K-08 Final Progress Report

Evaluating e-Prescribing in a Community-Based, Integrated Health System

Principal Investigator
Emily Beth Devine, PharmD, MBA, PhD, BCPS, FASHP

Primary Mentors
Sean D. Sullivan, PhD, David K. Blough, PhD, Diane P. Martin, PhD,
Thomas H. Payne, MD, FACMI, Peter Tarczy-Hornoch, MD, FACMI

Secondary Mentors
David W. Bates, MD, MS, FACMI, Dean F. Sittig, PhD, FACMI, David H. Smith, RPh, MHA, PhD

Co-investigators at The Everett Clinic
Albert W. Fisk, MD, MMM, Nathan M. Lawless, RPh, ChE, Jennifer Wilson-Norton, RPh, MBA

Organization
University of Washington
Seattle, WA

Dates of Training Grant
August 1, 2006, through July 31, 2011

AHRQ Project Officer
Kay Anderson, PhD

Acknowledgement of Agency Support
Agency for Healthcare Research and Quality K-08 Mentored Clinical Scientist Training Award

Grant Award Number
5-K08-HS014739

Structured Abstract

Purpose: The purpose of this mentored clinical scientist training award was to provide the protected time for the primary investigator to achieve two aims: 1) to obtain advanced training in health services research methods and 2) to use these newly acquired skills to design, conduct, analyze, and disseminate the findings of a sequence of research projects centered on evaluating the impact of the use of an electronic prescribing (or computerized provider order entry; CPOE) system on outcomes.

Scope: The projects evaluated a CPOE system for medications implemented in the ambulatory setting of the largest independent medical group in Washington State. The primary investigator designed and completed four companion studies that together explored the impact of implementation of the CPOE system on four distinct outcomes.

Methods and Results: This report summarizes the results of those studies, in the context of the investigator completing her dissertation research. It then describes the investigator's follow-on research projects both within and external to the framework of medication management HIT. It describes her evolution into an independent investigator and describes her grantsmanship, teaching, mentoring, and service-related activities. It concludes by describing the investigator's current research program and her vision for her future as an independent health services research scientist.

Conclusion: Support from AHRQ, in the form of a mentored clinical scientist training grant, has enabled this investigator to obtain skills in advanced health services research methods that she is now applying to launch her career at the intersection of comparative effectiveness research and clinical research informatics.

Key Words: mentored clinical scientist training grant, health services research, electronic health records, computerized provider order entry systems, medication management health information technology

Purpose of the Grant

The purpose of this mentored clinical scientist training award was to provide the protected time and support for Dr. Devine to achieve two aims: 1) to obtain advanced training in health services research methods and 2) to use these newly acquired skills to design, conduct, analyze, and disseminate the findings of a sequence of research projects centered on evaluating the impact of the use of an electronic prescribing (or computerized provider order entry; CPOE) system in the context of an electronic health record (EHR). Dr. Devine achieved her first aim when she was awarded a Doctor of Philosophy degree in Health Services Research from the School of Public Health, University of Washington (UW), Seattle, WA, in 2008. To achieve her second aim, she developed her research program at the intersection of health services research and biomedical and health informatics, focusing on what the Agency for Healthcare Research and Quality (AHRQ) now calls Medication Management Health Information Technology (IT).[1]

The purpose of this report is to summarize Dr. Devine's training. More importantly, the purpose of this report is to summarize the results of the studies she has completed and those she is currently conducting in the area of Medication Management Health IT. Finally, this report summarizes the scholarly and professional activities Dr. Devine has been pursuing since being awarded her PhD in December 2008.

Scope

Background: When Dr. Devine first proposed her research program, the evidence demonstrating the positive impact of CPOE systems on medication errors and adverse drug events (ADEs) was largely limited to inpatient academic medical centers that had developed their own EHRs, that is, 'homegrown' systems. To begin to fill this evidence gap, Dr. Devine forged a partnership with the Chief Medical Officer and the clinical pharmacists at the largest independent medical group in Washington State – The Everett Clinic. Her goal was to study the impact of a CPOE system on medication errors and ADEs in the ambulatory care setting. This study was to be at the forefront of such evaluations conducted in the ambulatory care setting. Dr. Devine designed a study to evaluate the impact of The Everett Clinic's CPOE system on medication errors and ADEs. She also designed three companion studies that explored the impact of implementation of the CPOE system on three additional, distinct outcomes. These were evaluating 1) the time intensity of using the CPOE system for providers and staff, 2) the perceptions of providers and staff around adoption of the CPOE system, and 3) the attitudes of providers and staff around adoption of the CPOE system. Her dissertation was composed of the first three of these studies.

Using the findings of these studies, Dr. Devine next conducted three follow-on studies. These are 1) evaluating the impact of stepwise implementation of clinical decision support (CDS) alerts on prescriber adherence to clinical guidelines for laboratory monitoring of medications prescribed for patients in a diabetic registry, 2) assessing the usability of a CPOE system through computerized simulations, and 3) conducting a cost-effectiveness analysis of a CPOE system *versus* handwritten prescribing on medication safety (medication errors and ADEs averted).

