinic varied. Year 1 data samples (derived from paper charts) represent the baseline for the project data pool. During Year 2, some participating clinics continued electronic data entry in the records management system while others continuing manual charting. Thus, a mixture of paper-based and electronic records existed. Since there was not a significant pool of electronic-only records for healthcare Clinics, no records were sampled from this year. For Year 3 data, any clinic which met the criterion of 100 percent electronic charting by January 1, 2009 was included in the potential data set pool. Fourteen (14) healthcare Clinics met this definition and their records were included in the data pool (see Appendix 3 for list of Clinics). The Year 3 records were electronically derived from the master database’s individual charts utilizing the reporting capabilities of the HEALTHeSTATE™ software. Each patient listed in an individual clinic’s diabetic registry was included in the data pool. Individual clinic records were maintained in discrete files for that clinic.

All research data records involved with this project are classified as confidential and were de-identified in the analysis of individual clinic diabetes registry and charted paper entries. Results from the registries, in the form of ordinal numbers, were entered into spreadsheets either manually or electronically and original records disassociated from the tallies. The collected data is physically secured in locked facilities and will be destroyed in May 2015.

Creating the Random Sample

From the 14 clinics included in the research pool, study patients were selected who met the criteria of: a diagnosis of diabetes (ICD-9 codes 250.xx) and at least 2 visits to their primary care provider during the study year.
From the dataset of annual (2007-2009) records, a total of 3773 charts were reviewed: 2007 – 1037; 2008 – 1226; and 2009 – 1410.

To create a simple random sample for each clinic, the total study patient population was entered into Raosoft’s Sample Size Calculator (see Appendix 4). The sample size was calculated using a 5 percent margin of error and a 95 percent confidence level.

Results for the 14 clinics are noted below.

<table>
<thead>
<tr>
<th>CLINIC</th>
<th>TOTAL DIABETICS</th>
<th>SAMPLE SIZE</th>
<th>TOTAL MEETING CRITERIA 2007</th>
<th>TOTAL MEETING CRITERIA 2008</th>
<th>TOTAL MEETING CRITERIA 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheeling Health Right</td>
<td>764</td>
<td>256</td>
<td>156</td>
<td>153</td>
<td>156</td>
</tr>
<tr>
<td>WVHR</td>
<td>749</td>
<td>255</td>
<td>69</td>
<td>115</td>
<td>105</td>
</tr>
<tr>
<td>Fairmont</td>
<td>670</td>
<td>245</td>
<td>125</td>
<td>131</td>
<td>131</td>
</tr>
<tr>
<td>Sissonville</td>
<td>426</td>
<td>203</td>
<td>115</td>
<td>177</td>
<td>169</td>
</tr>
<tr>
<td>Dawes</td>
<td>402</td>
<td>197</td>
<td>114</td>
<td>159</td>
<td>169</td>
</tr>
<tr>
<td>Ebenezer</td>
<td>383</td>
<td>193</td>
<td>80</td>
<td>65</td>
<td>149</td>
</tr>
<tr>
<td>Clendenin</td>
<td>352</td>
<td>184</td>
<td>122</td>
<td>145</td>
<td>138</td>
</tr>
<tr>
<td>Eastern Panhandle</td>
<td>275</td>
<td>161</td>
<td>66</td>
<td>104</td>
<td>119</td>
</tr>
<tr>
<td>Beckley</td>
<td>207</td>
<td>135</td>
<td>44</td>
<td>63</td>
<td>71</td>
</tr>
<tr>
<td>Good Samaritan</td>
<td>200</td>
<td>133</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Mercer Health Right</td>
<td>160</td>
<td>114</td>
<td>36</td>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td>Milan Puskar</td>
<td>151</td>
<td>105</td>
<td>76</td>
<td>97</td>
<td>87</td>
</tr>
<tr>
<td>Health Access</td>
<td>72</td>
<td>61</td>
<td>16</td>
<td>31</td>
<td>30</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>4811</strong></td>
<td><strong>2242</strong></td>
<td><strong>1037</strong></td>
<td><strong>1326</strong></td>
<td><strong>1410</strong></td>
</tr>
</tbody>
</table>

**DATA ANALYSIS AND RESULTS**

This study was designed to assess the effect upon health care outcomes that implementation of an electronic medical records system might provide as measured by individual A1c, LDL, and blood pressure levels for patients with diabetes mellitus.

**Dependent Variables**

Dependent variables included glycemic control, lipid control, and hypertension control as measured by HbA1c, LDL, and systolic/diastolic blood pressure testing.

