The Effects of Doctor-Patient Portal Use on Health Care Utilization Rates and Cost Savings

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February 2017

Abstract

Using a unique longitudinal dataset, we exploit within-patient variations in the timing of activation and subsequent use of the patient portal. Active portal use is motived by a significant uptick in office visits and phone encounters. This is followed by a drop back to pre-portal use, as portal use substitutes for the increase in office visits and telephone encounters. Portal use reduces office visits and telephone encounters by 14-percent and 19-percent per year, respectively, over a three year period. Total cost savings are estimated to be $89.73 per patient for a three year period, net of operating expenses and patients and doctors opportunity costs. This results in total cost savings for $171,473 for a little over 2000 patients. Portal use enables physicians to manage a larger panel of patients: an 11 percentage point increase in the percent of portal users allows a physician to see 26 more patients a year, after accounting for physicians' time responding to patient inquires within their normal work load. The stability of the system given the free riding inherent in all but a small number of users paying for the service is also discussed. (JEL I12, I18, I19)

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I. INTRODUCTION

Medicine has undergone an electronic revolution. In the Health Information Technology for Economic and Clinical Health Acat (HITECH) of 2010, the federal government committed almost $30 billion toward achieving electronic health record (EHR) adoption nationwide (Blumenthal and Tavenner, 2010). The HITECH invested heavily in EHR adoption because of their potential for economic and clinical transformation. A core principle behind the HITECH act was that adoption alone was not sufficient, but that it was necessary to demonstrate 'meaningful use' of EHRs before their use could demonstrate significant improvements in patient care.

One such meaningful use criterion required patients to have the ability to view, download, and transmit health information from the HER (CMS, 2012). This criterion has served as the impetus for the now widespread adoption of secure patient portals, EHR linked applications that allow patients to electronically access health information and interact with their health care providers (Ammenwerth, Schnell-Inderst, and Hoerbst, 2012). Patient portal based chronic disease management has shown promise in improving outcomes in several conditions, including chronic kidney disease, diabetes mellitus, and depression without requiring face-to-face provider time (Urowitz, Wiljer, and Cafazzo, 2012; Mendu and Waikar, 2015; Allen et al., 2008). As such, patient portals are a potential source for high-value, high-quality care at sharply reduced cost, compared to traditional patient care; e.g., office visits and phone consultations.

Despite its potential importance for patients' health care utilization and providers' health care delivery, empirical evidence on the impact of a patient portal use is surprisingly scarce. When the doctor-patient portal was first conceived, its adoption was accompanied by the expectation that medical services provided using the patient portal would be reimbursed (Whitten

and Kuwahara, 2003; Detmer et al., 2008).[2] However, these services are not reimbursed by the vast majority of payers (Demiris, Afrin, and Lynch, 2008; Detmer, et al., 2008). One major impediment to patient portal reimbursement has been a lack of empirical evidence about the effect of doctor-patient portal use on health care utilization, along with the cost savings from portal use. Most studies to date have been based on hypothetical models, rather than practice data (Detmer et al., 2008).[3] A shift to payment-per-episode models that will reimburse physician practices and thereby incentivize use of e-health management services requires economic analyses rooted in actual, not hypothetical data (Detmer et al., 2008). Our study fills this gap, using a unique panel dataset that exploits within-patient variations in the timing of activation and subsequent use of the portal system for the seven General Internal Medicine practices at the Ohio State University Wexner Medical Center. By leveraging within-patient changes before and after starting active portal use (a. k. a. an "event-study" approach), the data shows that portal use reduces office visits and telephone encounters, as use substitutes for these traditional patient care encounters.

The analysis shows that active portal use is motivated by a sharp increase in patients' office visits and phone encounters coincident with starting active portal use, followed by a sharp drop, close to pre-use levels, for these encounters as a consequence of portal use. Active portal use results in net cost savings of $89.73 per patient over the three year study period (2010-2012), accounting for both patient and doctors' opportunity costs. With a little over 2000 patients in the sample, this results in total cost savings of $171, 473 over the three year period. In addition, estimates are provided for the potential increase in doctors' patient loads resulting from portal

[2] Using standard evaluation and management (E&M) coding criteria, a majority of electronic message threads can fulfill standard office visit reimbursement criteria (Detmer et al., 2008).

[3] One exception to this is Baker et al. (2005) discussed after reporting our results.

use, after netting out doctors' time spent using the portal within the normal work day; 26 more patient visits a year for each doctor in the practice, totaling 806 visits a year.

Currently there is massive free riding by most insurance companies with respect to physicians' costs of operating the patient portal, as they typically pay nothing toward these costs. This threatens to undermine the longer run viability of the system. Reimbursement of providers' time spent with the portal is essential to the long run viability of the cost savings and increased patient loads identified here. While this will not, by itself, solve the high cost of medical care, it is an important step in that direction. We briefly discuss ways to bridge this gap in the concluding section of the paper.

II. DATA AND EMPIRICAL STRATEGY

The patient portal in question (MyChart from Epic Systems Corporation, Verona, WI) was introduced into The Ohio State University Wexner Medical Center in mid year of 2008. [4] Currently there are over 132,500 patients actively using the system within the Medical Center as a whole. Our data set begins with the year 2009 and ends with 2013. The analysis is restricted to patients who had one of four encounters (a patient portal message, an office visit, a telephone call, or a request for a prescription refill) in *each* year beginning with 2009 (the first full year of patient portal implementation) and ending in 2013 (the last year for which we have data).[5] That is, the focus is on established patients who have consistently used clinic services for the entire sample period.[6] The sample is further restricted to the patients who began *active* portal use in this time period, yielding the three cohorts of active portal users for the event analysis, shown in

[4] See a brief description of MyChart in the Online Appendix.
[5] Patients in the practice who did not have one of these encounters (e.g., someone who only had a blood test) are excluded from the sample.
[6] Focusing on these patients enables consistent estimation of cost savings from portal use over the entire sample period.

Figure 1. Patients who began use in 2009 and 2013 are excluded as active portal use began in the middle of 2009 (incomplete "before" data) and the data set ends in 2013 (incomplete "after" data).[7]

The analysis is based on within patient variation in use of clinic services used before and after starting active portal use. The alternative is to compare portal users to non-users. However, the latter might be substantially different from active users, as there are a number of significant differences in observable characteristics between users and non-users (see Table A2 in the Appendix). These differences in observable characteristics suggest differences in non-observable characteristics as well (Angrist and Pischke, 2014), so that comparing users to non-users is likely to be less reliable. To avoid any potential bias resulting from these differences, the empirical analysis is restricted to active portal users, relying on changes in office visits and telephone encounters before and after active portal use.

A key assumption of the within patient analysis is that the timing of active portal use is uncorrelated with other factors affecting health care utilization. Evidence in support of this assumption is two-fold: First, as shown in Table 1, demographic characteristics at our disposal (age, gender, race, and ethnicity) for portal users are statistically indistinguishable across each of the three patient cohorts. So that at least these characteristics are uncorrelated with starting active portal use. Second, Figure 2 shows a sharp increase in office visits across cohorts coincident with starting active portal use, along with similar increases in telephone encounters (see Figure A2 in the Appendix). This is consistent with a deterioration in patient health prompting, with portal use serving as a partial substitute for the increased need for office visits and telephone encounters.

[7] A much larger number of patients registered for an account but did not use it for this time period.

Using patient-clinic-year level data, we estimate the following event-study regression model:

$$(1) \qquad Y_{ict} = \alpha + \sum_{\kappa=-3}^{3} \beta_\kappa \cdot D_{\kappa,i} + X'_{ict}\gamma + \psi_i + \lambda_c + \delta_t + \varepsilon_{ict},$$

where Y_{ict} is an outcome variable (e.g., the number of office visit per year) for patient *i*, in clinic *c*, in year *t*; $D_{\kappa,i} \equiv \mathbf{1}\{calendar\ year - year\ of\ active\ use = \kappa\}$ is an event-year indicator, which is equal to one when the calendar year of data (*t*) is κ years after the first year of active portal use; X_{ict} is a vector of time-varying covariates (namely patients age); ψ_i are patient fixed effects; λ_c are clinic fixed effects; δ_t are year fixed effects; and ε_{ict} is an unobserved error term. The clinic fixed effect controls for any differences in insurance type, medical use, and other characteristics between the seven clinics in the sample. The year fixed effect controls for any general changes over time in these variables. The parameters of interest here are the β_κ values, used to compare variation in the dependent variable for each year relative to the first year of active portal use.[8] The standard errors are corrected for heteroscedasticity, and clustered at the patient-level.

