

## Impact of using administrative vs. chart-abstracted data on calculations of financial incentives for health care providers in a pay-for-performance program

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**Background:** Pay-for-performance programs often rely on claims and other administrative data sources, but it is not clear whether these data accurately reflect information contained in patients' medical records. To evaluate the impact of using administrative data on the calculation of financial incentives in a study of pay for performance, we compared the calculation of financial incentives based upon administrative data with calculations using data collected via chart review to reward use of guideline-recommended antihypertensive medications.

**Methods:** Trained abstractors collected data from VA medical records reflecting care provided to hypertensive patients between April and July 2009. The same data elements were collected from administrative data, including patients' comorbidities that impact drug regimens, current antihypertensive medications, and medication allergies or contraindications. Two clinicians, an internist and a cardiologist, independently reviewed procedure and diagnosis codes (ICD-9-CM and CPT) for conditions identified as compelling indications by JNC 7 guidelines for hypertension treatment: diabetes mellitus, chronic kidney disease, unstable angina, myocardial infarction, ischemic heart disease, and nephropathy. We also reviewed diagnoses codes to identify contraindications to certain therapies, e.g., angioedema. When possible, we supplemented diagnoses and procedure codes with laboratory data to identify certain conditions (e.g., diabetes). We identified clinically relevant allergy information and vital sign data from the VA Corporate Data Warehouse (one of the administrative data sources). Using these data, we determined whether or not a patient's antihypertensive medication regimen was consistent with JNC 7 guidelines.

**Results:** 2834 of 2840 patients (99.8%) were eligible for evaluation in the administrative data. Comparing the chart abstracted and administrative data, 84.4% of patients had the same comorbidity history for the 6 conditions examined. Agreement was highest for diabetes ( $\kappa = 0.92$ ) and lowest for unstable angina ( $\kappa = 0.38$ ). In the medical record data, 72.3% of patients received guideline-recommended medications compared to only 62.7% in the administrative data. Over half (55.6%) were identified in both sources ( $\kappa = 0.46$ ). Among the patients with the same comorbidity history in both data sources ( $n = 2391$ ), chart abstracted data showed that 71.9% received appropriate medications while administrative data identified 63.1% of patients ( $\kappa = 0.51$ ). Overall, incentive earnings decreased by an average of \$28.37 (SD = \$33.68) (11.6% [SD = 9.9%]) for the 85 health care personnel when we calculated payments using only administrative data. Compared to the payments providers received in the study, seventy-nine (92.9%) providers would have received less money, three (3.5%) would have received the same amount, and three (3.5%) would have earned more money.

**Conclusions:** We found moderate agreement for use of guideline-recommended antihypertensive medications when we compared abstracted data from medical records to data in VA administrative sources. Overall, incentive payments decreased by an average of 11.6% when evaluating providers' performance using only administrative data. Given the resources and time needed to abstract medical record data, quality initiatives implementing pay for performance should consider using administrative and claims data to evaluate provider performance.

## Potentially Avoidable 30-day Hospital Readmissions in Medicine Patients: Derivation and Validation of a Prediction Model

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**Background:** Hospital readmission prediction models are useful to target post-discharge interventions to patients who might benefit the most. Most existing risk prediction models perform poorly, do not differentiate between avoidable and unavoidable readmissions, or rely on information not commonly available prior to discharge.

To help clinicians target transitional care interventions most effectively, we derived and internally validated a prediction model for potentially avoidable 30-day hospital readmissions in medical patients using readily available administrative and clinical data.

**Methods:** This retrospective cohort study included 10,731 admissions to the medical services of Brigham and Women's Hospital (BWH) during the 2009-2010 academic year. The outcome was an index admission followed by a potentially avoidable 30-day readmission to any service at BWH or to two other hospitals in the Partners Healthcare system, which together account for over 80% of readmissions. Potentially Avoidable Readmissions (PAR) were differentiated from non-avoidable readmissions using a validated computerized algorithm based on administrative data (SQLape<sup>®</sup>) commonly used in Switzerland to benchmark and compare hospitals. Admissions were randomly assigned to derivation (2/3) and validation (1/3) sets. Baseline demographic data, previous health care utilization, co-morbid conditions, and laboratory testing were used as predictors in a logistic regression model with 30-day PAR as the dependent variable.

