

## Changes in Use and Geographic Variation in Percutaneous Coronary Intervention (PCI) for Stable Angina Following Publication of the COURAGE Trial

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**Background:** Prior research demonstrates substantial geographic variation in clinical practice that is not associated with health status or patient outcomes. Lack of clarity regarding the best approach to a clinical condition is often cited as a cause of such variation. The COURAGE trial, published in 2007, was a highly publicized, multi-center randomized, controlled trial that found that optimized medical therapy alone was as effective as percutaneous coronary intervention (PCI) plus optimized medical therapy for patients with stable angina. We examine whether overall use and geographic variation in use of PCI for stable angina declined following publication of COURAGE.

**Methods:** We measured trends in PCI volume in Arizona, California, Florida, Massachusetts, Maryland, and New Jersey using the State Inpatient Discharge databases. These capture a near 100% sample of all inpatient discharges, including discharges for non-elderly patients. We supplemented these data with regional characteristics from the Dartmouth Atlas of Healthcare such as HRR-level inpatient spending for decedents in the last 6 months of life (a generally-accepted measure of regional practice patterns), hospital characteristics, physician availability, and availability of PCI. We examined geographic variation in hospital referral region (HRR)-level PCI volume for stable angina pre- (2006) and post- (2008) publication of the COURAGE trial and compared those to contemporaneous changes in PCI volume for two “control” conditions not studied in the COURAGE trial, acute myocardial infarction and unstable angina (AMI/UA). Geographic variation was measured in two ways: 1) weighted coefficient of variation (CV), which is the ratio of the standard deviation of the prevalence rates to the mean rate among the HRR, weighted by the population in each HRR, and 2) interquartile ratio (IQR), the ratio of the highest-use HRR to the lowest-use HRR. Multivariate linear and logistic regression was used to examine the impact of age, sex, prevalence of AMI/UA (measure of health status), and non-clinical factors on the use of PCI for stable angina. 72 hospital referral regions which represented 290,950 PCI for stable angina and 350,398 PCI for AMI/UA were included in the analysis.

**Results:** Following the publication of the COURAGE trial PCI volume for stable angina declined 25% (mean = 1.2 per 1,000 residents to 0.82, SD = 0.68 to 0.48,  $p = 0.002$ ) and decreased 9% for AMI/UA (mean = 1.28 to 1.14, SD = 0.72 to 0.66,  $p = 0.22$ ). Both the CV (0.62 to 0.63 for stable angina and 0.58 to 0.58 for UA/AMI) and the IQR (2.5 to 2.5 for stable angina and 2.3 to 2.5 for AMI/UA) were unchanged. In multivariable regression models, rate of AMI/UA and spending for decedents in the last 6 months of life were found to be significantly associated with changes in PCI for stable angina ( $p < 0.05$ ). Other non-clinical factors were not associated with changes in PCI volume for either stable angina or AMI/UA.

**Conclusions:** While use of PCI for stable angina declined after the publication of the COURAGE trial, there was substantial geographic variation in use of PCI for stable angina that existed prior to its publication that did not change following it. Although non-clinical factors explain this finding in part, even this large, well conducted trial with clear implications for the optimal treatment of PCI did not have the desired effect of reducing geographic variation in healthcare utilization for this condition.

## **An Evaluation of Continuity Clinic Re-design in an Internal Medicine Residency Program**

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**Background:** There have been recent calls for improved internal medicine outpatient training. Charged by participation in the ACGME Education Innovation Project, the Mayo Clinic Internal Medicine Residency Program implemented a continuity clinic re-design in the 2010-11 academic year. Changes included 1) separation of the inpatient and outpatient experiences, 2) development of outpatient care teams, and 3) additional rotations with concentrated continuity clinic exposure. In order to link these structural processes to outcomes, we assessed the impact of clinic re-design on clinical and educational outcomes.

**Methods:** 96 residents in our Primary Care Internal Medicine site participated in this study. The pre-intervention study interval was July '09-June '10; the post-intervention interval was July '10-June '11. Continuity of care was assessed from the perspective of the resident (proportion of visits in which residents see their own patients). Quality of care was assessed through an existing primary care database for diabetes, hypertension and preventive service measures. Patient satisfaction was measured with the ABIM Patient Assessment Module. Residents assessed perceived safety and quality of the care environment through a 13-item survey administered four times per year. Educational outcomes were assessed through an existing electronic evaluation database across multiple domains. We used this database to measure resident satisfaction with clinic, resident performance in clinic, and faculty rating of the clinic experience. Attendance at teaching conferences was tracked via electronic card swipe. Outcomes were assessed for each variable using generalized estimating equations.