III. RESULTS

A. Patient Portal Users Health Care Behavior

Figure 2 reports office visits in the years prior to utilization of the patient portal and the years after that for the patients starting active portal use in 2010, 2011, and 2012, respectively. Notice the uptick in office visits for each cohort in their first year of active portal use compared to the immediate preceding years; e.g., for those starting active portal use in 2010 compared to their office visits in 2009. (Figure A2 shows a similar pattern for telephone encounters.) These

[8] We normalize β_0=0 so that β_κ (κ=-3,-2,-1, 1, 2, 3) are relative to the first year of active portal use (κ=0).

patients would have a strong incentive to use the portal as a low cost, and more convenient, alternative to an office visit or the repeated phone calls necessary to speak to a doctor or nurse practitioner. The patient portal permits them to communicate directly with their doctor much in the same way that email, or texts, work outside of clinic use. The monthly-data for office visits provides further support for this uptick in office visits motivating portal use, as there are spikes in use within each month that patients started active portal use (see the box in Table A1 in the Appendix). Similar patterns are reported for all three cohorts for office visits and telephone encounters. It is these upticks in office visits and telephone encounters, coincident with initiating active patient portal use, which is exploited in the empirical analysis. That is, these upticks provide the basis for using the within-patient variation in office visits and telephone encounters against which to measure the cost savings from portal use.

For all three cohorts there is a sharp decrease in office visits after the first year of active use, as well as for telephone encounters (Figure A2 in the Appendix). These reductions are not a one-time event, with average office visits and telephone encounters more or less stabilized at the lower rate in later years as well. The ability of portal use to substitute for office visits and telephone encounters is in large measure driven by patients with more chronic medical conditions such as diabetes mellitus and chronic kidney disease, as these are easily and efficiently handled via portal use. That these chronic, age related medical conditions are driving portal use is consistent with users' average ages (in their 50s and 60s; see Figure A1), with many of these patients being familiar with email and/or texting, which is what portal use reduces to.

At this point the reader might object to the analysis on several grounds. First, the analysis suffers from a selection effect by only including active portal users. The response is simple – there is no claim that the cost savings identified here would apply equally to all patients

in the clinic. Rather, they apply to this class of patients which, as will be shown, still results in substantial savings in treatment costs and patients' opportunity costs after accounting for the cost of operating the system. Further, while it remains to be seen if more widespread portal use results in similar savings, this is the best we have for right now. Second, the reader might object that the sharp drop in office visits and telephone encounters following active portal use results from patients simply recovering from the health issues prompting portal use. This is implausible on several grounds: (i) patients suffering from chronic health problems do not suddenly recover (e.g., no longer need to worry about type 2 diabetes), and (ii) as shown in Figure 3, the number of office visits *plus* patient portal encounters after starting active portal use is essentially flat, consistent with portal use substituting, in part, for office visits and telephone encounters (see Figure A3 for the latter).[9]

Table 2 summarizes the reductions in office visits for each year following active portal use. Panel A shows the per-patient decreases. For example, the decrease in the number of office visits (per patient) in the first year following active portal use (Column (1)) averages 0.33: a 14-percent reduction in office visits relative to the first year of active portal use.[10] Panel B shows the implied decrease in office visits (compared to first year of active portal use). These are obtained by estimating the per-patient decrease in each year multiplied by the number of portal users in that cohort.[11] Pooling across all three cohorts the total decrease in office visits in the first year following the start of active portal use is 631 (the bottom row of Panel B, Column (1)). Using only the first-year decrease in office visits to estimate the impact of portal use would constitute

[9] As noted, the event analysis is restricted to patients who remained in the practice from the time they started portal use to the end of our sample data, 2013. So attrition resulting from deaths are excluded.

[10] The latter averaged 2.28 office visits per patient.

[11] They are based on (i) the 2011 cohort experiencing the same average decrease in the third year of portal use as the 2010 cohort and (ii) the 2012 cohort having the same average decrease in the second (third) year of portal use as the 2010-2011 (2010) cohort.

an extremely conservative estimate, as the number of office visits remains at or below the first year for the two cohorts we have data for. As such, the analysis on the cost savings from portal use (will be shown below) focuses on the cumulative reduction in office visits for each cohort (Column (4) in Table 2).

Table 3 reports the estimated reduction in phone encounters using the same format as Table 2. The first-year decrease in the number of phone encounters (per patient) following active portal use is 0.63: a 19-percent decrease relative to phone encounters in the first year of active portal use.[12] Pooling across all three cohorts, the total decrease in telephone encounters in the first year after starting active portal use is 1,204, with a cumulative decrease of 3,478 encounters over the three year period (Column (4)).[13]

B. Cost Savings

Table 4 reports the cost savings for portal use along with portal costs. Cost savings include patient and insurance company's savings in terms of reductions in office visits, and clinic savings from the reduction in telephone encounters. Also included are savings in terms of patient's opportunity costs associated with office visits, as well as doctors' opportunity costs for the time spent responding to the typical portal inquiry. Certain obvious things are left out of the analysis: Patient portal most likely also cuts down on the need for after hours and emergency room visits. But unfortunately there are no measures for this in the data set. Also left out are doctors' and nurses' opportunity cost for responding to patient inquiries that would not substitute for office visits. Undoubtedly there are other, small, elements left out of the analysis that the

[12] The average number of telephone encounters (per patient) in the first year of active portal use was 3.27.
[13] The cumulative decrease over three years is calculated using the same procedures as for office visits.

reader can think of. Nevertheless, the cost savings, along with the cost for operating the portal, provide reasonable estimates of net (social) saving for the sample population.

Columns (1) to (3) break the data out for each year in the sample, with aggregate data for the three year period 2011-2013 reported in Column (4). Rows listed under A give the practice costs for using the portal. Row 1 accounts for the salary and benefits for the two full time personnel responsible for operating and maintaining the portal. Row 2 reports the number of active portal users for the entire Wexner Center Medical Complex for the sample years, with the third row reporting average cost per patient for the personnel operating the system (row 1 divided by row 2). Row 4 reports the vender's annual license and maintenance fee per active user.[14] Note, in estimating average fixed costs (row 3) we divide the fixed costs by the number of active portal users instead of all patients at the Medical Center. This is a conservative (upper bound) measure of average cost, as no doubt a number of additional users could be accommodated with no increase in the personnel cost. Total costs of $25,470 are calculated multiplying the average cost (per user) by the number of portal users in each year.

Rows listed under B show the reductions in health care costs for active portal users (which will be referred to as Benefits for short). These benefits consist of reductions in: 1) the number of office visits multiplied by the average clinic reimbursement rate (both patients and insurance companies) per office visit[15] and; 2) the number of telephone encounters multiplied by

[14] MyChart comes as part of EPIC, a comprehensive system for managing patient medical records, with the medical center paying a number of license fees to do so. There is no upfront license fee for MyChart, with a per capita fixed fee for *active* users. MyChart is not considered to be part of the core license fees, but purchase of these other, core modules, are required to use the patient portal.

[15] The average reimbursement per office visit across all payers is based on the following payer mix for the clinics in the sample: i) private insurance: 61%, ii) Medicare: 19%, iii) Medicaid: 18%, and iv) other: 2%. The cost calculation is for all return office visits in a given sample year, which do not include new patient appointments and preventive health physicals, as the latter cannot be replaced with portal use.

the average cost per telephone encounter for call center staff compensation.[16] Total benefits over the three year period are $168,837, resulting in a net saving of $143,367 (row C), with average net savings of $75.02 per-patient over the three year period (a yearly benefit of 25.01 per-patient). This represents a benefit-to-cost ratio of 6.6 (row D). Baker et al. (2005) studied a different Internet-based system (webVisit), reporting a monthly benefit of $1.71 per-patient compared to a cost of $0.29 in 2001-02. This gives a yearly net benefit of $17.0 per patient, compared to our estimate of $25.01. However, Baker et al. (2005) only considered reductions in office visits, with no calculations for possible reductions in telephone encounters. In addition, they did not include the cost of operating and maintaining the system. Nevertheless both sets of calculations are similar. In what follows we add in savings in patient opportunity costs and subtract out doctors' opportunity costs, neither of which are considered in Baker et al. (2005).

The benefits reported in rows B and C in the table are only part of the benefits from portal use. There is also the matter of the opportunity (and travel) costs to patients resulting from the reduction in office visits. Total social benefits (row E) adds these total benefits ($44,302 over the sample period) to the net benefits in row C. Patient opportunity costs equal the reduction in number of office visits multiplied by the average foregone hourly earnings per office visit; $25.20.[17] Adding these costs to the savings reported in row C yields total social benefits, net of costs, of $187,669 over the three year period, a yearly average of $32.73 per patient.

[16] The average cost per telephone encounter is based on average weekly compensation and benefits per staff member in the call center, divided by the average number of weekly telephone calls handled per staff member. This is multiplied by an estimate of the reduction in the number of telephone encounters resulting from patient portal use. The latter is estimated by the ratio of portal encounters divided by the sum of telephone calls and portal encounters.
[17] The $25.50 is based on average hourly earnings of full-time workers aged 45 to 54 in 2013 (U.S. Bureau of Labor Statistics, 2014) multiplied by average time spent per office visit (1.033 hours).The time costs consist of i) 22 minutes spent with the physician for routine care in general medicine (National Ambulatory Medical Care Survey, 2010); ii) 21 minutes of waiting time (Vitals, 2012); and iii) 19 minutes of travel time for routine care (Yen, 2013).