**Results:** There were 2,398 (22 %) admissions followed by a 30-day readmission, of which 1,101 (10%) were identified as PAR. The prediction score identified 6 independent factors, which we refer to as the PAR ScOrE: any ICD-9 coded Procedure, number of Admissions in the previous 12 months (0, 1 to 5, or >5), Renal failure (glomerular filtration rate of 0-29, 30-59, or  $\geq 60$  ml/min) at the time of discharge, low Sodium level (< 135 mmol/l) at the time of discharge, discharge from an Oncology service, and Elective admission (Table). We then developed a scoring system to stratify risk of potentially avoidable 30-day readmission into 4 categories. With this prediction model, low-risk patients having 0-1 points (13% of patients) had a 3% risk of PAR, while high-risk patients having  $\geq 7$  points (15% of patients) had a 27% risk of PAR. The PAR ScOrE had a good discriminatory power (C-statistic 0.72 and 0.70) and had good calibration (Hosmer-Lemeshow goodness-of-fit statistic  $P=0.67$  and  $P=0.72$ ) in the derivation set and validation set, respectively.

**Conclusions:** This simple prediction model accurately identifies the risk of potentially avoidable 30-day readmission in medical patients. While it still needs external validation, this score has potential to easily identify patients in need of more intensive transitional care interventions to prevent avoidable hospital readmissions.

## Has Quality Improvement Resulted in the Reduction of Inappropriate Care?

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**Background:** In the past decade there has been a major focus on improving the quality of care. However, efforts to improve the quality of healthcare have largely concentrated on developing publicly reportable underuse measures. Overuse and misuse of health care services are also important aspects of the quality of healthcare. We compared changes in the quality of ambulatory care in the US between 1998/1999 and 2008/2009 using measures of underuse, misuse, and overuse of health care services.

**Methods:** We performed a cross-sectional analysis of the National Ambulatory Medical Care Survey (NAMCS) and the outpatient department component of the National Hospital Ambulatory Medical Care Survey (NHAMCS), which are nationally representative annual surveys of visits to non-federally funded ambulatory care practices. We identified a total of twenty-three quality indicators using a combination of current quality measures and guideline recommendations. Each indicator was chosen because it pertained to outpatient quality of care and could be reliably calculated using information in the 1998, 1999, 2008, and 2009 NAMCS and NHAMCS. We categorized our quality indicators into underuse (9), overuse (12), and misuse (2). We estimated the rates of underuse, overuse, and misuse and their 95% confidence intervals, accounting for the complex sampling design of the NAMCS and NHAMCS.

**Results:** We observed a statistically significant improvement in six out of nine underuse quality indicators. In the ten year interval under consideration, there was an improvement in the use of antithrombotic therapy for atrial fibrillation (45.9% to 71.9% , $p<.01$ ), the use of aspirin in coronary artery disease (CAD) (28.4% to 64.5%, $p<.01$ ), the use of beta blockers in congestive heart failure (CHF) (20.6% to 59.7% , $p<.01$ ) and beta blockers in CAD (28.1% to 55.2% , $p<.01$ ). There were also improvements in the use of statins in CAD (26.8% to 58.6%,  $p<.01$ ) and diabetes (12.1% to 36.2%,  $p<.01$ ). We observed an improvement in only two of 12 overuse quality indicators, one indicator became worse and 9 did not change. There was a statistically significant decrease in the overuse of cervical cancer screening in visits for females older than 65, (3.1 to 2.2%,  $p=.02$ ) and a statistically significant decrease in the overuse of antibiotics in asthma exacerbations (22.3% to 6.8% , $p<.01$ ). However, there was an increase in the overuse of prostate cancer screening in men older than 74, from 3.5% to 5.7% ( $p=.03$ ). There were no changes in the remaining nine overuse measures: laboratory screening tests and ECG testing in general medical exams, antibiotics for upper respiratory infections and acute bronchitis, mammography for women older than 74, pap tests in women younger than 21, and imaging in acute back pain. Out of the two misuse indicators, there was one significant improvement. The proportion of patients with a urinary tract infection who were prescribed an inappropriate antibiotic decreased from 24.9% to 2.7% ( $p<.01$ ). There was no change in the proportion of elderly patients who were prescribed inappropriate medications.

**Conclusions:** Quality improvement efforts have resulted in the reduction in the underuse of appropriate ambulatory care. However despite significant policy attention focused on reducing waste in the US health care system, we found little improvement in the delivery of inappropriate ambulatory care in the past decade.