**Results:** Clinical outcomes before and after re-design are depicted in Table 1. Perceived safety and quality of the clinic was higher in the post-intervention year (p-value range 0.026 to <0.0001). Mean attendance at teaching conferences was higher in the post-intervention year (56.7 vs. 63.1, p<.001). There was no significant difference between study intervals for the remaining educational outcomes.

**Conclusions:** Continuity clinic re-design through separation of the inpatient-outpatient experiences and additional structural changes was associated with increased resident panel size but a reduction in continuity of care with little change in other clinical parameters. Perceived safety and quality in the outpatient setting improved. Attendance at teaching conferences improved while the remaining education outcomes were unchanged. These data provide important information for iterative residency re-design to optimize clinical care, patient continuity, and educational experiences.

## Transitions of Care Internal Medicine PGY1 Ambulatory Education: Pilot Year 1

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**Background:** In one out of every five hospital discharges, there is an adverse event which can lead to hospital readmission or an ER visit. In July 2007, the American College of Physicians, Society of Hospital Medicine, and Society of General Internal Medicine came together to address quality issues and to develop consensus standards for transitions of care between inpatient and outpatient settings. While the learning of care transitions is a hidden curriculum at many medical institutions, trainees are still expected to master this challenging skill set by the end of residency. We proposed that introducing proper transitions of care strategies via small group, interactive didactics and a piloted post-discharge hospital home visit in the PGY1 internal medicine curriculum would increase confidence in the implementation of safer discharges for hospitalized patients.

**Methods:** In pilot year 1 at the University of Pennsylvania, the first week of PGY1 internal medicine ambulatory blocks from July through December included an hour long didactic session on "Transitions of Care". This interactive, small group session discussed pertinent topics such as: identifying vulnerable patients, working with multidisciplinary team members, the basics of home services and skilled nursing facilities, medication reconciliation, discharge summaries/instructions, and patient communication. During the next 3 weeks of the block, half of Internal Medicine interns were randomized to go on a post-discharge home visit. Home visits were piloted in 2009 with the University of Pennsylvania Transitions of Care Nursing Team led by Mary Naylor. On the last didactic session of the month, we reviewed discharge summaries/instructions. There was also a debriefing session for those who attended a post-discharge home visit.

**Results:** An IRB approved pre-intervention survey was given immediately before the first and last session to all the interns and 27 paired evaluations were reviewed. Overall, the interns showed an increased degree of confidence in: identifying potential threats to a well executed transition between sites of care ( $p < 0.001$ ); anticipating the consequences of a poorly executed care transitions ( $p < 0.001$ ), and knowledge of the community resources available to patients with chronic illness ( $p < 0.001$ ). In addition, they showed increased knowledge in the roles of physical therapists ( $p < 0.001$ ), occupational therapists ( $p < 0.001$ ), nursing ( $p < 0.010$ ), and social work ( $p < 0.030$ ).

**Conclusions:** This pilot transitions of care education initiative for internal medicine interns showed increased confidence in high risk discharge issues and increased knowledge of community resources and the role of multidisciplinary team members in safe transitions of care. Future directions include having all interns participate in post hospital discharge home visits and further evaluation of the long term impact of a transitions of care education program.

## **Low SES is Associated with Increased Risk for Hypoglycemia in Type 2 Diabetes Patients: Results from the Diabetes Study of Northern California (DISTANCE)**

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**Background:** Minimizing hyperglycemia is a clinical priority and quality goal in diabetes care. Hyperglycemia-lowering therapies can improve diabetes-related outcomes, but may also increase the risk of hypoglycemia. Past European studies have reported greater risk of hypoglycemia among those with low socioeconomic status (SES), but this research was conducted prior to the focus on more intensive glucose lowering. Therefore, we sought to determine if low income, a marker of low SES, was associated with greater risk for hypoglycemia in a modern U.S. cohort of adults with diabetes.

**Methods:** We conducted a cross-sectional analysis of the DISTANCE study, a survey follow-up cohort comprised of adult diabetes patients enrolled in the Kaiser Permanente Northern California diabetes registry. DISTANCE included an ethnically stratified random sample, and the baseline survey (response rate 62%) was conducted in English, Spanish, Mandarin, Cantonese, and Tagalog. The outcome of interest was patient report of 1 or more episodes of significant hypoglycemia, those resulting in unconsciousness or requiring outside assistance, in the past 12 months. The exposure of interest was household income. We specified unadjusted (bivariate) and multivariate logistic regression analysis, controlling for sociodemographic variables such as age, gender, race/ethnicity, education, and health literacy, and clinical variables such as medication use (insulin, secretagogues, metformin, or mixed), HbA1c, duration of diabetes, chronic kidney disease, self blood glucose monitoring, CVA, and dementia. Models accounted for the complex sampling design (non-proportional sampling fractions) through expansion weights, for survey response bias using Horvitz-Thompson weights, and for item non-response with multiple imputation.

