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**HEALTH CARE REFORM**

**Developing a Model for Attending Physician Workload and Outcomes**

With increased economic pressures on hospitals, limitations on resident physician hours, and payment reductions for preventable harms, hospitals seek to increase productivity while improving the quality of patient care. Frequently, relative value units and patient encounters are used to track physician productivity and establish national benchmarks.1,2 However, productivity varies based on a range of characteristics that are not generally reported, limiting the accuracy of comparisons across institutions. Also, comprehensive process and outcome measures from different stakeholders’ perspectives need to be established to align diverse health care interests, ensure widespread acceptability, and provide comprehensive goals.3 In the present study, we (1) identify an actionable measure of attending physician workload; (2) characterize factors accounting for differences in workload; and (3) identify a congruent set of measures that would be valued by disparate stakeholders.

**Methods.** We performed in-depth semistructured interviews with 8 hospital program directors in the Maryland/District of Columbia region exploring measures of workload, factors causing its variation, and potential safety and quality concerns. We then used a modified Delphi technique with small groups of hospitalists, nonphysician practitioners, house staff, and hospital administrators from private, academic, and community hospitals. Participants identified, critiqued, organized, and operationalized characteristics affecting attending workload. The authors also performed a stakeholder analysis and reviewed the nurse staffing and resident physician work hours literature to identify pertinent patient safety and quality outcomes for attending physicians.4,5

**Results.** We found that workload was frequently tracked both as number of patient encounters and relative value units. Hospitalist directors reported difficulty in determining the relative value units of a particular service or shift, but the number of encounters could be tracked easily and controlled through systematic mechanisms.

Factors identified as affecting workload centered around physician, hospital, team, and patient characteristics (Figure). Physician characteristics included demographics, practice environment, work day activities, and compensation; hospital factors were primarily location and services related. Team characteristics included assistance, delegation of tasks, geographical localization of patients, and system controls for patient volume. Important characteristics of the patient group served included age, complexity of care, and access to health care.

Our literature review and stakeholder analysis revealed outcomes considered attributable to attending physicians: tests, radiographs, procedures and consultations ordered; critical value response time; medication errors; incident reports; morbidity; mortality; completeness of treatment discussions; patient satisfaction; and overall quality of care. Other suggested measures included procedure, test, admission or discharge delays; number of patients cross-covered; handoffs; transfers to higher levels of care; medication reconciliation; communication with the primary care provider; and readmission.

**Discussion.** This is the first study, to our knowledge, to explore attending physician workload, develop a model for factors that may affect it, and identify generalizable process and outcome measures for attending physicians. Both relative value units and patient encounters are typically reported as hospitalist benchmarks,1 but participants believed that number of patient encounters could be more easily tracked and intervened on in real time. They also identified factors affecting workload as physician, hospital, team, and patient characteristics. Of these categories, team structure is likely the most modifiable. By using different team structures, such as with house staff or midlevel care providers, workload and efficiency may be improved.6

From our review of the literature and stakeholder analysis, we found that pertinent process and outcome measures centered around the hospitalization and transitions of care. Hospitalization outcomes focused on reducing unnecessary testing and consultation, increasing patient flow, addressing safety concerns, and providing high-quality patient-centered care. Transition of care measures focused on potential patient care delays and preventing clinical decompensation and readmission. Re-
admissions are currently being used as a benchmark; these other measures may also be used in the future.

Limitations of the study include potential lack of generalizability because our participants were from the Maryland/District of Columbia area. However, we had broad representation of the private, community, and academic settings, and many workload and quality concerns transcend geographic and service-level boundaries. Second, some of the categories of factors affecting workload may not be readily modifiable. However, we also present factors that can be intervened on, such as assistance (house staff and midlevel care providers) or geographic localization of patients. Understanding of both the modifiable and fixed factors is important for the overall assessment of how to influence workload.

