

Volume #5, Issue #1

Summer 2013

Special points of interest:

- **Electronic Health Records & Meaningful use**
- **Robotics & Antineoplastic preparation**
- **Over 14 recent publications from Center employees**
- **Global Fellows Corner with Susan Wells, M.B.Ch.B., Ph.D.**

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Center Updates: a seasonal review

Preventing Adverse Drug Events: A Look at Medication Errors

In recent years, prescription medicine use has become increasingly widespread. Clinicians have access to an armamentarium of over 10,000 prescription medicines, and nearly one in every three adults in the United States take 5 or more medications. These advances in clinical therapeutics have undoubtedly resulted in major improvement in health for patients and many diseases, but they have also opened the door for increased risks associated with adverse drug events (ADEs). Recently, the Agency for Healthcare Research and Quality (AHRQ) published a patient safety primer which highlighted the issue of medication errors and ADEs; what they are, the risks factors for ADEs, and how they can be prevented.

In general, the agency defines a medication error as any error which occurs along the pathway that begins when the clinician prescribes a medication and ends when the patient receives the medication. ADEs, on the other hand, are defined as harm experienced by a patient as a result of exposure to

medication. The risk factors that are associated with ADEs come in two forms: patient-specific and drug-specific. Patient-specific risk factors include polypharmacy (taking more medications than clinically intended), and limited health literacy, and numeracy (the ability to use arithmetic operations for daily tasks). Drug-specific risk factors arise primarily from the high-alert medications listed by the Institute of Safe Medication Practices (ISMP). Included in this list are medications which have dangerous adverse effects, but also include look-alike, sound-alike medications, which have similar names and physical appearances but completely different pharmaceutical properties. However, it has been observed that most ADEs are caused by commonly used medications whose benefits outweigh the risks, such as antidiabetic agents and antiplatelet agents.

In order to prevent ADEs, the agency created a table highlighting the safety strategies associated with each step of the pathway between a clinician’s deci-

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A Look at Electronic Health Records: the Meaningful Use Program

In 2009, the Health Information Technology for Economic and Clinical Health (HITECH) established Medicare and Medicaid incentives programs to encourage the adoption of electronic health records (EHRs) by hospitals and medical professionals. As part of the incentives programs, eligible healthcare professionals who showed “meaningful use” of certified EHRs were eligible for payments up to \$44,000, whereas those who did not are subject to penalties after 2015. In a recent article published by the New England Journal of Medicine, Dr. Adam Wright, along with center director Dr.

David Bates and collaborators at Harvard, the University of Texas, and Boston University analyzed the rate at which eligible professionals were attaining to meaningful use between April 2011 and May 2012.

As of May 2012, 62,226 of a total 509,328 (12.2%) eligible professionals in the United States had attested to meaningful use under the Medicare program, including 9.8% of specialists and 17.8% of primary care providers (PCPs). Attestation rates varied significantly from state to state, ranging from

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Classifying drug-drug interactions: reducing alert fatigue

Reducing the number of alerts shown to providers increases clinician attentiveness to clinically significant alerts and improves patient safety.

In a recent article published in the Journal of the American Medical Informatics Association, Shobha Phansalkar et. al. analyzed the problem of alert fatigue associated with the use of clinical decision support systems in electronic health records (EHRs). More specifically, the team focused on drug-drug interaction (DDI) alerts, which have been reported to have override rates of over 90%. The objective of the study was to reduce alert fatigue by safely classifying some DDIs as non-interruptive to the provider's workflow. Reducing the number of alerts shown to providers increases clinician attentiveness to clinically significant alerts and improves patient safety.

In order to conduct their analysis the team obtained the alert logs spanning 6 months from one academic medical center, which employs a commercially developed EHR, with a vendor developed medication knowledge base. The threshold of inclusion was set to those interactions with override rates of greater than 90%, which represent the alerts that have the largest contribution to alert fatigue. The final interactions were presented to a panel that included

11 experts with broad expertise in the area of medication-related decision support from the perspective of the clinician-end user, pharmacist, pharmacologist, and clinical informaticists. Each panel was provided a list of interactions along with all the information associated with the interaction, such as the severity level, type of interaction, predisposing risk factors, and management options to reduce the severity of the interaction. Using this information, each panelist was asked to assess whether the interaction could be safely made non-interruptive or not. Finally, a consensus meeting was held to discuss panelist's ratings on the interactions.