Settings: With the exception of the usability study, Dr. Devine has conducted her work at The Everett Clinic. She conducted the usability study at the University of Washington Medical Center. During the years she was conducting the first four studies at The Everett Clinic (2004-2007), The Everett Clinic was using the EHR and CPOE system developed internally by their wholly owned IT subsidiary. In 2007, The Everett Clinic made the deliberate decision to abandon their homegrown system in favor of a vendor-purchased system. In late 2007, The Everett Clinic installed EpicCare® (Madison, WI; http://www.epic.com/). Dr. Devine has

completed two of the latter three projects in the environment of the EpicCare EHR. She has conducted the usability study using a prototype of the CPOE system that will be implemented at the University of Washington Medical Center in early 2012 – the Cerner Millenium (PowerChart) system® (Kansas City, MO; http://www.cerner.com/solutions/Hospitals_and_Health_Systems/), an inpatient system.

Participants: The participants in all of Dr. Devine's studies to date primarily have been physicians but also included nurses and medical assistants. The nature of Dr. Devine's research does not lend itself to the inclusion of AHRQ's priority populations. Her subjects are the healthcare professionals who own (as is the case for physicians at The Everett Clinic) or who are employees of a health system.

Summaries of Research Emphasis in Medication Management Health IT

Dr. Devine's dissertation is listed here.

- Devine EE. Evaluating the impact of an ambulatory computerized provider order entry system on outcomes in a community-based multispecialty health system. [dissertation] Seattle (WA): University of Washington; 2008

Following are the abstracts of Dr. Devine's publications that emanated from her dissertation work. The paper published in *J Am Med Inform Assoc* was designated as an 'Editor's Choice' selection for that issue. A few of Dr. Devine's studies are represented in the recently published AHRQ Evidence Report on Medication Management Health IT.[1]

- **Devine EB**, Hansen RN, Wilson-Norton JL, Lawless NM, Fisk AW, Blough DK, Martin DP, Sullivan SD. The impact of computerized provider order entry on medication errors in a multispecialty group practice. J Am Med Inform Assoc 2010;17:78-84

  OBJECTIVE: Computerized provider order entry (CPOE) has been shown to improve patient safety by reducing medication errors and subsequent adverse drug events (ADEs). Studies demonstrating these benefits have been conducted primarily in the inpatient setting, with fewer in the ambulatory setting. The objective was to evaluate the effect of a basic, ambulatory CPOE system on medication errors and associated ADEs.

  DESIGN: This quasi-experimental, pre-test/post-test study was conducted in a community-based, multispecialty health system not affiliated with an academic medical center. The intervention was a basic CPOE system with limited clinical decision support capabilities.

  MEASUREMENT: Comparison of prescriptions written before (n=5016 handwritten) versus after (n=5153 electronically prescribed) implementation of the CPOE system. The primary outcome was the occurrence of error(s); secondary outcomes were types and severity of errors.

  RESULTS: Frequency of errors declined from 18.2% to 8.2%, a reduction in adjusted odds of 70% (OR: 0.30; 95% CI: 0.23 to 0.40). The largest reductions were seen in adjusted odds of errors of illegibility (97%), use of inappropriate abbreviations (94%), and missing information (85%). There was a 57% reduction in adjusted odds of errors that did not cause harm (potential ADEs) (OR: 0.43; 95% CI: 0.38 to 0.49). The reduction in the number of errors that caused harm (preventable ADEs) was not statistically significant, perhaps due to few errors in this category.

  CONCLUSIONS: A basic CPOE system in a community setting was associated with a significant reduction in medication errors of most types and severity levels.

- **Devine EB**, Hollingworth W, Hansen RN, Lawless NM, Wilson-Norton JL, Martin DP, Blough DK, Sullivan SD. Electronic prescribing at the point of care: A time-motion study in the primary care setting. Health Serv Res 2010 Feb;45(1):152-71. Epub 2009 Nov 19

  OBJECTIVE: To evaluate the impact of an ambulatory computerized provider order entry (CPOE) system on the time efficiency of prescribers. Two primary aims were to compare prescribing time between (1) handwritten and electronic (e-) prescriptions and (2) e-prescriptions using differing hardware configurations.