## Duty Hours 2.0: Effect of the ACGME 16-Hour Rule on Quality and Efficiency of Care

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**Background:** Effective July 1, 2011, the Accreditation Council for Graduate Medical Education reduced interns' maximum consecutive hours of duty from 30 to 16. Vanderbilt's Internal Medicine Residency Program instituted 16-hour duty limits for all residents in April, 2011. We compared the quality and efficiency of care delivered to non-intensive care unit (ICU) medical inpatients under the 30-hour and 16-hour duty limits.

**Methods:** We defined two cohorts of patients admitted to and discharged from six internal medicine teaching services at Vanderbilt University Hospital, Nashville, TN, between July 1 and September 30, 2010 (30-hour cohort) and July 1 and September 30, 2011 (16-hour cohort). Data were extracted from the Vanderbilt Enterprise Data Warehouse (EDW) and the Rapid Response Team (RRT) Database. The EDW is a relational electronic data repository of clinical and administrative information and the RRT database is a manually maintained database of demographic and RRT/code event specific information. We compared the cohorts on indices of hospital continuity (number of handovers per week); efficiency (adjusted length of stay [LOS]); and the quality and safety of care delivery (30-day readmissions to the same facility, observed to expected mortality, in-hospital rapid response and code events, escalations of care to an ICU, and adverse events). Adverse events were defined by the number of Agency for Healthcare Research and Quality (AHRQ) patient safety indicators and University HealthSystem Consortium (UHC) complications. Nonparametric statistical tests were conducted to compare the quality and efficiency outcomes in the two groups.

**Results:** The 30-hour cohort included 987 patients and the 16-hour cohort included 903 patients. The 30-hour and 16-hour groups were similar in terms of age (median 53 vs. 54 years), gender (51% vs. 50% male), and payor mix (78% vs. 77% Medicare or commercial insurance). The median all patient refined diagnosis related group (APR-DRG) risk of mortality was 2 (interquartile range [IQR] 1, 3) in the 30-hour cohort and 3 (IQR 2,3) in the 16-hour cohort. The structural changes made to accommodate the 16-hour duty rule more than doubled the total number of weekly handovers across the six medicine teams (41 to 95). Adjusted LOS in days did not differ significantly (4.34 for 30-hour vs. 4.65 for 16-hour,  $p=0.33$ ). No differences were seen in AHRQ patient safety indicators (5 vs. 1 per 1000 patients,  $p=0.13$ ); UHC complications (34 vs. 30 per 1000 patients,  $p=0.58$ ); observed to expected mortality (0.23 vs. 0.3,  $p=0.9$ ); or all-cause 30-day readmission (19.55% vs. 19.05%,  $p=0.75$ ). While there was no significant difference in the number of rapid response team calls (26 vs. 38 per 1000 patients,  $p=0.18$ ) and codes (1 vs. 3 per 1000 patients,  $p=0.28$ ), there was an increase in the number of escalations of care to an ICU (9 vs. 23 per 1000 patients,  $p=0.01$ ) in the 16-hour cohort.

**Conclusions:** Despite the shortened resident duty hours and increased number of total handovers of care, we observed no statistically significant difference in the efficiency or quality of care provided to non-ICU medical inpatients. The finding of increased care escalations to an ICU needs to be further monitored from both a quality and utilization perspective. This may be due to temporal trends towards higher acuity of patients as reflected by APR-DRG risk of mortality or may represent a more proactive escalation of care.

## Impact of Vendor Computerized Physician Order Entry on Adverse Drug Events in Patients with Renal Impairment

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**Background:** Adverse drug events (ADE) are common among hospitalized patients with renal impairment. Computerized physician order entry (CPOE) systems with clinical decision support (CDS) may help prevent many ADEs by providing timely laboratory information, recommending renally-adjusted doses, and offering a knowledge base to assist with prescribing. However, decision support for renal disease varies widely among current vendor systems. Given the uncertain benefits of CPOE, especially with the wide range of associated CDS, we sought to determine the impact of these systems on the rates of ADEs among patients with kidney disease in the community hospital setting, where mainly vendor-developed applications are used.

**Methods:** We conducted a before-and-after quasi-experimental study from January 2005 to September 2010 at five Massachusetts community hospitals to evaluate the impact of CPOE implementation on ADE rates. Three distinct levels of CDS were studied: basic CPOE only; rudimentary CDS with laboratory display; and, advanced CDS with suggested renal dosing and automated corollary laboratory orders for monitoring. We sampled a total of 1,590 patients with renal impairment (defined as an admission creatinine  $\geq 1.5$  mg/dL) who were prescribed a renally-cleared and/or nephrotoxic drug. Charts were reviewed for orders, medication lists, laboratory reports, admission histories, notes, discharge summaries, and flow sheets. The primary outcome was the rate of preventable ADEs. Secondary outcomes were the rates of potential ADEs and the average lengths of stay. The occurrence of each outcome was determined according to hospital site and rates were calculated. To account for hospital effects in the analysis, we fit a fixed-effects model using Poisson regression.