The results showed that the alert logs consisted of 4077 DDI pairs. Excluding interactions that accounted for less than 0.2% of alerts in the data set and those with override rates less than 90%, a list of 114 DDI alert pairs was generated. From this list, the top 50 most frequently occurring DDIs were selected, based on the number of alerts these DDIs generated. Of the 50 interactions that were assessed, one DDI between iron salts and protein pump in-

hibitors was found to occur twice and was counted once to bring the total of reviewed interactions to 49. In all, the panel came to the consensus that 16 of the interactions should remain interruptive in nature, whereas 33 could safely be made non-interruptive in nature.

Overall, the study provided a list of interactions that can be safely made into non-interruptive alerts, reducing alert fatigue. However, the team highlighted that the study performed had several key limitations, such as the fact that the DDIs came from only one large institution and how an expert panel process was utilized rather than a formal evidence review for the individual interactions.

Phansalkar S, van der Sijs H, Tucker AD, Desai AA, Bell DS, Teich JM, Middleton B, Bates DW. [Drug-drug interactions that should be non-interruptive in order to reduce alert fatigue in electronic health records](#). J Am Med Inform Assoc. 2013 May 1;20(3):489-93.

The majority of errors are likely to occur at prescribing and transcribing stages

Medication errors, continued

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sion to prescribe a medication and the patient actually receiving the medication. Overall, there are 4 major steps outlined in the pathway: prescribing, transcribing, dispensing, and administration. The majority of errors are likely to occur at prescribing and transcribing stages, but special attention must also be warranted to medication administration errors that are common in both the inpatient and outpatient settings. The agency also addresses that while the strategies enumerated in the table can prevent ADEs when used individually, fundamentally, improving medication safety cannot be divorced from the overall goal of reducing preventable harm from all causes.

To find more patient safety primers written by the AHRQ, visit <http://psnet.ahrq.gov/primerHome.aspx>

Electronic Personal Health Records and the Changing Medical Industry

In the past decade, there has been a significant increase in the number of personal computers. As a result, consumers have become more likely to perform a variety of tasks online, such as shopping and banking. Therefore, it should come as no surprise that medical records have followed the same route, resulting in the formation of electronic personal health records (PHRs). The intended goal of PHRs is to provide the patient with an easy-to-manage source of their medical records so that the patient might be more involved in their own health care. In a recent article published in the *Journal of the American Medical Association*, Dr. David W. Bates and Dr. Susan Wells discuss the implementation of PHRs, and their effects on the medical industry.

There are two main electronic architectures: one linked directly to the physician's practice based electronic health record, known as a patient portal, and the other free-standing in cyberspace, without a linkage. Patient portals appear to be vastly more popular and offer many more advantages than free-standing PHRs. Specific information from the medical record that is difficult and time-consuming for patients to access otherwise, like lab and test results, are included in patient portals, along with additional services such as patient reminders for preventative health checks and the ability to securely email physicians. Research suggests that patient portals improve patient satisfaction, enhance per-

sonal empowerment, and increase patient-physician communication. Patient portals also have the potential to improve patient outcomes through enhanced safety. However, the extent to which care is actually improved is uncertain, and the features necessary to achieve improved health outcomes are unclear.

Some evidence suggests that patient portals can have a profound effect on the way care is delivered. Two studies from early experiences within Kaiser Permanente (Northwest and California) found that implementing a patient portal linked to the Kaiser electronic health record system reduced face-to-face outpatient visits by 6.7%. Another study reported a 25.3% decrease in primary care and 21.5% decrease in specialty care associated with PHR implementation. The number of telephone and electronics contacts increased substantially, implying a substantial amount of care could be delivered virtually rather than face-to-face.

However, these studies did not examine total utilization or hospitalization rates; issues addressed in another study led by Dr. Ted Palen. In his study, Palen et. al. examined the relationship between online patient access to health information through a patient portal and health care utilization. This work came from the Colorado region of Kaiser Permanente, but used the same integrated system, and the same electronic health record and ven-

dor portal were evaluated. The study found that the adoption of a patient portal was associated with greater use of services, including emergency department visits (11.2 per 1000 members per year) and hospitalizations (19.9 per 1000 members per year). Many potential reasons exist for why the results between the two studies vary, such as differing aspects of care in each region not reported in the analysis, or prior studies may have been performed in sites with more highly integrated care.