**Independent Variable**

The independent variable for this study is represented by an indicator of the year [2007 (paper) or 2009 (electronic)] in which the outcome measures were taken.
Patient Marker Thresholds

- HbA1c less than 7
- LDL less than 100 mg/dl
- BP 130/80 mm Hg

Healthcare Effectiveness Data and Information Set (HEDIS) measures were used to determine patient marker thresholds (http://www.ncqa.org/tabid/1044/Default.aspx).

Statistical Analysis

The difference in the mean percentage for each of the measures across all of the centers before and after conversion was checked for significance using a two-tailed Student’s t test. The differences are significant if the Probability (P) that the means are not different is less than 0.05 (P < 0.05).

Mean and Standard Deviation Percentages of A1c, LDL and BP Falling Below Their Respective Thresholds

<table>
<thead>
<tr>
<th>Threshold Measures</th>
<th>2007 Paper</th>
<th>2009 Electronic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (%)</td>
<td>Std Dev</td>
</tr>
<tr>
<td>A1c &lt; 7</td>
<td>43.41</td>
<td>9.88</td>
</tr>
<tr>
<td>LDL &lt; 100</td>
<td>43.32</td>
<td>11.33</td>
</tr>
<tr>
<td>BP &lt; 130/80</td>
<td>46.76</td>
<td>12.16</td>
</tr>
</tbody>
</table>

n=2,242

There were no significant (P < 0.05) differences

Results indicate that changes in percentage of patient threshold measures were not statistically significant to draw any conclusions. Percentage of total patients presenting an A1c score of less than 7 decreased after implementation of the EHR system. Total patients who presented with lower LDL and blood pressure levels increased after EHR implementation, but only slightly. Therefore, due to the lack of statistical significance, the clinical relevance of these changes cannot be extrapolated or utilized in the formation of valid conclusions.

LESSONS LEARNED

In this study, the use of electronic health records vs. charting patient progress in paper formats does not appear to have resulted in any substantial improvement in the health outcomes of diabetic patients. Thus, the hypothesis is not proven either true or false.

Such results are not unique to HEALTHeWV as noted by Dr. David J. Ballard at Baylor University’s Health Care System in Texas:

Comparing the numbers at clinics before and after the EHR was put in place, Ballard says, showed that when the electronic system was used, more patients met standards deemed "optimal" by the health care center and its doctors. But when the researchers broke the results down further, they showed that electronic health records aren’t a panacea. Improvements tended to be limited to quick fixes: With a prompt to add aspirin to a list of medications for a patient with diabetes, or a reminder to prescribe a drug to lower cholesterol or blood pressure, the electronic system got results. "It improves outcomes that are easily achieved by pharmacological therapy," Ballard says.
Yet when it came to things that couldn’t simply be fixed with the stroke of a pen—say, getting someone to quit smoking or to closely manage blood glucose—the system made little difference. “Educating people requires physician time,” says Cliff Fullerton, MD, a Baylor Health Care System doctor who helped design and implement the Baylor EHR. "Getting an EHR … doesn’t buy that extra 15 or 20 minutes to talk to the patient." (Diabetes Forecast: 2010).

It is likely that workers at the 14 clinics in this research project did not take full advantage of the tools within the HEALTHeWV diabetes registry. The reasons most probably are related to:

- A significant learning curve for clinic employees to overcome in a short period of time
- A less flexible point of entry for data (laptops or desktop computers were used – no voice recognition software was available)
- Varying experiential levels among clinic staff – few technophiles are employed in the clinics
- Cultural acceptance of the benefits to be reaped from utilizing the full capabilities of the system (as opposed to feeling that the system was imposed upon the staff)

Research results have reiterated the need for continuous work with all clinic employees and staff. Specifically, the HEALTHeWV project staff will concentrate on:

1. Re-educate and re-orienting clinicians and support staff on meaningful use of HEALTHeWV electronic health records.
2. Developing, distributing, and analyzing a survey to assess which method(s) of training will be most beneficial to clinicians and clinical support staff
3. Implementing results of the needs assessment survey to redesign or enhance training opportunities to accommodate varied learning styles, preferred method of instructional delivery, and frequency of delivery
4. Reintroduce diabetes registry training to focus on how the reminders, prompts, and reporting capabilities can be used to improve care coordination; reduce healthcare disparities; improve population health outcomes; and engage patients, families, and the entire care team in the wellness process.
Sources Consulted


APPENDICES
APPENDIX 1

HEALTHHeWV Program and Assisting Staff

Principal Investigator
J. Davitt McAteer, J.D.
Vice-President Sponsored Programs

Executive Director – Health Technology Programs (Principal Investigator through January 2010)
Dr. Mazharullah Shaik, MD

Interim Director – Health Technology Programs
Sandy Linsky

Principal Project Researcher
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Manager, Health Applications and Clinical Services

Research Report Editor
Dr. Charles A. Julian, PhD

Analysis of Data
Dr. Theodore S. Erickson, Dr. Ben Hitt, and Ralph Seward
Wheeling Jesuit University

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Melissa Mealy, M.A.