  DATA SOURCES/STUDY SETTING: Primary data on prescribers/staff were collected (2005-2007)

at three primary care clinics in a community-based, multispecialty health system.
STUDY DESIGN: This was a quasi-experimental, direct-observation, time-motion study conducted in two phases. In phase 1 (n=69 subjects), each site used a unique combination of CPOE software/hardware (paper based, desktops in prescriber offices or hallway workstations, or laptops). In phase 2 (n=77), all sites used CPOE software on desktops in examination rooms (at point of care).
DATA COLLECTION METHODS: Data were collected using TimerPro software on a Palm device.
PRINCIPAL FINDINGS: Average time to e-prescribe using CPOE in the examination room was 69 seconds/prescription event (new/renewed combined), which was 25 seconds longer than to handwrite (99.5 percent confidence interval [CI]: 12.38) and 24 seconds longer than it took to e-prescribe at offices/workstations (99.5 percent CI: 8.39). Each calculates to 20 seconds longer per patient. **CONCLUSIONS:** E-prescribing takes longer than handwriting. E-prescribing at the point of care takes longer than e-prescribing in offices/workstations. Improvements in safety and quality may be worth the investment of time.

- **Devine EB**, Payne TH, Williams EC, Sittig DF, Tarczy-Hornoch P, Martin DP, Sullivan SD. Prescriber and staff perceptions of a computerized provider order entry system in primary care: A qualitative study. BMC Medical Informatics and Decision Making 2010, 10:72

  BACKGROUND: The United States (US) Health Information Technology for Economic and Clinical Health Act of 2009 has spurred adoption of electronic health records. The corresponding meaningful use criteria proposed by the Centers for Medicare and Medicaid Services mandate use of computerized provider order entry (CPOE) systems. Yet, adoption in the US and other Western countries is low, and descriptions of successful implementations are primarily from the inpatient setting (less frequently from the ambulatory setting). We describe prescriber and staff perceptions of implementation of a CPOE system for medications (electronic- or e-prescribing system) in the ambulatory setting.
  METHODS: Using a cross-sectional study design, we conducted eight focus groups at three primary care sites in an independent medical group. Each site represented a unique stage of e-prescribing implementation: pre/transition/post. We used a theoretically based, semi-structured questionnaire to elicit physician (n=17) and staff (n=53) perceptions of implementation of the e-prescribing system. We conducted a thematic analysis of focus group discussions using formal qualitative analytic techniques (i.e., deductive framework and grounded theory). Two coders independently coded to theoretical saturation and resolved discrepancies through discussions.
  RESULTS: Ten themes emerged that describe perceptions of e-prescribing implementation: 1) improved availability of clinical information resulted in prescribing efficiencies and more coordinated care; 2) improved documentation resulted in safer care; 3) efficiencies were gained by using fewer paper charts; 4) organizational support facilitated adoption; 5) transition required time and resulted in workload shift to staff; 6) hardware configurations and network stability were important in facilitating workflow; 7) e-prescribing was time neutral or time saving; 8) changes in patient interactions enhanced patient care but required education; 9) pharmacy communications were enhanced but required education; 10) positive attitudes facilitated adoption.
  CONCLUSIONS: Prescribers and staff worked through the transition to successfully adopt e-prescribing and noted the benefits. Overall impressions were favorable. No one wished to return to paper-based prescribing.

Dr. Devine published four additional manuscripts that reflect these four earlier studies in Medication Management Health IT conducted at The Everett Clinic. The citations for these are listed here.

- **Devine EB**, Wilson-Norton JL, Lawless NM, Hansen R, Hazlet TK, Kelly K, Hollingworth W, Blough DK, Fisk AW, Sullivan SD. Characterization of prescribing errors in an internal medicine clinic. Am J Health-Syst Pharm 2007;64:1062-70
- Hollingworth W, **Devine EB,** Hansen RN, Lawless NM, Comstock B, Wilson-Norton JL, Tharpe KL, Sullivan SD. The impact of e-prescribing on prescriber and staff time in ambulatory care clinics: A time-motion study. J Am Med Inform Assoc 2007;14:722-30

- **Devine EB**, Wilson-Norton JL, Lawless NM, Hollingworth W, Hansen RN, Fisk AW, Sullivan SD. Implementing an Ambulatory e-Prescribing System: Strategies Employed and Lessons Learned to Minimize Unintended Consequences. In: Henriksen K, Battles JB, Keyes MA, Grady ML, editors. Advances in patient safety: New directions and alternative approaches. Vol. 4. Technology and Medication Safety. AHRQ Publication No. 08-0034-4. Rockville, MD: Agency for Healthcare Research and Quality; August 2008
- **Devine EB**, Patel R, Dixon D, Lawless NM, Wilson-Norton JL, Sullivan SD. Assessing physician and staff attitudes toward e-prescribing adoption in primary care: Use of a survey instrument. Inform Prim Care 2010;18(3):177-87

Dr. Devine's three follow-on studies in Medication Management Health IT, supported by her K-08, are in varying stages of completion and are described here.