One cost element not accounted for so far consists of doctors time associated with patient portal encounters. Many private insurance companies do not pay anything for this. Exceptions for our sample consist of Ohio State University health insurance plans and, more recently, Medicare. The latter provides a flat compensation of $36 for each month doctors and staff spend 20 minutes or more in patient interactions over the Internet or by phone. Ohio State University health plans currently pay $32 per patient-doctor interaction that substitutes for an office visit, with no co-pay.

The estimated average doctor's time cost per portal encounter is 5 minutes which, given the average hourly compensation for a general internal medicine practitioner in our sample is a cost of $9.21 per encounter.[18] These costs total $16,196 (reported in row F) and are subtracted from total social benefits $187,669 (reported in row E). The resulting social cost savings (reported in row G) are $60,722 in the first year following active portal use, with three-year net cost savings of $171,473 (yearly savings of $29.91 per patient).

C. Efficiency Gains in Physician Workload

Portal use reduces the average number of times a physician sees a patient (per year), allowing physicians to manage a larger panel of patients. To estimate this effect, we use physician-level data on office visits from the seven Internal Medicine clinics in 2015. One potential concern here is that there may be unobserved heterogeneity of patients (and/or physicians) across clinics. For example, some clinics may encourage patients to use the portal more than other clinics, which will bias the estimates. To account for these unobserved differences across clinics, we estimate the following fixed effect regression using physician-level data:

$$Y_{jc} = \alpha + \beta \cdot Percent\ User_{jc} + \lambda_c + \varepsilon_{jc}$$

[18] The estimated time cost comes from the practitioners involved in this study.

where Y_{jc} is a patients' per-year visit rate for physician j in clinic c; $Percent\ User_{jc}$ is percent of patients using the patient portal per physician j in clinic c; λ_c are clinic fixed effects; and ε_{jc} is an unobserved error term.

Column (3) of Table 5 reports the regression results. The first row shows the estimate for all physicians: an 11 percentage-point increase in the percent of active portal users from 2010 (24%) to 2013 (35%) reduces office visits by 0.12 *per physician* (per year).[19] This implies that each physician could see 26 more patients a year. [20] The estimates reported in the second row of Table 5 show similar results for those physician with established practices (more than one year) in the clinics.

IV. Summary and Discussion

The net benefits of a roll out of an internet-based doctor-patient portal at The Ohio State University Wexner Medical Center are reported. The main findings are that active use of the portal is, at least in part, prompted by an increase in patient office visits and telephone encounters in the same year as starting to use the portal. These increases are reduced back to pre-portal use, or below, using the portal. There is no overall increase in patient portal encounters plus telephone calls while actively using the portal compared to total telephone encounters prior to using the portal. This indicates that doctors and nurses are not being overwhelmed with nuisance inquiries, a question of concern for some of the practitioners we have talked to. The evidence is consistent with the premise that the reductions in office visits and telephone encounters, beginning with active patient portal use, can be causally attributed to patient portal. That is, portal use partially substitutes for office visits and telephone encounters.

[19] The percent of active portal users is calculated based on the total number of established patients who have consistently used clinic services for the entire sample period.

[20] The average number of patients (per physician per year) is 316 so *38 more* patients ($316 \times 0.12 = 38$) can be seen. Then subtracting out the physician's set aside time for dealing with the increase in portal (the equivalent of seeing 12 patients) for a net increase of 26 patient visits a year. Physician portal time and time per office visit per patient are estimated to be the same as reported in the text (5 and 22 minutes respectively).

Using relatively conservative measures the total cost savings from reduced office visits and telephone encounters over the three year period is $168,837 compared to total costs for operating the portal of $25,470, for net benefits per patient of $75.02, a benefit-to-cost ratio of 6.6. These benefits do not account for patient opportunity costs as well as doctors opportunity costs, which if added in would result in a per capita net social benefit of $89.73 per patient summed over a three year period.

There have been large scale increases in patient portal use for the seven clinics since the detailed data available for this study, totaling 9,706 *active* portal users as of 2015 (versus the 1,911 in our sample). If the new patient portal users are comparable to the ones included in the present sample, the estimated social cost savings would be 0.9 million dollars for a three year period (Table A3 in the Appendix). More conservatively, if we assume that with expanded portal use, average per-patient cost saving is fifty percent of the savings reported here, projected social cost-savings would be 0.4 million dollars over a three year period (see Table A4 in the Appendix). More clarity regarding these projections would require detailed analysis for this expanded patient population, which we hope to do in the future.

However, there is a major impediment to realizing these cost savings, namely the failure to pay doctors for their time interacting with patients. A number of negative longer run outcomes are likely to result from this: First, to the extent possible, one is likely to find cost shifting, with the cost of regular office visits increasing. This was observed in hospitals' responses to reduced Medicare payments in the 1980s, with the reduced Medicare payments effectively offset, dollar for dollar, by increases in the cost of private insurance (Cutler, 1998). Alternatively, one might anticipate increasing reluctance on the part of doctors to use electronic portals (Vydra et al., 2015), much as Medicare cuts to hospitals in 1990s led to reductions in hospital capacity (beds

and nurses) and hospital closings (Cutler, 1998). The corresponding effect here would be starting to charge patients directly for using the electronic portal. This in turn would lead to less portal use and increased office visits due to moral hazard, as costs for office visits would still be covered by insurance. This in turn would sharply reduce the net benefits from portal use, and increase costs to those insurance companies who fail to compensate doctors for portal use. Any of these alternatives would severely limit the net benefits documented here. Given what is known about free riding, one cannot anticipate a rush of insurance companies to spontaneously start paying for these services out of their own self-interest.

Finally, payments to doctors for their interactive communication with patients would ultimately permit a given physician to handle more patients, even with time set aside for handling the added workload (Plener, Hayward, and Saibil, 2014). Our analysis shows that an 11-percentage-point increase in the number of patient portal users for our sample frees up time for individual physicians to see, on average, 26 more patient visits in a year. These efficiency gains are of increasing importance given the wider access to medical care resulting from the Affordable Care Act, exactly the patient population that could least afford to pay for top tier service permitting direct doctor-patient interactions. The net saving in patient portal use will not, by itself, stymie the ever increasing cost of medical care. But it could take an important step in doing so.

REFERENCES

Allen, Marybeth, Lisa I. Iezzoni, Annong Huang, Linchang Huang, and Suzanne G. Leveille. 2008. "Improving Patient-Clinician Communication about Chronic Conditions: Description of an Internet-Based Nurse E-Coach Intervention." *Nursing Research*, 57(2):107-112.

Ammenwerth, Elske, Petra Schnell-Inderst, and Alexander Hoerbst. 2012. "The Impact of Electronic Patient Portals on Patient Care: a Systematic Review of Controlled Trials." *Journal of Medical Internet Research*, 4(6): e162.

Angrist, Joshua D. and Jörn-Steffen Pischke. 2014. *Mastering ´ Metrics*, Princeton University Press.

Baker, Laurence, Jeffrey Rideout, Paul Gertler, and Kristiana Raube. 2005. "Effect of an Internet-Based System for Doctor-Patient Communication on Health Care Spending." *Journal of the American Medical Informatics Association*, 2(5):530-536.

Blumenthal, David, and Marilyn Tavenner. 2010. "The "Meaningful Use" Regulation for Electronic Health Records." *New England Journal of Medicine*, 363(6): 501–4.

Centers for Medicare and Medicaid Services (CMS). "Stage 2 Overview Tipsheet." [Internet] Baltimore (MD): CMS; [last updated 2012 Aug; cited 2014 Aug 11]. Available from: http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/Downloads/Stage2Overview_Tipsheet.pdf.

Cutler, David M. 1998. "Cost Shifting or Cost Cutting?: The Incidence of Reductions in Medicare Payments." Tax Policy and the Economy, Vol 12. James Poterba (ed). Cambridge, MIT Press.

Demiris, George, Lawrence B. Afrin, and Cecil Lynch. 2008. "Patient-centered Applications: Use of Information Technology to Promote Disease Management and Wellness. A White Paper by the AMIA Knowledge in Motion Working Group." *Journal of the American Medical*

Informatics Association. 15(1)8-13.

Detmer, Don, Meryl Bloomrosen, Brian Raymond, and Paul Tang. 2008. "Integrated Personal Health Records: Transformative Tools for Consumer-Centric Care." *BMC Medical Informatics and Decision Making*, 8(45).

Jacobson, Louis S., Robert J. LaLonde and Daniel G. Sullivan. 1993. "Earnings Losses of Displaced Workers." *American Economic Review*, 83 (4): 685-709.

Mendu, Mallika L., and Sushrut S. Waikar. 2015. "Electronic Health Record Patient Portals in CKD and Hypertension Management: Meaningfully Used?" *Clinical Journal of the American Society of Nephrology*, 10(11); 1897–99.

