idea that more data give better prediction is predictively logical. Eventually, a practical contribution would be to use the information learned from this study and generate an algorithm that can facilitate discharge decisions to provide high quality follow-up care to minimize readmission following CABG.

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Commentary: Adding time-dependent variables to readmission predictors—not a perfect solution to limiting readmissions

Victor A. Ferraris, MD, PhD

Hospital readmissions following cardiac operations surfaced to prominence in 2017, when the US Department of Health and Human Services expanded their financial penalty for hospital reimbursement to include readmissions following coronary artery bypass operations. The unintended consequence of this financial penalty actually might have resulted in higher patient mortality in some “safety net” hospitals caring for indigent and underinsured patients with difficulty in returning to the hospital for postoperative complications. This increased mortality raised concerns about the value of using readmissions as a financial quality measure.¹

In this issue of the *Journal*, Manyam and colleagues² present a study that explores the association of time-dependent perioperative variables with 30-day readmission rate after

CENTRAL MESSAGE

Adding time-dependent variables to readmission predictors improves risk prediction but may provide limited outcome improvements.

coronary artery bypass operations. They included 6 time-dependent variables in their regression model: preoperative hemoglobin A1c level, preoperative creatinine, preoperative hematocrit, intraoperative hemoglobin, postoperative creatinine, and postoperative hemoglobin. The adequacy of the final prediction model was excellent, with an area under the curve value of ~0.9. They concluded that the addition of time-dependent perioperative variables into risk prediction models provides better prediction and more accurate models for predicting readmission.

Technically, the authors used a static model, which converts time-dependent variables into variables with several discrete values at 2 or more times of interest, such as before and after an operation. This is much different, and much simpler from a computational standpoint, than including time-dependent variables as a continuous variable with a

From the Division of Cardiothoracic Surgery, University of Kentucky and Lexington VA Medical Center, Lexington, Ky.

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Address for reprints: Victor A. Ferraris, MD, PhD, Division of Cardiothoracic Surgery, Lexington VA Medical Center, Room B504, 1101 Veterans Drive, Lexington, KY 40502 (E-mail: ferraris@uky.edu).

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wide range of values over time and an equivalent number of outcome values in a regression model known as multivariate analysis of variance. The authors recognized the complexity of using continuous values of hemoglobin A1c, creatinine, and hematocrit in a prediction model and chose to model these 3 continuous variables with 2 discrete values before and after or during the operation. From a clinical standpoint, the authors' choice of modeling before and after the operation makes sense, although it might not be as rigorous as possible. Others have used similar modeling to study endocarditis.³

The fact that it is possible to predict readmission following cardiac operations with some degree of certainty leads to a logical extension that evaluates the means of limiting readmissions. As the authors point out, patients who stay longer in the hospital after an operation tend to have fewer readmissions. There is not much clarity about modifiable risk factors that can potentially limit readmissions.⁴ Discharge planning and patient education are suggested options to limit readmissions but with inconsistent

benefits. Patient characteristics explain only a minor part of readmission rates, and most patient factors associated with readmissions are nonmodifiable (eg, age).⁵ Thus, readmission after cardiac operations remains a rather perplexing complication of the procedure, but the addition of time-dependent predictors of readmission may stimulate further work in this area.

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Commentary: Readmission risk reduction and the new age of data integration

Paul Kurlansky, MD

On October 1, 2012, the Secretary of the Department of Health and Human Services established the Hospital Readmissions Reduction Program. In 2017, the program was expanded to include coronary artery bypass surgery in the penalty of reduced hospital reimbursement. The program has not been without its controversies. The risk model supporting the program has relatively poor discrimination¹; the decision to exclude socioeconomic factors in the modeling may have adversely impacted safety net hospitals²; and the

Impact of readmission reduction program on raw and adjusted readmission/mortality rates.³

CENTRAL MESSAGE

Regardless of one's perspective on readmissions, creative use of robust and integrative approaches to data acquisition and analysis will continue to improve the risk models of the future.

program may have actually resulted in a greater patient mortality.³

Central to these controversies is the ability to determine which readmissions might be avoidable. From the

From the Division of Cardiac Surgery, Columbia University, New York, NY.

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Address for reprints: Paul Kurlansky, MD, Black Building 210, 650 West 168th St, New York, NY 10032 (E-mail: Pk2245@cumc.columbia.edu).

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