Study #1: The impact of stepwise implementation of clinical decision support (CDS) alerts on prescriber adherence to clinical guidelines for laboratory monitoring of medications prescribed for patients in the diabetic registry

This is a retrospective database analysis that focuses on drug-laboratory pairs and entails comparing data from three timeframes, each representing a unique stage of CDS alert implementation: baseline, simple alert, and more sophisticated alert (Epic's SmartSets®). Dr. Devine is comparing the impact of these CDS alerts on prescriber adherence to national guidelines, adopted locally by The Everett Clinic, for all patients cared for through The Everett Clinic's Diabetes Registry, specifically for antidiabetic and antihyperlipidemic medications and their corresponding laboratory values, both for safety (renal function, liver function, myositis) and for surrogate markers of clinical outcomes (low-density lipoprotein, hemoglobin A1c). To determine whether lack of adherence to these guidelines is associated with downstream ADEs, the dataset contains ICD-9 codes for disease states that can be associated with lack of appropriate laboratory monitoring for safety labs (renal disorders, hepatic disorders, and myositis/rhabdomyolysis). The Everett Clinic implemented the third and most sophisticated stage of CDS alert monitoring in October 2011. Thus, data that reflect the first two timeframes (baseline and simple alerts) have been sequestered. Data that reflect the third and final timeframe will be sequestered after a 2-month adoption period and a 4-month data collection period. Dr. Devine anticipates analyzing this dataset in mid-2012. The functionality of Epic's SmartSets should greatly facilitate drug-laboratory monitoring, yet this feature of the Epic EHR has not been rigorously studied. This study will contribute to the growing body of knowledge about the impact of CDS alerts on process and outcome measures.

Study #2: Assessing the usability of a CPOE system through computerized simulations

The usability study involved primary data collection. Although Dr. Devine had originally planned to conduct this study at The Everett Clinic, they could not support this study in the near term. Therefore, to complete this study, Dr. Devine partnered with Dr. Casey Overby, a recent graduate of the PhD program in Biomedical and Health Informatics at the University of Washington. Drs. Devine and Overby conducted companion studies. Dr. Overby studied the uptake and effect of the presentation of personalized (patient-specific) pharmacogenomic knowledge resources, presented as CDS alerts, on prescribing decisions in the context of using a CPOE system. Dr. Devine studied the usability of the CPOE system for prescribers. As a student in the Biomedical and Health Informatics PhD program, Dr. Overby curated and formatted the pharmacogenomic knowledge resources and programmed the logic rules for the CDS alerts in the test-bed of the CPOE system at the University of Washington. Dr. Devine developed the hypothetical patient case scenarios and identified potential subjects. The drugs under study were selected because their FDA drug labels contain information that suggests or recommends dose modification for patients with certain genetic profiles (e.g., prescribing clopidogrel in a hypothetical patient with a CYP2C19 variant allele that predisposes to being a

poor metabolizer). Many of these drugs are cardiology or oncology drugs; thus, subjects were cardiology and oncology fellows.

The two studies were timely, as the University of Washington was preparing to implement the Cerner Millenium CPOE system (Discern®) in early 2012. Drs. Devine and Overby worked in the test-bed environment of the Discern system. Seven cardiology fellows and three oncology fellows completed Dr. Devine's usability study during the summer of 2011. Dr. Devine is currently analyzing these data. The results will be useful locally, to tailor the presentation of CDS alerts. In that the results reflect the use of one of the most widely used CPOE systems in the nation, these results will be generalizable to other settings. Furthermore, to the investigators' knowledge, this is the first study to evaluate the impact of the presentation of personalized pharmacogenomic information at the point of electronic prescribing. Both the presentation of pharmacogenomic knowledge in the prescribing context and the development of pharmacogenomic knowledge resources are at the leading edge of CDS evaluations. Drs. Devine and Overby plan the following two publications from their work:

- **Devine EB**, Overby CO, Lee C, Abernethy N, Tarczy-Hornoch P A Usability Evaluation of Pharmacogenomic Clinical Decision Support Aids in a Computerized Provider Order Entry System. *Intended for J Am Med Assoc*
- Overby CL, **Devine EB**, Abernethy N, Tarczy-Hornoch P. Assessing Clinical Opinions and Use of Genetic Test Results and Decision Support Aids in Prescribing Decisions. *Intended for J Am Med Assoc*

Study #3: The cost-effectiveness analysis of a CPOE system versus handwritten prescribing on medication safety (medication error and adverse drugs events averted)
Although Dr. Devine had originally planned to conduct a cost-benefit analysis of the CPOE system at The Everett Clinic, by the time she was ready to undertake this study, The Everett Clinic was already committed to implementing Epic's EHR. Thus, the information would not have been useful to them. Furthermore, other investigators have already used the CBA framework to build the case for widespread adoption of EHRs and CPOE systems[2]; the nation has embraced this notion. Dr. Devine realized the body of literature that evaluates the cost effectiveness of implementation of a CPOE system is virtually nonexistent. Thus, she undertook a cost-effectiveness analysis (CEA), modeling it using a decision analytic framework, the cost-effectiveness of a CPOE system on medication safety. She populated the numerator using cost data from Wang's study[2] and the denominator with the results of her own medication error/ADE study (Devine, et al. *JAMIA* 2010). Using these data, she estimated the '*cost-effectiveness of a CPOE system per ADE averted in the ambulatory setting.'* She used handwritten prescriptions as the reference strategy and a time horizon of 5 years, and she limited the ADEs to those resulting from prescribing-related medication errors. Based on data obtained from The Everett Clinic, she estimated the number of 'prescriptions per provider per year' at 6750. Using this cohort, the model estimated that the CPOE system resulted in a cost savings of $174,139 and prevented 3077 medication errors and 19 preventable ADEs per provider over the 5-year time horizon. CPOE was the dominant strategy. Dr. Devine is now updating her model with cost data and time estimates from her time-motion study (Devine, et al. *HSR* 2009) from The Everett Clinic and will submit the results of this work for publication. The results of this study will also make a contribution to the CPOE literature. Indeed, the recently published AHRQ Evidence Report of Medication Management Health IT notes that few studies in the CPOE literature have evaluated the economic outcomes of these systems.[1]