Regardless, PHRs are here to stay, and the benefits associated with the tethered architecture appear to be the most beneficial. Improving the speed and user experience for portals and delivering more content that applies to everyone via mobile devices should radically change what patients are able to do. However, it will be helpful for organizations encouraging the adoption of PHR portals to know what to expect as a result. Drs. Bates and Wells concluded by stating that while more studies are needed to determine the full benefits of patient portals, these systems should be adopted now regardless of their effects on utilization, because it should be possible in the future to leverage those systems to improve care in myriad ways.

Bates DW, Wells S. [Personal health records and health care utilization](#). *JAMA*. 2012 Nov 21;308(19):2034-6

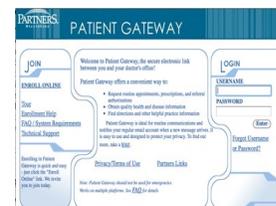


Image of the login screen for Patient Gateway, the patient portal used by BWH. For more info on Patient Gateway, visit <https://www.patientgateway.org/scripts/phsweb.mwl?APP=PTGW&OPT=START>

The intended goal of PHRs is to provide the patient with an easy-to-manage source of their medical records to that the patient might be more involved in their healthcare needs.

Awards & Honors

We are pleased to announce that Jeffrey L. Schnipper, MD, MPH, a physician in BWH's Department of Medicine, received the 2013 Excellence in Research Award from the Society of Hospital Medicine (SMH).

In addition, the Society of General Internal Medicine (SGIM) presented David W. Bates, MD, MSc, with the Robert J. Glaser award for outstanding contributions to research, education, or both in general internal medicine. The award is the highest honor given by the SGIM and is supported by grants from the Henry J. Kaiser Family Foundation, the Commonwealth Fund, and individual contributors.

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In survey responses, 84% (59/70) stated that they were satisfied or very satisfied with receiving automated email notifications of TPAD results on their discharged patients



Automated Email Notification for patients with TPADs

The transition to the ambulatory setting after hospital discharge is susceptible to communication failure of vital patient information, such as the results of tests pending at discharge (TPADs). Failure to follow up TPAD results can lead to readmissions, delays in diagnosis and treatment, and sometimes patient harm. In a recent paper published in the Journal of the American Medical Informatics Association, Dr. Anuj Dalal et al. discussed the implementation of an automated email notification system designed to push the finalized TPAD results to the responsible inpatient-attending physician at discharge and how this system facilitates communication with the primary care physician (PCP).

The study conducted by the team contained two phases. Phase 1 involved measuring the volume of tests processed, the effect of initially configured suppression rules, and the reliability of discharge time entry and provider identification for any patient discharged with TPADs. Phase 2 measured the volume of automated email notifications received by physicians stratified by notification type for patients with TPADs. In addition, a brief survey was sent out to the randomly selected inpatient-attending physicians asking them to rate their satisfaction with the automated email system.

In Phase 1, there were 82 correctly identified patients with TPADs. Of these 82 patients, the system detected 264 chemistry and 141 hematology TPADs, triggered 136 emails (1.7 emails per patient) with two or more emails triggered on 28 patients (34%), and 73 abnormal results (18%) flagged. The system triggered emails on 1 patient incorrectly (1.2%), and three responses were re-

ceived stating that emails were sent to the wrong provider.

In Phase 2, 95 patients of randomly selected physicians were discharged with non-suppressed TPADs. During the one month period, inpatient-attending physicians received approximately 1.6 notifications per discharged patient, and anywhere from one to 32 emails in total. The majority of emails sent to inpatient-attending physicians were microbiology notifications (58%). In terms of user satisfaction, a total of 70 completed surveys from 29 physicians were received. In survey responses, 84% (59/70) stated that they were satisfied or very satisfied with receiving automated email notifications of TPAD results.

Based on these results, the team concluded the strategy of pushing the results of TPADs to the responsible physicians during a patient's transition post discharge is potentially effective in mitigating an otherwise unresolved patient safety concern. However, the team noted that further studies are needed to rigorously evaluate the effect of the system on awareness and satisfaction of both inpatient and ambulatory physicians, to analyze downstream actions taken in response to notifications, and to further elucidate desired features to maximize utility.