National Ambulatory Medical Care Survey. 2010. "National Ambulatory Medical Care Survey: 2010 Summary Tables."

Plener, Ian, Andrew Hayward, and Fred Saibil. 2014. "E-mail Communication in the Management of Gastroenterology Patients: A Review?" *Canadian Journal of Gastroenterology and Hepatology*, 28(3):161-165.

Urowitz, Sara, David Wiljer, and Joe Cafazzo. 2012. "Improving Diabetes Management with a Patient Portal: A Qualitative Study of Diabetes Self-Management Portal." *Journal of Medical Internet Research*, 14(6):e158

U.S. Bureau of Labor Statistics. 2014. "Highlights of Women's Earnings in 2013." BLS Reports.

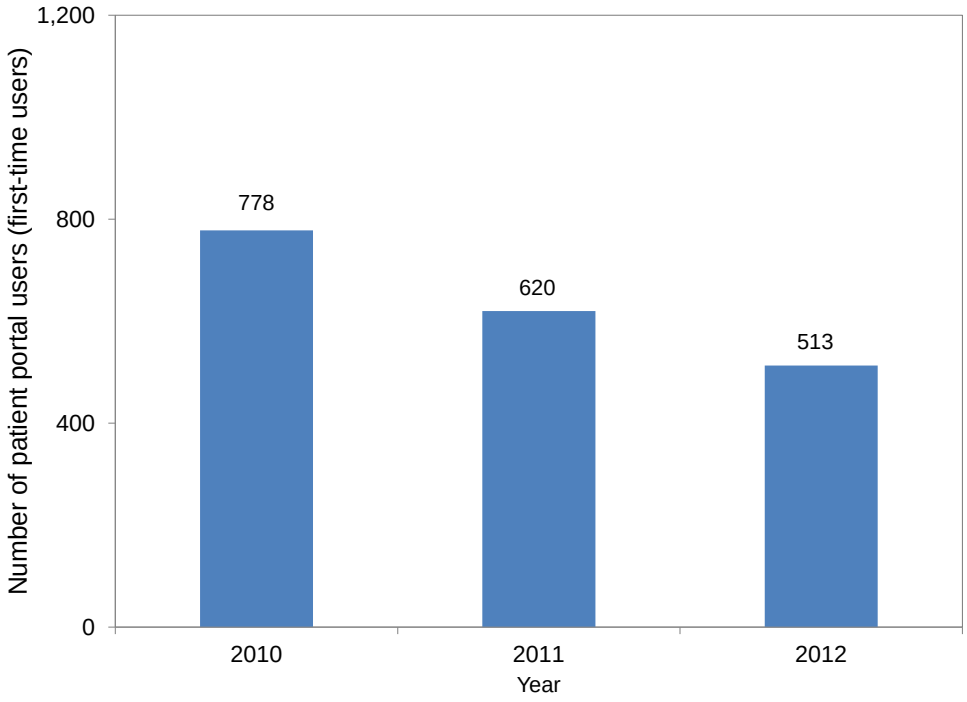
Vitals. 2012. "Data Reveals Physician Office Wait Times Vary Between States, Regions and Major U.S. Cities."

Vydra, Taylor P., Edward Cuaresma, Matthew Kretovics, and Seuli Bose-Brill. 2015. "Diffusion and Use of Tethered Personal Health Records in Primary Care." *Perspectives in Health Information Management*, 12(Spring): 1c.

Whitten, Pamela, and Emily Kuwahara. 2003. “Telemedicine from the Payor Perspective.” *Disease Management and Health Outcomes*, 11(5):291-298.

Yen, Wei. 2013. “How Long and How Far Do Adults Travel and Will Adults Travel for Primary Care.” Research Brief No.70, Washington State Office of Financial Management.

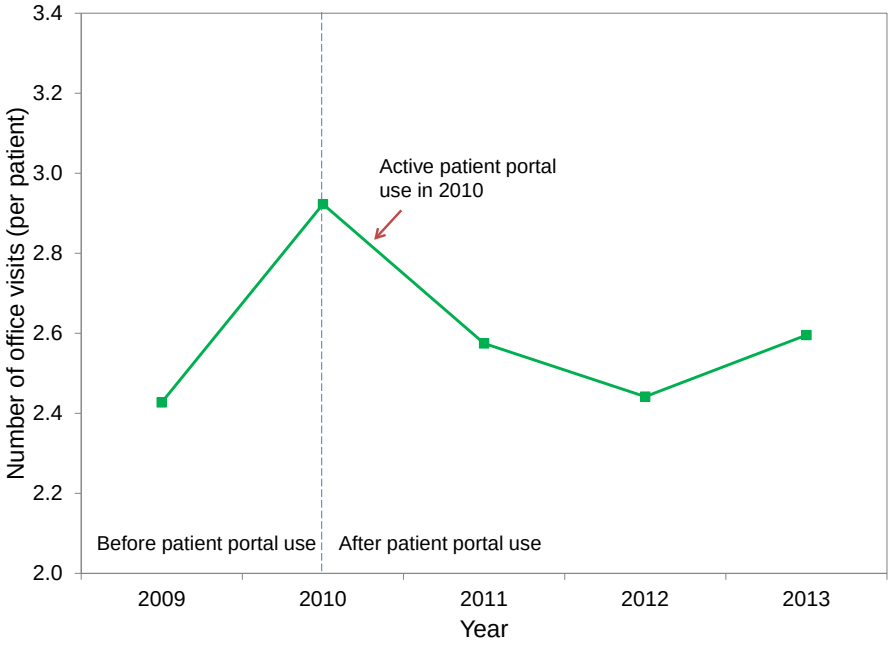
FIGURE 1
Number of First-Time Patient Portal Users.



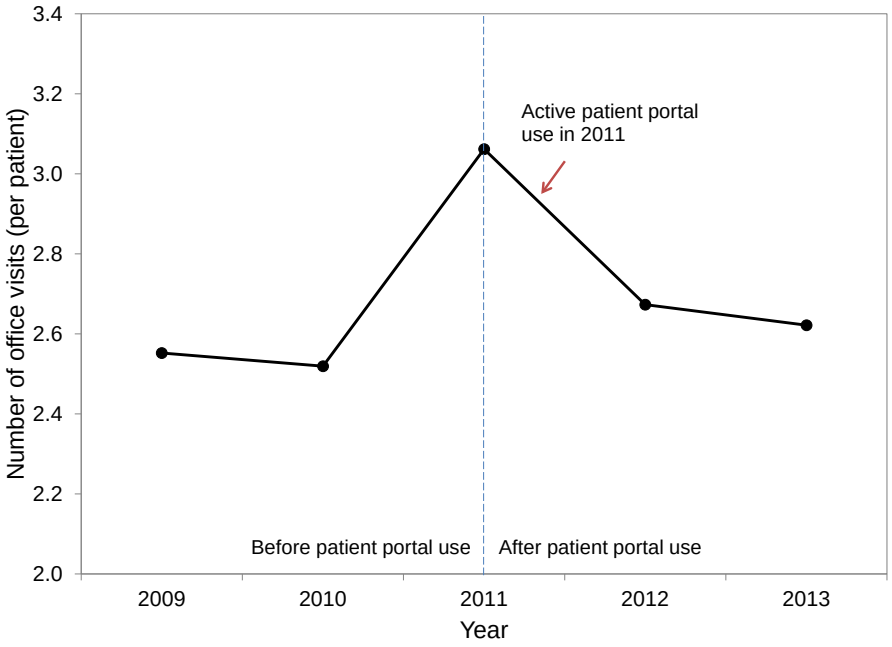
Notes: Data come from 1,911 patient portal users who had one of four encounters (a patient portal message, an office visit, a request for a prescription refill, or a telephone call) in each year from 2009 (the first full year the portal was in effect) to 2013.