Dr. Devine has continued to collaborate with Dr. Overby in the area of personalized pharmacogenomics. To date, this has resulted in one publication in a conference proceeding

and one manuscript currently under peer review. For these projects, Dr. Devine was serving as Dr. Overby's mentor while the latter was a PhD student. Throughout the remainder of this document, publications wherein Dr. Devine has served as a mentor to graduate students are indicated with an asterisk (*).

- *Overby CL, Tarczy-Hornoch P, Hoath J, Smith JW, Fenstermacher D, **Devine EB.** An Evaluation of Functional and User Interface Requirements for Pharmacogenomic Clinical Decision Support. First IEEE Conference on Healthcare Informatics, Imaging, and Systems Biology. July 27-29, San Jose, CA (peer-reviewed manuscript)
- *Overby CL, **Devine EB**, Tarczy-Hornoch P, Kalet. Deriving Rules and Assertions From Pharmacogenomic Knowledge Resources In Support Of Patient Drug Exposure Predictions. (under revision at *J Am Med Inform Assoc,* October 2011)

Dr. Devine's Research Emphasis in Areas External to Medication Management Health IT
In addition to her work in Medication Management Health IT, Dr. Devine has concurrently conducted research projects that all fall broadly under the rubric of health services research. The list of these publications follows. She was particularly pleased to be able to write and publish one of the featured articles for the AHRQ Web M&M online newsletter. She is also now mentoring graduate students from the Health Sciences schools at the University of Washington. These publications reflect the results of these efforts.

- ***Devine EB**, Cross JT, Kowdley KK, Sullivan SD. The cost of treating ribavirin-induced anemia in hepatitis C: The impact of using recombinant human erythropoietin. Curr Med Res Opin 2007;23:1463-72
- Wittkowsky AK, Nutescu E, **Devine EB.** Compression stockings to prevent post-thrombotic syndrome: a role for anticoagulation clinics? J Thromb and Thrombolysis 2008 26(3):248-50. Epub 2007 Nov 30
- **Devine EB,** Hopefl A, Wittkowsky AK. Adherence to guidelines for the management of excessive warfarin anticoagulation. J Thromb Thrombolysis 2009;27:379-84 (Epub ahead of print: May 9, 2008)
- **Devine EB.** The art of obtaining grants. Am J Health-Syst Pharm 2009;66:580-7
- ***Devine EB**, Hoang S, Wilson-Norton JL, Lawless NM, Fisk AW. Strategies to Optimize Medication Use in the Physician Group Practice: The Role of the Clinical Pharmacist. J Amer Pharm Assoc 2009;49(2):181-91
- ***Devine EB,** Chan LN, Babigumira J, Kao H, Drysdale T, Reilly D, McNeely M, Sullivan SD. Postoperative acquired coagulopathy: A Pilot Study to Determine the Impact on Clinical and Economic Outcomes. Pharmacotherapy 2010;30:994-1003
- **Devine B.** Bad writing, wrong medication [Spotlight]. AHRQ WebM&M [serial online]. April 2010. Available at: http://www.webmm.ahrq.gov/case.aspx?caseID=215
- *Cheng MM, Ramsey SD, **Devine EB**, Garrison LP, Bresnahan BW, Veenstra DL. A systematic review of the evidence supporting the clinical and economic value of oncology orphan drugs marketed in the United States. (under revision at *Journal of Managed Care Pharmacy*, October 2011)
- *Gillard, Patrick, **Devine EB,** Varon S, Maglinte GA, Hansen RN, Sullivan SD. Mapping from disease-specific measures to health-state utility values in migraineurs. (under revision at *Value in Health, October 2011)*

Since 2009, Dr. Devine has studied in depth and published using the emerging method of indirect treatment comparisons conducted in a Bayesian framework. This area of interest has now broadened into a focus in evidence synthesis, an area of research that is both timely and

necessary to inform comparative effectiveness research (CER). In 2010, she had the privilege of serving on the Task Force that published a white paper, entitled "Good Research Practices in Comparative Effectiveness Research: Indirect Treatment Comparisons," convened by the International Society for Pharmacoeconomics and Outcomes Research (ISPOR), of which she is a member.