Dalal AK, Schnipper JL, Poon EG, Williams DH, Rossi-Roh K, Macleay A, Liang CL, Nolido N, Budris J, Bates DW, Roy CL. [Design and implementation of an automated email notification system for results of tests pending at discharge](#). J Am Med Inform Assoc. 2012 Jul-Aug;19(4):523-8

Into the Future? How The Use of Robotics Can Help Antineoplastic Preparation

In a recent paper published by the American Society of Clinical Oncology, Dr. Andrew Seger et. al. analyze the impact of robotic antineoplastic preparation on the safety, workflow, and costs associated with the practice. Due to the high toxicity and narrow therapeutic window of antineoplastic therapy, standard pharmacy practices involving antineoplastic preparation and adjuvant medication compounding present unique safety concerns for both the patient and the staff, as well as consume a great deal of time and money. Therefore, the team looked at how robotics may provide safety, efficiency and cost savings advantages for these procedures.

For this study, the team looked specifically at four major areas of concern: medication and staff safety, medication accuracy, workflow of medication preparation, and costs of medication preparation. The standard, manual process for antineoplastic and adjuvant medication production in the pharmacy was compared with the process followed by the Health Robotics CytoCare robot, which maintained ISO Class 5 standard for aseptic handling of medications with minimal microbiologic contamination. Unintended consequences of robotic use, including mechanical and software failures and the accuracy of prepared drugs were also assessed.

The based on 1,421 and 972 drug preparations that were observed in the baseline and intervention periods, respectively. They found nine (0.7%) and seven (0.7%) serious medication errors (MEs), as well as 73 (5.1%) and 28 (2.9%) staff safety events in the baseline and intervention periods, respectively. There were 45 events of unintended consequence (4.6%) specifically attributed to the new technology, although none of the events resulted in the production of a final product, and were thus not considered serious MEs. Accuracy measurements including 184 baseline preparations and 110 interventions showed that there were 23 failed baseline preparations (12.5%) and one failed intervention preparation (0.9%) using the cutoff point of more than $\pm 5\%$ variance. On secondary analysis using the industry standard of more than $\pm 10\%$ variance, eight baseline preparations (4.3%) failed

whereas no intervention preparations failed.

Overall, the study found a significant reduction in the number of potentially harmful staff safety events. There were no cost savings in terms of labor and any savings in the cost of medications were not determined as there was great volatility in the market due to medication shortages during the study period. The findings also showed significantly increased accuracy of prepared chemotherapy and adjuvant medications by robot compounding, with a reduction in failure rate from 12.5% to 0.9%. By eliminating the pharmacy technician's handling of opened/exposed antineoplastic and adjuvant medications during robotic preparations, the team was able to significantly reduce the ancillary costs associated with several components of the closed-system transfer device, accounting for 60% of the overall cost for the device. When this data was annualized for the 16,500 antineoplastic bags/syringes prepared for the hospital in 2009, they would have saved \$115,500 in material costs.

In conclusion, the implementation of robotics to manufacture antineoplastic and adjuvant medications seems to be advantageous in the fact that robots can help reduce the number of staff safety events that occur, as well as decrease ancillary costs significantly. The accuracy obtained by the machines in the preparation of antineoplastic and adjuvant doses is much greater than the accuracy from manual preparation. While the robotics introduced unintended mechanical and software failures, none of these failures were considered to be safety hazards. However, additional studies are needed to be made to assess the overall cost and benefits of this alternative to manual preparation of antineoplastic and adjuvant medications and better understand new innovations in mechanical and software upgrades of these products.

Seger AC, Churchill WW, Keohane CA, Belisle CD, Wong ST, Sylvester KW, Chesnick MA, Burdick E, Wien MF, Cotugno MC, Bates DW, Rothschild JM. [Impact of robotic antineoplastic preparation on safety, workflow, and costs.](#) *J Oncol Pract.* 2012 Nov;8(6):344-9, 1 p following 349.



Image of an Health Robotics CytoCare robot. For more on Health Robotics, visit <http://www.health-robotics.com/en/>

When the data was annualized for the 16,500 antineoplastic bags/syringes prepared for the hospital in 2009, they would have saved \$115,500 in material costs

Global Fellows Corner

In this new section, we will share the story of one of the Center's Global Fellows – what brought them here, what they learned, and what their take away will be.