FIGURE 2
Number of Office Visits (per patient)

Panel A. 2010 cohort of active portal users



Panel B. 2011 cohort of active portal users



Panel C. 2012 cohort of active portal users

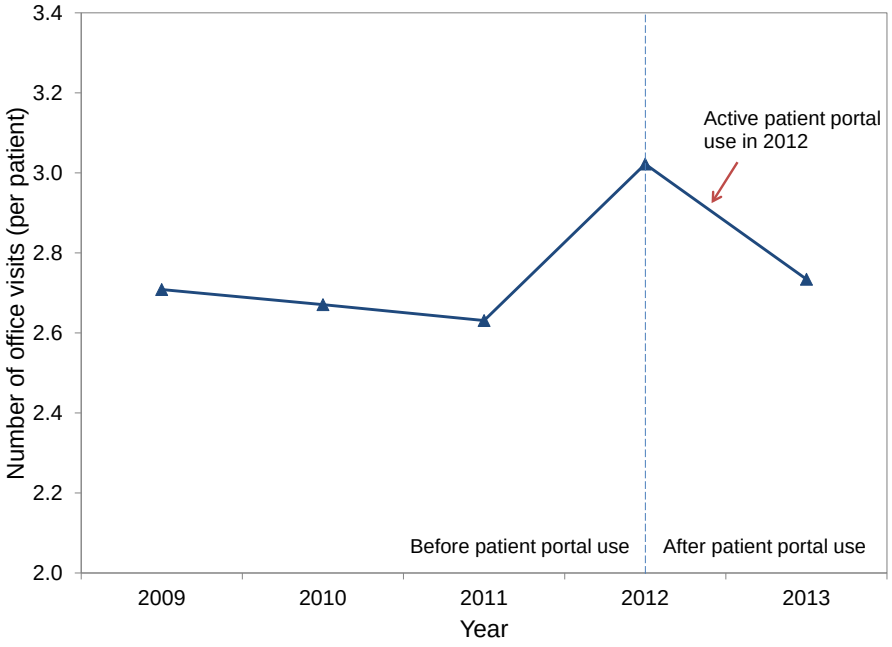
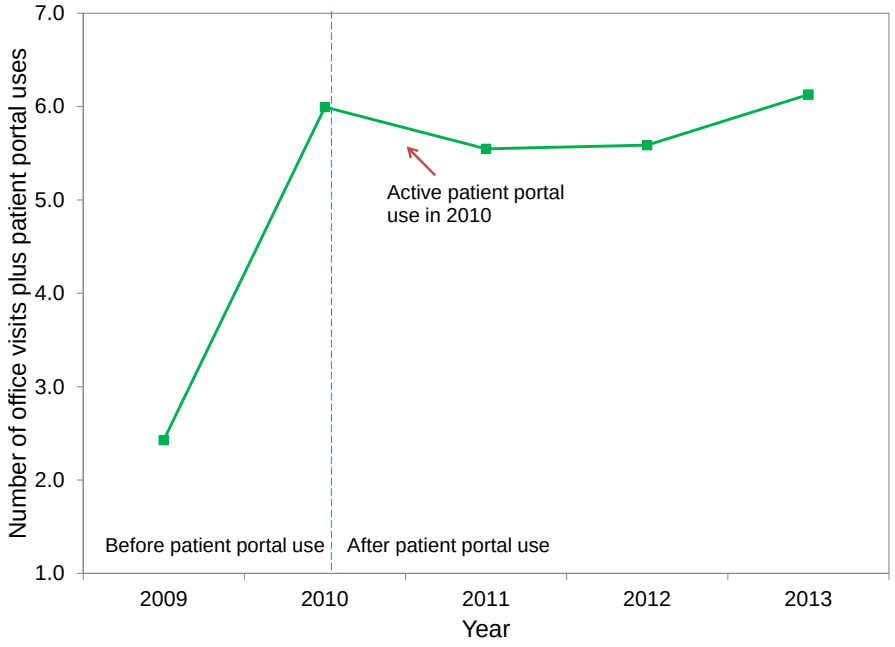
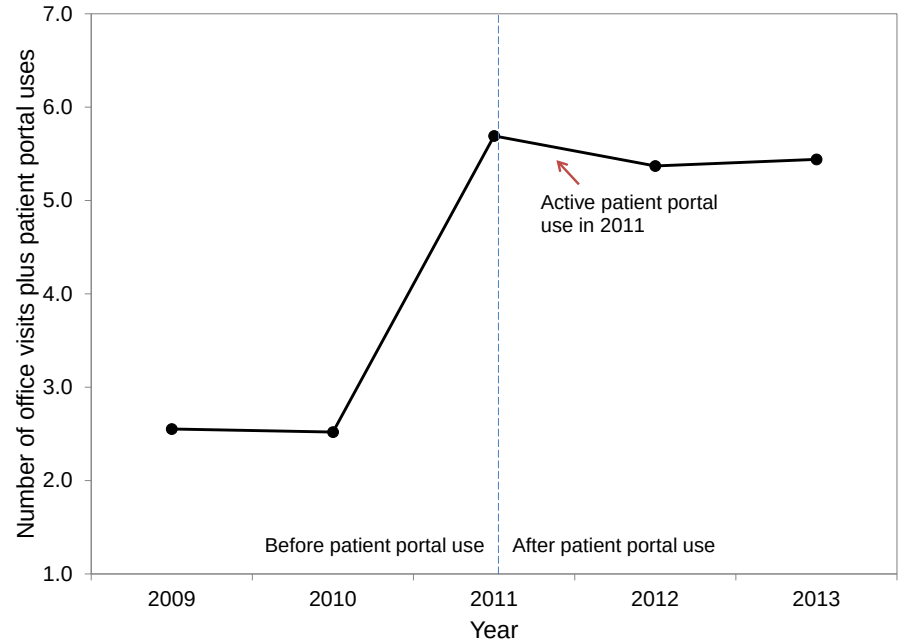


FIGURE 3
Total Number of Office Visits plus Patient Portal encounters (per patient)

Panel A. 2010 cohort of active portal users



Panel B. 2011 cohort of active portal users



Panel C. 2012 cohort of active portal users

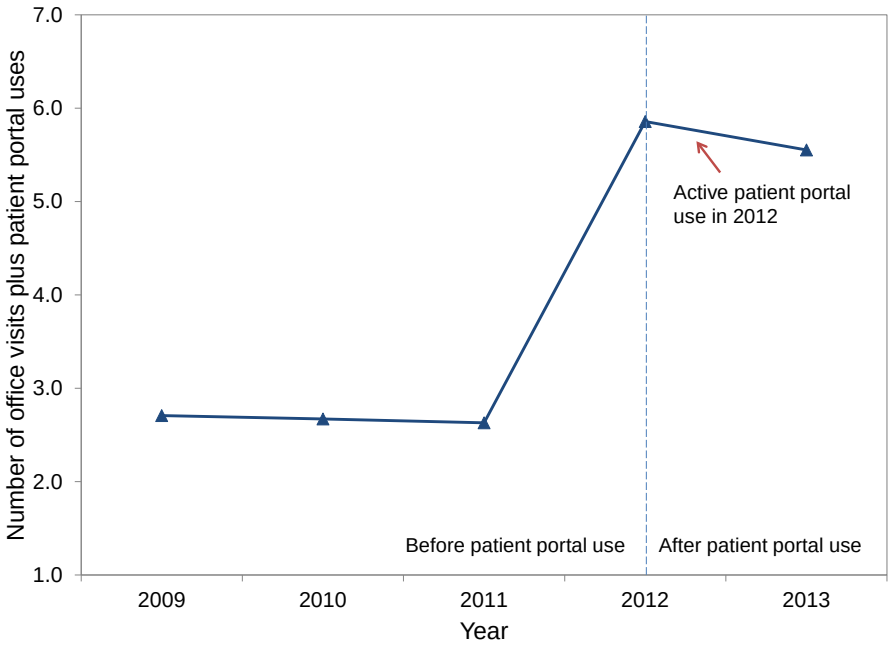


TABLE 1
Demographic Characteristics of Study Sample
(standard errors in parentheses)

	2010 users	2011 users	2012 users	F-statistics for between-group difference {p-values}
	(1)	(2)	(3)	(4)
Age in 2009	51.23 (14.74)	52.78 (14.12)	52.52 (14.93)	2.26 {0.104}
Male (%)	36.12 (48.07)	35.97 (48.03)	33.72 (47.32)	0.45 {0.640}
White (%)	87.15 (33.49)	84.52 (36.20)	82.85 (37.73)	2.40* {0.091}
Hispanic (%)	1.29 (11.27)	1.13 (10.57)	0.78 (8.80)	0.37 {0.693}
Number of patients	778	620	513	1,911

* Significant at the 10 percent level.

TABLE 2
Effect of Patient Portal Use on Office Visits
[absolute value of t-statistics in brackets]

	Subsequent year after active patient portal use			Cumulative Reduction for Cohort
	Year 1 (1)	Year 2 (2)	Year 3 (3)	(4)
Panel A. Estimates	-0.33***	-0.33***	-0.26***	
(per patient)	[6.96]	[5.57]	[3.22]	
Panel B. Implied reductions in office visits				
2010 cohort (number of patient: 778)	257	257	202	716
2011 cohort (number of patient: 620)	205	205	161	571
2012 cohort (number of patient: 513)	169	169	133	471
Pooled (number of patient: 1,911)	631	631	496	1,758

*** Significant at the 1 percent level.

TABLE 3
Effect of Patient Portal Use on Telephone Encounters
[absolute value of t-statistics in brackets]

	Subsequent year after active patient portal use			Cumulative Reduction for Cohort
	Year 1 (1)	Year 2 (2)	Year 3 (3)	(4)
Panel A. Estimates	-0.63***	-0.65***	-0.54***	
(per patient)	[6.80]	[5.40]	[3.28]	
Panel B. Implied reductions in telephone encounters				
2010 cohort (number of patient: 778)	490	506	420	1,416
2011 cohort (number of patient: 620)	391	403	335	1,129
2012 cohort (number of patient: 513)	323	333	277	933
Pooled (number of patient: 1,911)	1,204	1,242	1,032	3,478