- ***Devine EB,** Alfonso R, Sullivan SD. Comparative effectiveness of biologic therapies in rheumatoid arthritis: An indirect comparisons approach. Pharmacotherapy 2011;31:39–51
- Jansen JP, Fleurence R, **Devine EB**, Itzler R, Barrett A, Hawkins N, Lee K, Boersma C, Cappelleri JC. Interpreting indirect treatment comparisons and network meta-analysis for health care decision-making: Report of the ISPOR Task Force on Good Research Practices – Part 1. Value in Health 2011;14:417-28

In July 2011, a colleague, Dr. Fred Wolf, invited Dr. Devine to present at the closed conference of the professional group called the Society for Research Synthesis Methodology (SRSM; http://www.srsm.org/). This is a small, self-selected group of methodologists who specialize in methods of research in evidence synthesis. The group is composed of methodologists from three disciplines: educational statistics, social science statistics, and healthcare evidence synthesis statistics. The collaboration between Drs. Devine and Wolf has resulted in presentations at both the SRSM meeting in Ottawa, Canada, (July 2011) and the Cochrane Collaboration in Madrid, Spain (October 2011). Drs. Devine and Wolf hope to continue their collaborations in this increasingly important area.

- Wolf F, Nguyen H, **Devine B.** Exploring indirect effects of comparative effectiveness in a Cochrane review. 19th Cochrane Colloquium, Madrid, Spain, October 2011 (poster)
- Wolf F, **Devine B.** Comparing Results of Frequentist and Bayesian Approaches to Explore the Comparative Effectiveness of Subgroups in a Cochrane Systematic Review. Society for Research Synthesis Methodology, Ottawa, Canada, July 2011 (podium)

In addition, Dr. Devine is currently mentoring several graduate students as they study methods in evidence synthesis. Following is a list of projects for which Dr. Devine is providing mentorship to graduate students on the University of Washington Health Sciences campus:

- *Cheng MM, Blough DK, Goulart B, Veenstra DL, **Devine EB.** A mixed treatment comparison of therapies for symptomatic, previously untreated chronic lymphocytic leukemia. (under revision at *Cancer Treatment Review,* October 2011)
- *Lin V, Devine EB. Comparing efficacies of biologics in the treatment of moderate to severe psoriasis: A Bayesian mixed treatment comparison approach. Intended for *J Rheumatol*
- *Wong W, Lin V, **Devine EB.** Statins in the prevention of dementia and Alzheimer's Disease: A Meta-Analysis. Intended for *Pharmcoepidemiol and Drug Saf*

In addition to her publications, Dr. Devine has presented posters and podium presentations at numerous meetings, specifically presenting the results of her funded work at the AHRQ Annual meetings in 2006, 2007, and 2009.

Grantsmanship

During the first year of her K-08, there was overlap for Dr. Devine's time on Dr. Sullivan's THQIT grant (Transforming Healthcare Quality through Information Technology). In 2008, before she graduated with her PhD, Dr. Devine and colleague Dr. Lingtak Chan secured a grant from Zymogenetics to conduct a case-control study of postsurgically acquired coagulopathy. Both of these grants are listed below.

2004-2007 **Agency for Healthcare Research and Quality** (5UC1 HS015319)

"Evaluating the Impact of an Ambulatory Computerized Provider Order Entry System with Clinical Decision Support Alerts on Outcomes"
Co-Investigator (Co-PIs: Sullivan & Fisk) – for The Everett Clinic Project
20%/15% then donated while on K-08
$1,030,363 (Federal)/$2,389,035 (including cost-sharing)

2008-2009, **Zymogenetics**
"Acquired Coagulopathy in Hospitalized Patients: A Pilot Study to Determine the Impact on Clinical and Economic Outcomes"
Co-Principal Investigator (with Chan)
10% time; $174,877

Since 2007, Dr. Devine has been submitting grants to federal funding agencies to continue her work in Medication Management Health IT at The Everett Clinic. Although in two instances she has come quite close to being funded, her scores have just missed the funding line. She submitted an R-18 to AHRQ in 2007 and one in 2008 (priority score 257). She submitted an RC-1 to the National Library of Medicine in 2009 (priority score 51; 10th percentile). She submitted an R-18 to AHRQ in 2010 (priority score 25; 11th percentile).

Dr. Devine currently has an R-21 under review at AHRQ.

2011-2014 **Agency for Healthcare Research and Quality** (1R21HS021306-01)
"Evaluating the Impact of an EHR-based, Patient Portal on Outcomes for Patients with Complex Chronic Diseases: Focus on Diabetes"
Principal Investigator – for The Everett Clinic Project
25%, $299,678

Since 2010, Dr. Devine has been serving in the role of co-investigator on two large, AHRQ-funded projects held by colleagues in the School of Medicine. She has recently added a third project, funded by the National Institute of Nursing Research. In addition, in 2011, an NIH Administrative Supplement to a University of Washington CTSA Grant supported her. Each of these funding mechanisms is listed below.