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Pam Scott

Clinical Systems Analyst
Brian Moore

Technical Support Specialist
Beth Coleman

Program Associate
Peggy Simmons

Manager, Public Relations – Sponsored Programs
Tricia Lollini
## APPENDIX 2
HEALTHeWV Sample Screen Shots

[Image of sample screen shots]

<table>
<thead>
<tr>
<th>Score</th>
<th>Edit</th>
<th>Question</th>
<th>Info</th>
<th>Response</th>
<th>Last Date Completed</th>
<th>External Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td></td>
<td><strong>Add</strong> Patient Lipid profile completed in less than 12 months?</td>
<td>Yes</td>
<td></td>
<td>6/6/2006</td>
<td>Yes</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td><strong>Add</strong> Patient with a low-density lipoprotein (LDL) less than 101 mg/dL?</td>
<td>Yes (LDL 95)</td>
<td></td>
<td>6/6/2006</td>
<td>Yes</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td><strong>Add</strong> Has patient had at least one HbA1c within 12 months?</td>
<td>Yes</td>
<td></td>
<td>6/6/2006</td>
<td>Yes</td>
</tr>
<tr>
<td>✗</td>
<td></td>
<td><strong>Add</strong> Patient HbA1c level less than 7.1%?</td>
<td>No</td>
<td>(10.1%)</td>
<td>6/6/2006</td>
<td>Yes</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td><strong>Add</strong> Patient assessed for nephropathy?</td>
<td>Yes</td>
<td></td>
<td>6/6/2006</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spot Urine Microalbumin</td>
<td>20</td>
<td></td>
<td>6/6/2006</td>
<td>Yes</td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td><strong>Edit</strong> Patient with blood pressure less than 130/80 mm Hg?</td>
<td>Yes (110/75)</td>
<td></td>
<td>05/14/2006</td>
<td>Yes</td>
</tr>
<tr>
<td>✗</td>
<td></td>
<td><strong>Edit</strong> Dilated fundus exam done within the last 12 months?</td>
<td>Unknown</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td><strong>Edit</strong> Patient received a well-documented foot exam to include a risk assessment in the past 12 months?</td>
<td>Yes</td>
<td></td>
<td>05/14/2006</td>
<td>Yes</td>
</tr>
<tr>
<td>✗</td>
<td></td>
<td><strong>Edit</strong> Self-management education to include nutritional counseling?</td>
<td>Unknown</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 3 – CLINICS INCLUDED IN RESEARCH PROJECT
DATA POOL

<table>
<thead>
<tr>
<th>Clinic</th>
<th>City</th>
<th>County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheeling Health Right</td>
<td>Wheeling</td>
<td>Ohio</td>
</tr>
<tr>
<td>Cabin Creek Health System - Sissonville</td>
<td>Sissonville</td>
<td>Kanawha</td>
</tr>
<tr>
<td>Cabin Creek Health System - Clendenin</td>
<td>Clendenin</td>
<td>Kanawha</td>
</tr>
<tr>
<td>Cabin Creek Health System - Dawes</td>
<td>Dawes</td>
<td>Kanawha</td>
</tr>
<tr>
<td>Health Access Clarksburg</td>
<td>Clarksburg</td>
<td>Harrison</td>
</tr>
<tr>
<td>Mercer Health Right</td>
<td>Bluefield</td>
<td>Mercer</td>
</tr>
<tr>
<td>Beckley Health Right</td>
<td>Beckley</td>
<td>Raleigh</td>
</tr>
<tr>
<td>Ebenezer Medical Outreach</td>
<td>Huntington</td>
<td>Cabell</td>
</tr>
<tr>
<td>Eastern Panhandle Free Clinic</td>
<td>Ranson</td>
<td>Jefferson</td>
</tr>
<tr>
<td>Milan Puskar Health Right</td>
<td>Morgantown</td>
<td>Monongalia</td>
</tr>
<tr>
<td>Monongahela Valley Association - Fairmont Clinic</td>
<td>Fairmont</td>
<td>Marion</td>
</tr>
<tr>
<td>West Virginia Health Right</td>
<td>Charleston</td>
<td>Kanawha</td>
</tr>
<tr>
<td>Hinton Health Right</td>
<td>Hinton</td>
<td>Summers</td>
</tr>
<tr>
<td>Good Samaritan Clinic</td>
<td>Parkersburg</td>
<td>Wood</td>
</tr>
</tbody>
</table>
APPENDIX 4 – SAMPLE SIZE CALCULATOR

Source: http://www.raosoft.com/samplesize.html