*** Significant at the 1 percent level.

TABLE 4
Cost Savings from Patient Portal Use

	Year 1 (1)	Year 2 (2)	Year 3 (3)	3-year period (2011-2013) (4)
A. Costs				
1. Salary and benefits of two Full Time Equivalent (FTE)s to keep the system running	$200,000	$200,000	$200,000	
2. Total number of active patient portal users (entire OSU Wexner Medical Center)[a]	77,338	115,385	132,572	
3. Average per user cost to keep system running (1÷2)	$2.59	$1.73	$1.51	
4. License fee per active user	$2.50	$2.50	$2.50	
Average cost of patient portal (per active user) (3+4)	$5.09	$4.23	$4.01	
Number of active patient portal users in the sample	1,911	1,911	1,911	
Total costs (average cost) × (number of users in the sample)	$9,719	$8,090	$7,660	**$25,470**
B. Benefits				
5. Reduction in number of office visits (total)	631	631	496	1,758
6. Average cost per office visit	$85	$85	$85	
Total benefits from reduction office visits (5×6)	$53,635	$53,635	$42,160	$149,430
7. Reduction in number of telephone encounters (total)	1,204	1,242	1,032	3,478
8. Average compensation (per telephone encounter)	$5.58	$5.58	$5.58	
Total benefits from the reduction in telephone encounters	$6,718	$6,930	$5,759	$19,407
Total benefits	$60,353	$60,565	$47,919	**$168,837**
(per capita benefits)	($31.58)	($31.69)	($25.08)	($88.35)
C. Net benefits (total benefits less total costs)	$50,634	$52,475	$40,258	**$143,367**
(net per capita benefits)	($26.50)	($27.46)	($21.07)	($75.02)
D. Benefit-to-Cost ratio	6.2	7.5	6.3	**6.6**
Patient opportunity costs				
9. Reduction in number of office visits	631	631	496	1,758
10. Average foregone hourly earnings (per office visit)	26.03	26.03	26.03	
Total patient opportunity costs (9×10)	$15,901	$15,901	$12,499	**$44,302**
E. Total social benefits (net benefits + total patient opportunity costs)	$66,535	$68,377	$52,757	**$187,669**
Cost of doctor's time				
11. Doctors' opportunity costs per patient portal encounter in place of office visit[f]	$9.21	$9.21	$9.21	

F. Total costs of doctor's time (9×11)	$5,813	$5,813	$4,570	**$16,196**
G. Social benefits net of doctors cost (total social benefits minus cost of doctors' time)	$60,722	$62,563	$48,188	**$171,473**
(net per capita benefits)	($31.77)	($32.74)	($25.22)	($89.73)

Notes: See text for details.

[a] As of 2013 (year 1), 2014 (year 2), and 2015 (year3), respectively.

TABLE 5
Effect of Patient Portal Use on Office Visit Rates per Physician
[absolute values of t-statistics in brackets]

Subgroup	Mean of number of patients (per physician) (1)	Mean of office visit rate (per physician) (2)	Change in office visit rate due to change in percent patient portal users (3)
All physicians	536	2.47	-0.011* [2.95]
Physicians with 1+ years practices	543	2.45	-0.010* [2.95]

Notes: Sample consists of 31 physicians, with 56,901 patient records in fiscal year 2015.

* Significant at the 10 percent level.

Appendix for

"The Effects of Doctor-Patient Portal Use on Health Care Utilization Rates and Cost Savings"

Daeho Kim, John H. Kagel, Neeraj Tayal, Seuli Bose-Brill, and Albert M. Lai

Brief Description of the Patient Portal:

MyChart (from Epic Systems Corporation, Verona, WI) is an electronic patient portal (i.e., personal health records (PHRs) tethered to a patient's electronic health record (EHR)) that allows patients to access their medical information (e.g., test results), communicate electronically and securely with their health care providers, schedule an appointment, request prescription refills, and so on. There are several other vendors offering this type of patient portal system, including Cerner, Allscripts, eClinicalWorks, and NextGen. MyChart is the most widely used patient portal among rated vendors (Kane and Chesanow, 2014). The key elements of active MyChart use reported on here – that it serves as a portal for patients directly communicating with their health care providers - would be present in these alternative patient portals.

Tables and Figures Referred to in the Text:

TABLE A1

The number office visits per month in 2010, by the first time of using the patient portal*

First time of using patient portal	Number of office visits per month in 2010											
	Jun	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan 2010	**57**	15	20	22	17	23	18	17	15	16	21	11
Feb 2010	29	**37**	18	19	17	20	21	20	8	12	12	15
Mar 2010	17	26	**45**	22	17	15	19	14	20	16	16	24
Apr 2010	15	14	23	**44**	15	16	16	10	12	11	9	15
May 2010	10	12	5	17	**30**	3	5	18	11	6	10	13
Jun 2010	8	9	22	16	18	**33**	15	15	8	23	10	5
Jul 2010	17	7	10	12	7	15	**42**	17	9	8	13	9
Aug 2010	13	13	16	11	15	18	33	**46**	23	22	18	10
Sep 2010	15	13	12	8	13	14	8	23	**30**	8	8	5
Oct 2010	10	10	13	12	9	5	18	13	21	**40**	6	9
Nov 2010	10	10	7	12	7	8	11	8	12	16	**28**	12
Dec 2010	8	12	14	21	11	7	9	11	11	12	21	**31**

* Data come from 829 patient portal users who first started using the patient portal in 2010.

TABLE A2
Demographic characteristics of the patient portal users and non-users
(standard errors in parentheses)

	Portal users (2010-2012 users)	Non-users	Between-group difference
	(1)	(2)	(3)
Age in 2009	52.1	55.6	-3.5***
	(14.6)	(15.3)	(0.4)
Male (%)	35.4	43.6	-8.2***
	(47.8)	(49.6)	(1.3)
White (%)	85.1	76.7	8.5***
	(35.6)	(42.3)	(1.1)
Hispanic (%)	1.1	0.7	0.4
	(10.4)	(8.6)	(0.2)
Number of patients	1,911	5,675	7,586

*** Significant at the 1 percent level.

Projected Cost-Savings from Large Scale Increase in Patient Portal Use:

We repeat the analysis on the cost savings from portal use, reported in the text, for the substantially larger number of patients using the portal in the seven Internal Medicine clinics as of 2015, 9,706 active users over a three year interval. The cost savings for these portal users, uses the same format as Table 4 in the text under different assumptions regarding the extent to which this larger patient population would use the portal in the same way as the patient population reported on in the text. Two sets of estimates are employed.

Table A3 assumes all patients use the portal in the same way as sample population: i.e., the estimated *per-patient* reduction in office visits and telephone encounters are the same as the yearly estimates reported in Tables 2 and 3 in the text. Total cost savings over the three year period are $881,670, $90.84 per patient. (The lightly higher per-patient number results from spreading the costs for operating the system out over the larger number of patients in question).

Table A4 is constructed under the more conservative assumption that the *per-patient* reduction in office visits and telephone encounters are 50% of the yearly estimates reported in Tables 2 and 3; i.e., less of a need to substitute portal use for office visits and telephone encounters. Total cost savings over the three year period under this scenario are $382,473, $39.41 per portal user (the per-patient cost savings have essentially been halved as only half the patients are using the portal in the same way as those reported in the text).

TABLE A3

Projected social cost-savings from increased patient portal use*

	Year 1 (1)	Year 2 (2)	Year 3 (3)	3-year period (4)
A. Costs				
1. Salary and benefits of two Full Time Equivalent (FTE)s to keep the system running	$200,000	$200,000	$200,000	
2. Total number of active patient portal users as of 2015 (entire OSU Wexner Medical Center)[a]	132,572	132,572	132,572	
3. Average per user cost to keep system running (1÷2)	$1.51	$1.51	$1.51	
4. License fee per active user	$2.50	$2.50	$2.50	
Average cost of patient portal (per active user) (3+4)	$4.01	$4.01	$4.01	
Number of active portal users as of 2015	9,706	9,706	9,706	
Total costs (average cost) × (number of active portal users as of 2015)	$38,908	$38,908	$38,908	**$116,723**
B. Benefits				
5. Reduction in number of office visits (total)	3,203	3,203	2,524	8,930
6. Average cost per office visit	$85	$85	$85	
Total benefits from reduction office visits (5×6)	$272,253	$272,253	$214,503	$759,009
7. Reduction in number of telephone encounters (total)	6,115	6,309	5,241	17,665
8. Average compensation (per telephone encounter)[c]	$5.47	$5.47	$5.47	
Total benefits from the reduction in telephone encounters	$33,448	$34,510	$28,670	$96,627
Total benefits	$305,701	$306,763	$243,172	**$855,636**
(per capita benefits)	($31.50)	($31.61)	($25.05)	($88.16)
C. Net benefits (total benefits less total costs)	$266,794	$267,855	$204,265	**$738,913**
(net per capita benefits)	($27.49)	($27.60)	($21.05)	($76.13)
D. Benefit-to-Cost ratio	7.9	7.9	6.2	**7.3**
Patient opportunity costs				
9. Reduction in number of office visits	3,203	3,203	2,524	8,930
10. Average foregone hourly earnings[d] (per office visit)	26.03	26.03	26.03	
Total patient opportunity costs (9×10)[e]	$80,715	$80,715	$63,594	**$225,024**
E. Total social benefits (net benefits + total patient opportunity costs)	$347,509	$348,570	$267,858	**$963,937**
Cost of doctor's time				

11. Doctors' opportunity costs per patient portal encounter in place of office visit[f]	$9.21	$9.21	$9.21	
F. Total costs of doctor's time (9×11)	$29,509	$29,509	$23,250	**$82,268**
G. Social benefits net of doctors cost (total social benefits minus cost of doctors' time)	$318,000	$319,061	$244,609	**$881,670**
(net per capita benefits)	($32.76)	($32.87)	($25.20)	($90.84)

* If the 2015 active portal users are as chronically ill as the 2010-2012 active portal users.