2010-2013 **Agency for Healthcare Research and Quality** (1R01 HS20025)
"Surgical Care and Outcomes Assessment Program Comparative Effectiveness Research Network (SCOAP-CERTN)"
Co-Investigator (PI: Flum)
15%/18.75%/20%; $11,799,186

2010-2013 **Agency for Health Care Research and Quality** (1R18 HS019531)
"Communication to Prevent and Respond to Medical Injuries: WA State Collaborative"
Co-Investigator (PI: Gallagher)
10%; $2,348,681

2011-2015 $1,975,439, **NIH: National Institute of Nursing Research** (1R01 NR012213)
"A Problem-Solving Intervention for Hospice Caregivers"
Co-Investigator (PI: Demiris)
10%

2010-2011 **NIH**, **CER Administrative Supplement to UW ITHS Grant** (5UL1 RR025014)
"CER Administrative Supplement, Workforce Development"
Co-Investigator (PI: Disis)
5%; $320,513

Current and Future Research Endeavors

While continuing to seek funding for her own work, Dr. Devine has engaged significantly in the three projects on which she is a co-investigator. For Dr. Demiris' study, titled "A Problem-Solving Intervention for Hospice Caregivers," she is leading a cost study. For Dr. Gallagher's study, titled "Communication to Prevent and Respond to Medical Injuries: WA State Collaborative," she is co-lead of the Evaluation Core. In this capacity, she is leading a project that evaluates the impact of communication training (e.g., Team STEPPS) and error disclosure training on clinical metrics, coining the term communication-sensitive events. For this project, she will use her health services research methods skills to create and execute a statistical analysis plan. She has also recently been asked by Dr. Gallagher to assume a larger role in serving as the faculty liaison for the Evaluation Core, in working with participating health systems, to ensure that the Evaluation Plan (to include interviews and web surveys) is executed correctly.

Dr. Devine's primary focus is with Dr. Flum's project, the "Surgical Care and Outcomes Assessment Program Comparative Effectiveness Research Network (SCOAP-CERTN)." This grant is one of the two grants funded under the RFA "Enhanced Registries for Quality Improvement and CER." The grant leverages the existing SCOAP QI network, which benchmarks surgical outcomes across 55 of 60 hospitals in Washington State, to perform CER. This grant is affording Dr. Devine numerous opportunities to serve in a leadership capacity. She is the lead co-investigator for the CER Core. Under her leadership, this core has developed and launched a prospective cohort study to compare clinical, functional, and quality-of-life outcomes for patients diagnosed with intermittent claudication. These patients are being cared for with one of three types of interventions: open surgical procedures, endovascular/stenting procedures, or medical management (usual care). Dr. Devine made full use of her health services research training in developing the protocol for this prospective observational study. She works closely with the team statistician and a vascular surgeon. In addition, Dr. Devine serves as a co-investigator on the Health Information Technology (HIT) Core. This leverages her experience in working with EHRs. This core is responsible for installation of the Microsoft Amalga Unified Intelligence System (UIS)® at approximately 10 hospitals throughout Washington State. Amalga is a software solution that brings historically disparate data together and makes it easy to identify and act on insights into clinical, financial, or operational performance. The SCOAP CERTN investigators are using Amalga to begin to automate data abstraction from disparate EHRs from 10 hospitals in the state to begin to conduct CER studies. Dr. Devine is leading the research study that will validate the data flowing from these EHRs into Amalga, with the goal of eventually using the product to conduct CER.

Involvement in the SCOAP CERTN project has provided Dr. Devine numerous opportunities for speaking engagements both within and outside the University of Washington. She has been quite active in the Electronic Data Methods (EDM) Forum, the grant that facilitates networking opportunities among investigators of the 11 grants funded under this same initiative; SCOAP CERTN is one of these 11. Dr. Devine represented the SCOAP CERTN project on a summer webinar hosted by the EDM Forum. She gave two presentations at the EDM Forum's Methods Stakeholders Symposium, one on the validation study and a second on the patient-reported outcomes survey center. She was also invited to speak about the SCOAP CERTN project at a meeting of the Community Stakeholders Forum of AHRQ's Effective Healthcare Program in October 2011. Dr. Devine has submitted a proposal in response to the EDM

Forum's call for commissioned papers; she has proposed to write a manuscript about the validation study. Finally, Dr. Devine has been invited to author a book chapter about using electronic data to conduct CER as part of a six-volume set on health services research to be published by Springer in 2012.

Participating as a co-investigator on Drs. Gallagher's and Dr. Flum's grants has enabled Dr. Devine to expand her network of colleagues and research ideas across the State of Washington. Dr. Devine intends to continue these important collaborations, both of which offer opportunities to ask follow-on research questions and seek additional funding for projects that Dr. Devine can lead. Dr. Devine currently describes her research program as being at the intersection of comparative effectiveness research and clinical research informatics.