**Results:** There was a 45% decrease in the rate of preventable ADEs following implementation (8.0/100 vs. 4.4/100 admissions;  $p < 0.01$ ), and the impact was related to the level of decision support ( $p = 0.03$  and  $0.02$  for pair-wise comparisons between advanced CDS vs. rudimentary CDS and basic CPOE, respectively). Basic CPOE was not associated with any significant benefit (4.6/100 vs. 4.3/100 admissions;  $p = 0.87$ ), and there was a decrease in preventable ADEs with rudimentary CDS, which did not meet statistical significance (9.1/100 vs. 6.4/100 admissions;  $p = 0.22$ ). However, substantial reduction was seen with advanced CDS (12.4/100 vs. 0/100 admissions;  $p = 0.01$ ). Despite these benefits, a significant increase in potential ADEs was found for all systems (55.5/100 vs. 136.8/100 admissions;  $p < 0.01$ ). There was a significant decrease in median length of stay following implementation at all sites (5.0 vs. 4.0 days;  $p < 0.01$ ).

**Conclusions:** Vendor-developed CPOE with appropriate CDS can reduce the occurrence of preventable ADEs, and was associated with a decreased average length of stay. Our findings support the use of vendor CPOE systems as a means to reduce drug-related injury and harm. The potential ADE rate could be reduced by making refinements to the vendor applications and their associated decision support.

## Implementation of an Electronic Health-Record-based Tobacco Care Management System for Improving Treatment in Primary Care

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**Background:** Effective treatments for tobacco cessation are underused in primary care. Using principles of chronic disease management, we designed and implemented a novel Tobacco Care Management system to improve the delivery of tobacco treatment at primary care visits. It used the electronic health record (EHR) and team-based care coordination to link smokers to treatment without increasing the burden on primary care providers (PCPs). We assessed the system's feasibility and acceptability to patients and to PCPs.

**Methods:** At 2 community health centers affiliated with a Boston, MA, health care system, we added a 1-click referral functionality to the EHR. It gave PCPs an easy way to refer smokers to a centrally-located tobacco treatment coordinator (TTC). The TTC called smokers referred from both health centers to counsel and connect them to local specialty tobacco services and the state quitline. The TTC reported back to PCPs after each referral and was available for their inquiries. We evaluated the implementation of the system over 18 months with a mixed-methods design. Using TTC and EHR records, we measured PCPs' utilization of the referral function and the proportion of smokers connected to treatment. At 2 semi-structured focus groups (n=24), we elicited PCP's reasons for using the system, barriers to use, expectations of the referral, and experience with real-time feedback. Two coders independently conducted content analyses of focus group transcripts.

**Results:** From 2/1/10-7/31/11, 33 (92%) of 36 PCPs used the functionality, generating 466 referrals for 422 unique patients (15% of 2,894 total smokers seen in the health centers during the study period, 42 patients were referred  $\geq 2$  times). The health centers differed in the race/ethnicity and insurance status of smokers, but within each center there was no difference between smokers who were and were not referred. The TTC reached 246 smokers (58% of 422 referred smokers) by telephone and connected 133 (32% of those referred) to further treatment. At 1 center, the clinic leader spontaneously sent PCPs monthly feedback about their utilization compared to their peers. This center generated 79% of the referrals, and in focus groups PCPs identified this feedback as a motivator for using the system. Other themes that emerged were appreciation of (1) the simplicity of the 1-click function, (2) the easy access to up-to-date tobacco resources, and (3) a time-efficient means of addressing smoking in addition to their own efforts. PCPs were discouraged when the TTC was unable to reach the smokers they had referred and wanted information about the quit rates of referred smokers. They collectively supported continuation of the system.

**Conclusions:** A novel EHR-based Tobacco Care Management system was adopted by PCPs, especially those who received regular performance feedback, and successfully connected one-third of referred smokers to tobacco treatment resources. It is a promising, time-efficient model for improving tobacco treatment in primary care. The integrated design with a system-wide care coordinator has the potential for adoption by patient-centered medical homes and is scalable to multiple clinics within a healthcare system.