This study has significant research implications. It recognizes that systems adapt differently to handle workload, and therefore it is important to understand the contextual factors within which patients are treated. This is essential to ensure accurate comparisons are being made among institutions. Second, the potentially modifiable factors we identified may be used to improve workload efficiency and should be further studied to assess their impact on both workload and outcomes. The Centers for Medicare & Medicaid Services Physician Quality Reporting System and value-based purchasing models make the study of attending physician outcomes increasingly important. Future research can use this workload model; identify the association of physician, hospital, team, and patient factors with outcomes; and determine targeted interventions to improve both the efficiency and quality of care.

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**Limit to Benefits of Large Reductions in Low-Density Lipoprotein Cholesterol Levels: Use of Fractional Polynomials to Assess the Effect of Low-Density Lipoprotein Cholesterol Level Reduction in Metaregression of Large Statin Randomized Trials**

A recent metaregression of 25 large statin randomized trials involving 155 613 participants and 23 791 major vascular events reported a significant reduction in the risk of major vascular events associated with a reduction in low-density lipoprotein cholesterol (LDL-C) level. The question that naturally follows is whether there is a threshold for the benefit of LDL level reduction that can be achieved with statins or whether greater reductions in LDL level would bring greater reductions in vascular events.

Conventional metaregressions such as the one by Delahoy et al., however, rely on “linear” modeling, which assumes that the association fits a line (a constantly increasing or decreasing risk as the exposure increases or decreases) and does not allow for alternative associations such as threshold effects. We performed a “flexible” (not “linear”) unrestricted maximum-likelihood metaregression (inverse variance-weighted regression) based on fractional polynomials of the reduction in LDL-C level on the logarithmic relative risk (RR) for major vascular events.

**Methods.** The mean absolute reduction in LDL-C level at 1 year and the RR for major vascular events were abstracted from each individual randomized trial included in the recent metaregression. First-order and second-order fractional polynomial models take the forms

\[ \log \text{RR} = \beta_1 + \beta_2 x^p + \beta_3 x^q \]

respectively. By choosing \( p \) and \( q \) from the predefined set \([-2, -1, -0.5, 0, 0.5, 1, 2, 3]\), a rich set of possible functions, including some so-called U-shaped and J-shaped relations, may be accommodated. The powers are expressed according to the Box-Tidwell transformation, in which \( x^p \) denotes \( x^p \) if \( p \neq 0 \) and \( \log x \) if \( p = 0 \). When \( p = q \), the model becomes \( \beta_1 + \beta_2 x^p + \beta_3 (\log x) \).

For each set of powers \( (p, q) \), we calculated \( \beta_1, \beta_2, \) and \( \beta_3 \) that minimized the deviance (sum of inverse variance-weighted squared residuals) using Microsoft Excel Solver (Microsoft Corp.). The best fit among the family of models thus generated is defined as that with the highest likelihood or, equivalently, that with the lowest deviance. The gain for a given model is defined as the deviance associated with the reference linear model \( (\beta_1 = 0, p = 1) \) applied in the recent metaregression minus that for the model in question; accordingly, a larger gain indicates a better fit.

**Results.** The conventional quadratic model \( (p = 1, q = 2) \) better fitted the data than the linear model (black line, Figure), with a gain in deviance of 12.87. The best-fitting model \( (p = -2, q = -2) \) red curve, Figure offered a gain in deviance of 13.30 with respect to the reference linear model, representing an almost horizontal line when the reduction in LDL-C level is more than approximately 40 mg/dL (to convert to millimoles per liter, multiply by 0.0259) \( \log \text{RR} \) [log RR] of 0.80 [-0.23], 0.79 [-0.24], 0.78 [-0.25], and 0.77 [-0.26] at the LDL-C level reductions of 40, 50, 60, and 70 mg/dL, respectively).

**Discussion.** Our fractional polynomials metaregression suggests almost no additional benefit in the use of statins beyond a 40 mg/dL decrease in LDL-C level in preventing major vascular events.

A traditional method of summarizing dose-response relations across studies is to estimate the change in the logarithm of the RR per unit of exposure within each study and to combine these estimates across studies. Such an approach could be misleading, however, because it assumes that the dose-response relation follows a specific model form, usually linear. Polynomial models, typically quadratic models, are used to represent nonlinearity. An alternative curve-fitting method,