Teaching and Mentoring

Dr. Devine has been appointed to the Graduate Faculty, with the designation of being qualified to chair both doctoral dissertation and master's level thesis committees. In 2009, shortly after she received her PhD, she was invited to join the Division of Biomedical and Health Informatics, Department of Medical Education, School of Medicine, as an adjunct faculty member. This year, she has been invited to serve in the same role in the Department of Health Services, School of Public Health. Over the past 2 years, she has served on the doctoral dissertation committees of three PhD students in Biomedical and Health Informatics. She has also served on the doctoral committee of one PhD student in the Pharmaceutical Outcomes Research and Policy Program (PORPP) – her home department – and on the thesis committee of two master's students. She is currently serving as a member of the doctoral dissertation committee of a student from the Public Health Genetics Program, School of Public Health, and is mentoring a second-year PhD student in the Department of Health Services.

Dr. Devine is now the Chair of the Curriculum Committee for the Pharmaceutical Outcomes Research and Policy Graduate Program (PORPP). In this role, she works closely with the Director of the Graduate Program for PORPP and with a Health Services faculty colleague to coordinate material for the graduate students in these programs. Dr. Devine is now leading an effort to create a course in "Advanced CER Methods" that will be of interest to PORPP and Health Services Graduate students. In addition, Dr. Devine and a faculty colleague have submitted a proposal, in response to a request for proposals (RFP) to the PhRMA Foundation, to develop a graduate program in CER. In response to this RFP, Drs. Devine and Garrison proposed instead a Graduate Certificate in CER.

Dr. Devine provides guest lectures in several graduate level courses, including classes in economic evaluation in medicine, meta-analysis, and patient-reported outcomes.

In September 2011, Dr. Devine joined a cadre of faculty from the UW in teaching in a 1-week training institute on CER, intended for graduate students, post-doctoral fellows, clinical practitioners, and research scientists from across the five-state WWAMI (Washington, Wyoming, Alaska, Montana, Idaho). The NIH Administrative Supplement to the UW CTSA supported this institute. Drs. Devine and Wolf led the sessions on Evidence Synthesis (meta-analysis and indirect/mixed treatment comparisons).

Since Fall 2008, Dr. Devine has course mastered a course on Study Design for the professional pharmacy (PharmD) students. This class entails exposing these professionals-in-training to the common types of study designs and teaches them how to critically evaluate the literature in all areas of practice. This Fall, the University of Washington School of Pharmacy has implemented a newly revised curriculum for the professional degree program. Dr. Devine was instrumental in

creating the vision for this revision and is now executing the vision in her revised course, titled "The Design and Analysis of Medical Studies," that she co-course masters with her biostatistician colleague, Dr. Dave Blough.

In 2010, in conjunction with the Chief Pharmacy Officer from the University of Washington Medical Center, Dr. Devine created an elective course in Medication Safety and Quality for these same PharmD students. Under the newly revised curriculum, Dr. Devine and Mr. Somani will be teaching this class again in Spring 2012, for the first time as a new class in the core curriculum.

Finally, Dr. Devine continues her quarterly seminars in outcomes research with the Pharmacy Residents from UW Medicine Pharmacy Services, and she mentors these residents on their requisite projects throughout their year at UWMC.

Service
Dr. Devine served on one of the Biomedical Committees of the UW Institutional Review Board from 2004-2011. Other university service activities have already been mentioned: serving as Chair of the PORPP Curriculum Committee and serving on the committee to revise the PharmD curriculum. In the professional arena, in addition to serving on the ISPOR Task Force for Good Research Practices for Indirect Treatment Comparisons, Dr. Devine is currently serving as a member of the Research Advisory Panel of the American Society of Health-System Pharmacists. She also continues to serve as a manuscript reviewer for several journals.

Summary
Dr. Devine has made excellent use of the resources provided her on her AHRQ-funded K-08. She has integrated completely and is fully engaged in the research, teaching, and service enterprises of the Health Sciences campus at the University of Washington and has launched a promising career as an independent investigator.

References

1. McKibbon KA, Lokker C, Handler SM, Dolovich LR, Holbrook AM, O'Reilly D, Tamblyn R, Hemens BJ, Basu R, Troyan S, Roshanov PS, Archer NP, Raina P. Enabling Medication Management Through Health Information Technology. Evidence Report/Technology Assessment No. 201. (Prepared by the McMaster University Evidence-based Practice Center under Contract HHSA 290-2007-10060-I). AHRQ Publication No. 11-E008-EF. Rockville MD: Agency for Healthcare Research and Quality. April 2011

2. Wang SJ, Middleton B, Prosser LA, et al. A cost-benefit analysis of electronic medical records in primary care. Am J Med. 2003 Apr 1;114(5):397-403