[a] As of 2015.

TABLE A4

Projected social cost-savings from increased patient portal use*

	Year 1 (1)	Year 2 (2)	Year 3 (3)	3-year period (4)
A. Costs				
1. Salary and benefits of two Full Time Equivalent (FTE)s to keep the system running	$200,000	$200,000	$200,000	
2. Total number of active patient portal users as of 2015 (entire OSU Wexner Medical Center)[a]	132,572	132,572	132,572	
3. Average per user cost to keep system running (1÷2)	$1.51	$1.51	$1.51	
4. License fee per active user	$2.50	$2.50	$2.50	
Average cost of patient portal (per active user) (3+4)	$4.01	$4.01	$4.01	
Number of active portal users as of 2015	9,706	9,706	9,706	
Total costs (average cost) × (number of active portal users as of 2015)	$38,908	$38,908	$38,908	**$116,723**
B. Benefits				
5. Reduction in number of office visits (total)	1,601	1,601	1,262	4,465
6. Average cost per office visit	$85	$85	$85	
Total benefits from reduction office visits (5×6)	$136,127	$136,127	$107,251	$379,505
7. Reduction in number of telephone encounters (total)	3,057	3,154	2,621	8,832
8. Average compensation (per telephone encounter)[c]	$5.47	$5.47	$5.47	
Total benefits from the reduction in telephone encounters	$16,724	$17,255	$14,335	$48,314
Total benefits	$152,851	$153,381	$121,586	**$427,818**
(per capita benefits)	($15.75)	($15.80)	($12.53)	($44.08)
C. Net benefits (total benefits less total costs)	$113,943	$114,474	$82,678	**$311,095**
(net per capita benefits)	($11.74)	($11.79)	($8.52)	($32.05)
D. Benefit-to-Cost ratio	3.9	3.9	3.1	**3.7**
Patient opportunity costs				
9. Reduction in number of office visits	1,601	1,601	1,262	4,465
10. Average foregone hourly earnings[d] (per office visit)	26.03	26.03	26.03	
Total patient opportunity costs (9×10)[e]	$40,358	$40,358	$31,797	**$112,512**
E. Total social benefits (net benefits + total patient opportunity costs)	$154,301	$154,831	$114,475	**$423,607**
Cost of doctor's time				
11. Doctors' opportunity costs per patient portal encounter in place of office visit[f]	$9.21	$9.21	$9.21	

F. Total costs of doctor's time (9×11)	$14,755	$14,755	$11,625	**$41,134**
G. Social benefits net of doctors cost (total social benefits minus cost of doctors' time)	$139,546	$140,077	$102,851	**$382,473**
(net per capita benefits)	($14.38)	($14.43)	($10.60)	($39.41)

* If fifty percent of the 2015 active portal users are as chronically ill as the 2010-2012 active portal users.
[a] As of 2015.

FIGURE A1
Patient age distribution (2010-2012 patient portal users)

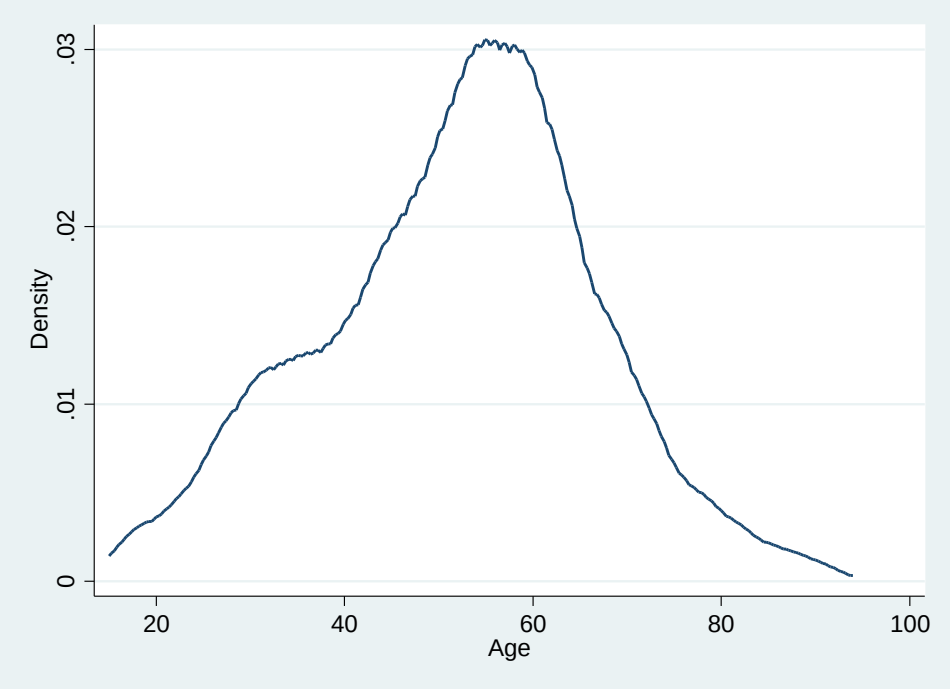
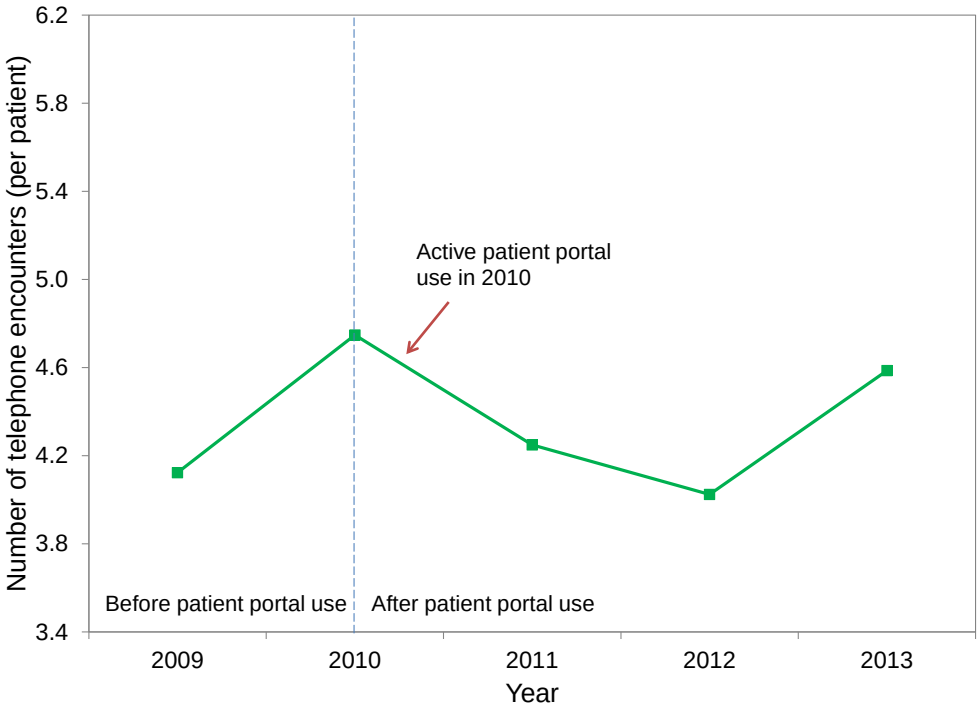
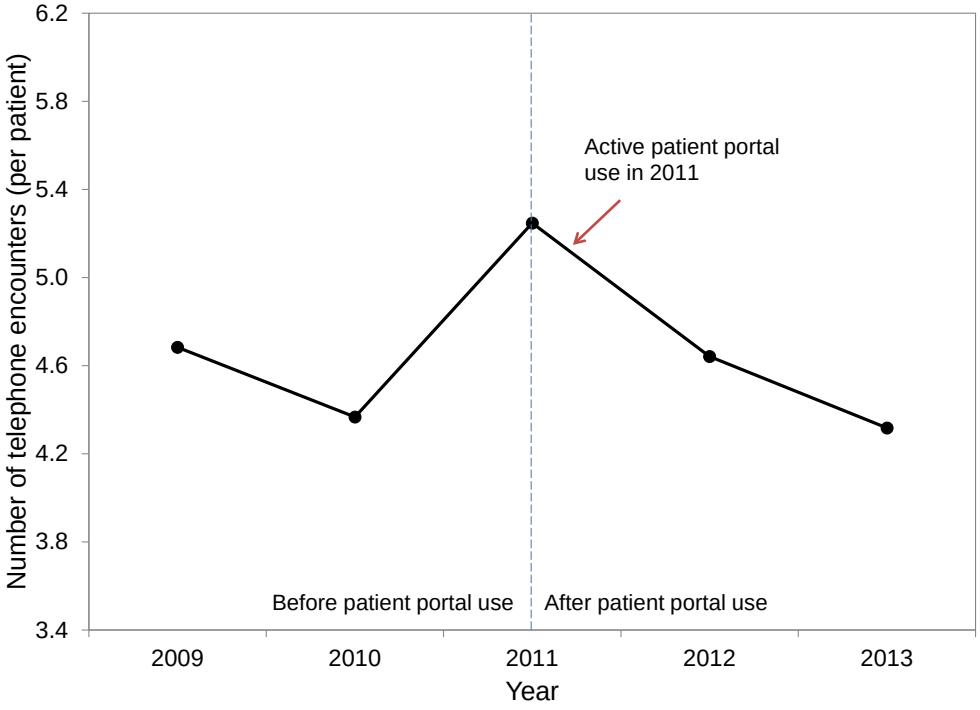