When Dr. Susan Wells reflected on time in America the past year here as part of the Global Fellows program at Brigham and Women's Hospital (BWH), she remarked that she was astounded at how different American customs were from where she lived. "It's fascinating," she explained, "every city I visited had different policies concerning important subjects, including medicine." For instance, in almost every state, policies concerning electronic health records (EHRs) differed. It was a significant change, considering most of her life up until the Global Fellows program had been spent on a small island halfway around the world.

Born in New Zealand, Dr. Wells studied at the local University of Auckland, and worked her way to become a family practitioner. After spending 10 years as a family practitioner, she went back to school in order to become a public health medicine specialist and has since moved into a research career. Since her transition into research, Dr. Wells has published over 55 peer-reviewed journal articles. She was the national lead in developing the web-based decision support tool, PREDICT, for assessing and managing cardiovascular and diabetes risk, which is now being used in primary care practices serving one-third of the New Zealand population. If all that weren't enough, Dr. Wells has also been a senior lecturer of clinical epidemiology and quality improvement (QI) at the University of Auckland for 7 years.

When asked about her work in the Global Fellows program, Wells explained the importance of electronic personal health records (PHRs) for all patients, especially those who suffer from multiple chronic conditions. "25% of all Americans suffer from chronic diseases but account for over 60% of all medical costs" Wells stated "therefore, it's important that clinicians find a way to more effectively partner with their patients in the delivery of care." One approach to this problem that she highlights is the use of patient portals (*see article, page 3*) to provide the patient easier access to electronic personal health records. More specifically, Wells' research looks at how different institutions utilize PHR systems, especially for people with chronic illness.

In general, Wells' research focuses on organizational strategies maximizing the benefits from PHRs especially for patients with one or more chronic diseases. As part of the Global Fellows Program, Wells, along with Dr. David Bates, focused on organizational strategies targeting people with chronic illness to adopt and use PHRs. Their project utilized a mixed methods design including a semi-structured telephone interview and a quantitative survey of PHR functions, features, and monitoring of patients. "Getting PHRs available to patients is not the only part of the problem" Wells explained "There are far more questions that need to be addressed when dealing with PHRs and patients with chronic illness." For instance, she asked each organization questions involving the usability of the PHR system, what the system offered to the patients, how the organization promoted the PHRs, and how the organization reached out to the patients who needed it the most.

Other work that Dr. Wells has been involved with has centered on the implementation of online, electronic shared decision-making tools. Along with the New Zealand Heart Foundation, Wells has pioneered the innovative "Your Heart Forecast." Since 2011, she has worked with Ko Awatea, an Institute for Healthcare Improvement partner in a regional Auckland Health Board, as a senior lecturer in health innovation and QI.

When asked what she was going to take away from this experience at BWH, Dr. Wells had to pause to think about it, since "there was so much I have learned and experienced throughout this year." For her, working with the men and women at BWH gave her the opportunity to step back and gain perspective on who she called "the most amazing people in health informatics." "All of the people I've worked with have been so welcoming, friendly, and patient" she said, noting the excellent work ethic of everyone as well. In terms of

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Selected Publications by members of the center

Simon SR, Keohane CA, Amato M, Coffey M, Cadet B, Zimlichman E, Bates DW. [Lessons learned from implementation of computerized provider order entry in 5 community hospitals: a qualitative study](#). *BMC Med Inform Decis Mak*. 2013 Jun 24.

Phansalkar S, Desai A, Yoshida E, Doole J, Czochanski M, Tucker AD, Choksi A, Middleton B, Bell D, Bates DW. [Criteria for assessing high-priority drug-drug interactions for clinical decision support in electronic health records](#). *BMC Med Inform Decis Mak*. 2013 Jun 13.

Farias M, Jenkins K, Lock J, Rathod R, Newburger J, Bates DW, Safran DG, Friedman K, Greenberg J. [Standardized Clinical Assessment And Management Plans \(SCAMPs\) provide a better alternative to clinical practice guidelines](#). *Health Aff (Millwood)*. 2013 May.