**Results:** 14,357 patients were included. The mean age of our sample was 58 years (SD 10 years), and was 49% female. The sample was 23% Asian, 22% white (non-Latino/a), 18% Latino/a, 17% African-American, and 20% mixed/other. The mean HbA1c was 7.6 (SD 1.6). 17% had household income below \$25,000 annually, and 33% had income >\$65,000. Hypoglycemia was common, with 11% of patients reporting significant hypoglycemia in the past year. In bivariate analysis, low SES was associated with nearly twice the frequency of hypoglycemia, with 16% of those with incomes <\$25,000 reporting hypoglycemia, compared to only 8.8% of those with incomes > \$65,000 (Cochran-Armitage test for trend Z score 7.82, p <0.0001). In our multivariate logistic regression analysis, hypoglycemia remained significantly associated with low SES. The effect was significant for both the poorest (incomes < \$15,000, OR hypoglycemia 1.51, 95% CI 1.11-2.05, p = 0.008) and the second poorest (incomes \$15,000-24,999, OR 1.41, 95% CI 1.01-1.99, p = 0.045) cohorts (reference group income >\$65,000).

**Conclusions:** Low income is associated with substantially increased hypoglycemia risk. This finding persisted even after adjustment for potentially confounding and mediating risk factors. Clinicians should be aware of this increased risk when caring for vulnerable patients and prioritize treatment strategies which minimize hypoglycemia. This has important implications for diabetes clinical guidelines and quality metrics, which must balance the risk of hypoglycemia against the benefits of diabetes treatment. More work is needed to understand why lower income is linked with greater risk of hypoglycemia and whether this disparity is modifiable.

## Development and Validation of a Predictive Model to Identify Patients Who Physicians Define as Complex

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**Background:** Health system redesign efforts increasingly focus on patients with complex health needs. The ability to prospectively identify patients defined as complex by their primary care physician (PCP) using available electronic data sources may allow health systems to better allocate resources and tailor programs to improve patient care and physician experience. We previously characterized physician-defined complexity and described associated factors. Here we develop and validate a predictive model for physician-defined complex patients.

**Methods:** 40 PCPs from 12 primary care practices in the Massachusetts General Hospital Practice-based Research Network reviewed a random sample of 120 of their own patients. After excluding patients for whom they were not responsible, PCPs identified 1126 of their 4302 patients as complex. We randomly split this PCP-reviewed cohort into two subsets: 2/3 for model development and the remaining 1/3 for model validation. We generated 1000 bootstrap samples from the development subset. For each sample, we ran separate logistic regression models with backward elimination (significance=0.05) to identify predictors for physician-defined complexity, stratifying our models by patient age (age<60, age≥60). We included only variables chosen in greater than half of bootstrap samples. We evaluated model discrimination using c statistics and calculated test characteristics. We obtained all predictive variables from an electronic data repository.

**Results:** Among patients under 60 years old, the odds of being identified as complex increased with age (OR 1.04 [1.03-1.06]), Charlson score (OR 1.52 [1.11-2.06]), number of prescribed medication (OR 1.08 [1.06-1.10]) and number of no shows in 3 years (OR 1.24 [1.13-1.36]), Hemoglobin A1c>9 (OR 9.43 [2.86-31.11]), Medicare (OR 5.07 [2.70-9.51]) or Medicaid (OR 1.76 [1.18-2.62]) insurance, depression (OR 1.73 [1.25-2.38]) or alcohol related diagnosis (OR 2.80 [1.39-5.65]), and billing codes for MRI (OR 1.54 [1.07-2.22]). Among patients 60 years or older, the odds of being identified as complex increased with age (OR 1.04 [1.02-1.06]), number of prescribed medications (OR 1.08 [1.05-1.10]) and number of no shows in 3 years (OR 1.34 [1.13-1.59]), Medicaid insurance (OR 2.66 [1.14-6.20]), diabetes (OR 1.96 [1.26-3.05]), atrial fibrillation (OR 2.19 [1.25-3.83]), and billing codes for psychotherapy (OR 3.31 [1.68-6.52]) or a complex patient visit (OR 1.54 [1.11-2.15]). C statistics from the development cohort were 0.82 for age<60 and 0.79 for age≥60 and 0.83 and 0.77 in the validation cohort, respectively. We defined complexity when predicted probability was ≥0.45 for age<60 and ≥0.59 for age≥60 to achieve highest accuracy, and this resulted in an overall accuracy of 82%. Table 1 shows model test characteristics in the to subsets.

**Conclusions:** We were able to develop a robust general model to predict PCP-defined patient complexity. Age, markers of chronic disease and mental illness, Medicaid insurance, and no show visits were common predictors of complexity in both age groups. Applying this type of predictive model to populations of patients may help health systems effectively identify complex patients for resource allocation and interventions to improve primary care quality and physician experience.