FIGURE A2
Number of telephone encounters (per patient)

Panel A. 2010 Cohort of active patient portal users



Panel B. 2011 Cohort of active patient portal users



Panel C. 2012 Cohort of active patient portal users

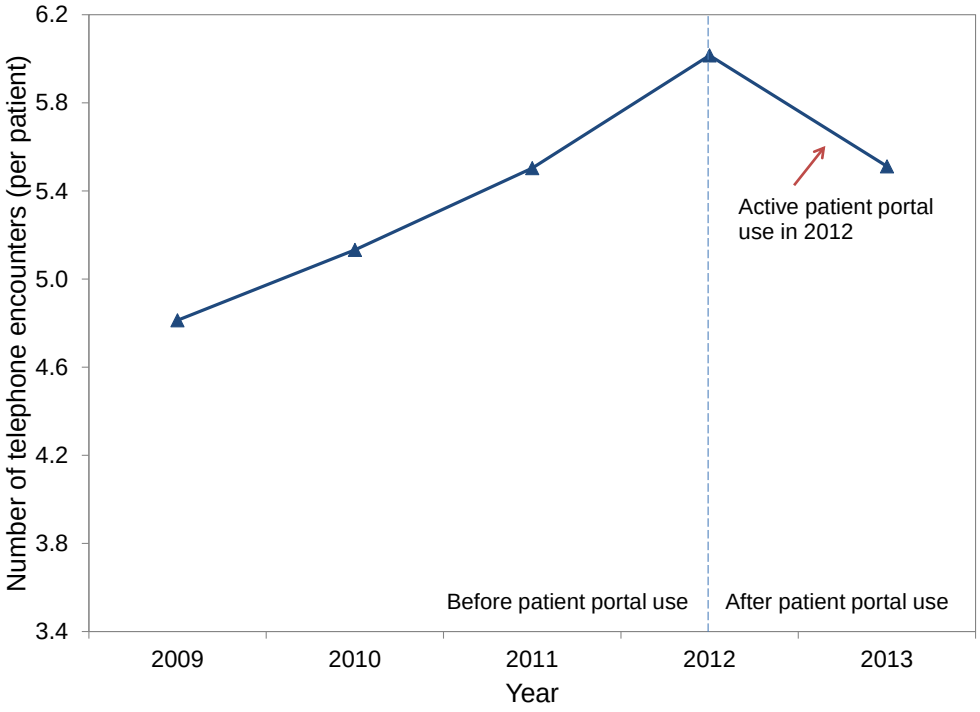
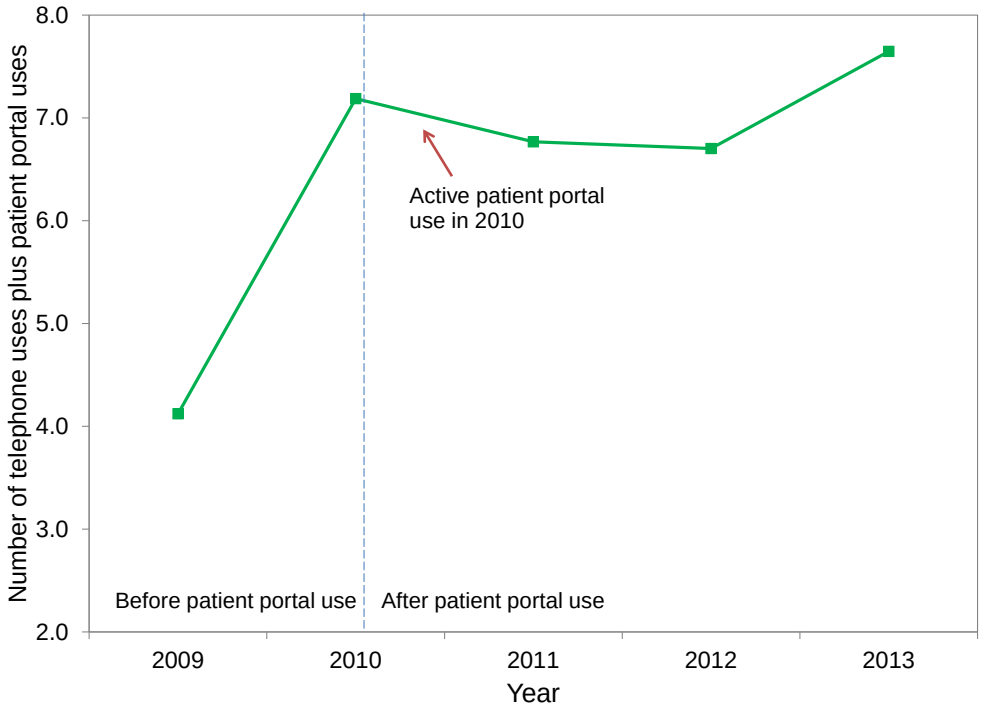
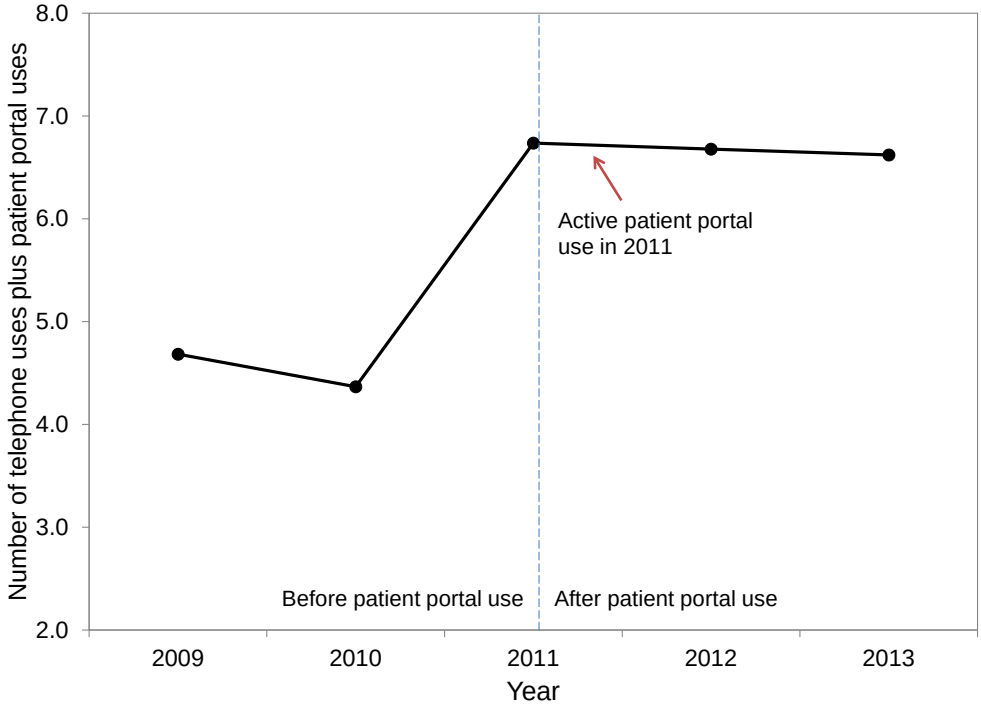


FIGURE A3
Total number of telephone encounters plus patient portal encounters (per patient)

Panel A. 2010 cohort of active patient portal users



Panel B. 2011 cohort of active patient portal users



Panel C. 2012 cohort of active patient portal users