Cresswell KM, Bates DW, Sheikh A. [Ten key considerations for the successful implementation and adoption of large-scale health information technology](#). *J Am Med Inform Assoc*. 2013 Jun.

Leung AA, Keohane C, Lipsitz S, Zimlichman E, Amato M, Simon SR, Coffey M, Kaufman N, Cadet B, Schiff G, Seger DL, Bates DW. [Relationship between medication event rates and the Leapfrog computerized physician order entry evaluation tool](#). *J Am Med Inform Assoc*. 2013 Jun.

Murray MF, Giovanni MA, Klinger E, George E, Marinacci L, Getty G, Brawarsky P, Rocha B, Orav EJ, Bates DW, Haas JS. [Comparing Electronic Health Record Portals to Obtain Patient-Entered Family Health History in Primary Care](#). *J Gen Intern Med*. 2013 Apr 16

Bates DW, Baysari MT, Dugas M, Haefeli WE, Kushniruk AW, Lehmann CU, Liu J, Mantas J, Margolis A, Miyo K, Nohr C, Peleg M, de Quirós FG, Slight SP, Starmer J, Takabayashi K, Westbrook JL. [Discussion of "Attitude of physicians towards automatic alerting in computerized physician order entry systems"](#). *Methods Inf Med*. 2013

Adler-Milstein J, Green CE, Bates DW. [A survey analysis suggests that electronic health records will yield revenue gains for some practices and losses for many](#). *Health Aff (Millwood)*. 2013 Mar.

Dykes PC, Carroll DL, Hurley AC, Benoit A, Chang F, Pozzar R, Caligtan CA. [Building and testing a patient-centric electronic bedside communication center](#). *J Gerontol Nurs*. 2013 Jan.

Rozenblum R, Lisby M, Hockey PM, Levtzion-Korach O, Salzberg CA, Efrati N, Lipsitz S, Bates DW. [The patient satisfaction chasm: the gap between hospital management and frontline clinicians](#). *BMJ Qual Saf*. 2013 Mar.

Shekelle PG, Pronovost PJ, Wachter RM, McDonald KM, Schoelles K, Dy SM, Shojania K, Reston JT, Adams AS, Angood PB, Bates DW, Bickman L, Carayon P, Donaldson L, Duan N, Farley DO, Greenhalgh T, Haughom JL, Lake E, Lilford R, Lohr KN, Meyer GS, Miller MR, Neuhauser DV, Ryan G, Saint S, Shortell SM, Stevens DP, Walshe K. [The top patient safety strategies that can be encouraged for adoption now](#). *Ann Intern Med*. 2013 Mar 5.

Farias M, Jenkins K, Lock J, Rathod R, Newburger J, Bates DW, Safran DG, Friedman K, Greenberg J. [Standardized Clinical Assessment And Management Plans \(SCAMPs\) provide a better alternative to clinical practice guidelines](#). *Health Aff (Millwood)*. 2013 May.



Take a look at
some recent
publications by
members of the
Center!



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Other Awards & Honors Received by Center Members:

- Anuj Dalal, MD, won 1st place at BWH's Clinical Innovation Day for his poster on transforming the acute care environment



The Meaningful Use Program, continued

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1.9% in Alaska to 24.2% in North Dakota. Family practitioners had the highest number of attestations (14,112 or 22.6%) and PCPs comprised 44.0% of all attestations. While these data suggest rapid growth in the number of providers attaining meaningful use, the team concluded that the pace must be accelerated so that most eligible professionals avoid penalties in 2015. Many barriers still exist for EHR adoption and meaningful use, including cost, workflow challenges, lack of knowledge, and lack of interoperability. A total of 62 federally funded regional extension centers are available to assist eligible professionals with EHR adoption at the moment, but long-term financial support for these extension centers is uncertain.

Wright A, Henkin S, Feblowitz J, McCoy AB, Bates DW, Sittig DF. [Early results of the meaningful use program for electronic health records](#). N Engl J Med. 2013 Feb 21;368(8):779-80

Susan Wells, Global Fellow

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lessons learned, Wells learned significantly more about the PHR system at BWH and all of the barriers that prevent similar systems from attaining their true potential. Using her newfound knowledge, Dr. Wells hopes to influence health policy in New Zealand in primary and secondary care so that one day those citizens will have access to PHRs as patients at BWH have access to Patient Gateway.

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