Body Mass Index vs Cholesterol in Cardiovascular Disease Risk Prediction Models

Traditional modifiable risk factors for cardiovascular disease (CVD) are smoking, high blood pressure, and unfavorable blood lipid concentrations. Models combining these factors predict CVD more accurately than models considering CVD risk factors in an isolated manner. Combined risk prediction models include the Framingham Risk Score or, from Europe, the SCORE (Systematic Coronary Risk Evaluation). One disadvantage of these assessments is that they require blood sampling for lipid measurements. This precludes the estimation of the 10-year risk of a CVD event, eg, from self-reports. In electronic health records, the lack of information on cholesterol was the most common reason why CVD risk could not be calculated. In contrast, blood body weight and height are available in virtually all health data sets. On the basis of the SCORE method and using a population sample from Switzerland, we aimed at comparing the traditional prediction model using total cholesterol with a version in which we replaced cholesterol with body mass index (BMI).

Methods. Subjects. Risk factor data stem from 17 791 men and women older than 16 years who participated in either of 2 CVD studies: the National Research Program 1A (NRP1A), a community health promotion initiative focused on CVD prevention, and the Swiss MONICA (Monitoring of Trends and Determinants in Cardiovascular Disease) population survey, an international project of the World Health Organization. We obtained mortality follow-up by anonymously linking the data from the CVD studies with the Swiss National Cohort (SNC), which encompasses all residents of Switzerland enumerated in the national 1990 or 2000 censuses as well as data from death and emigration registries until the end of 2008. Linkage success was 94% (NRP1A) and 97% (MONICA). The 95th percentile of follow-up was 31.2 years, during which 2170 men and 1761 women died (749 and 630 from CVD, respectively).

Measures. Blood sampling and cholesterol measurement were described. Body mass index was calculated from measured (without shoes) height and weight (calculated as weight in kilograms divided by height in meters squared). We defined smoking as smoking 1 ciaga-rette or more per day. Nonsmokers include former and never smokers. Systolic blood pressure was recorded as the mean of 2 measurements. Fatal CVD events were defined according to the Eighth Revision International Classification of Diseases codes 390 to 458 (until 1994) and International Statistical Classification of Diseases, 10th Revision codes 100 to 199.

Statistical Analysis. Risk models were calculated with Weibull proportional hazards regression as previously described. To compare the prediction abilities of the cholesterol and BMI model, we calculated the mean cross-validated (leave-one-out) Brier score, which measures the mean squared difference between the risk score and the actual outcome. The lower the difference, the better the respective risk prediction model. The Brier score covers both calibration and sharpness of a prediction model.

Results. Compared with cholesterol (eFigure; http://www.archinternmed.com), the BMI model (Figure) showed higher risks at all ages and could better discriminate persons at high and low CVD risk. Moreover, the synergistic effects in combination with smoking and in particular with blood pressure were stronger than with cholesterol. Body mass index, but not cholesterol, was significantly associated with mortality. The prediction ability of BMI was better based on the lower Brier score (eTable 1). Because explanatory variables (age, sex, smoking, and blood pressure) other than BMI or cholesterol remained the same in the 2 models, the difference between the Brier scores was small. In a common model with cholesterol, BMI remained significant, while cholesterol did not (eTable 2). Thus, cholesterol did not contribute to the explanation of the association between risk factors and mortality when BMI was included in the same model.

Comment. Using BMI instead of cholesterol in CVD risk prediction models may provide more accurate estimates. Traditional models such as Framingham or SCORE include cholesterol or total to high-density lipoprotein cholesterol ratio but do not consider BMI in their equation. In line with our results, Green et al found that using BMI instead of cholesterol allowed at least equivalent CVD risk estimation based on electronic health records and that the use of BMI could reduce unnecessary laboratory testing. The fact that BMI renders blood sampling unnecessary leads to a substantial increase of population-based samples available for CVD risk estimation. The use of BMI may not only ease CVD risk assessment but could have further advantages. Compared with dyslipidemia screening, screening for obesity has a stronger scientific foundation and is unconditionally recommended. Furthermore, lifestyle changes (diet and physical activity) promoting weight loss or preventing weight gain may improve health more strongly than lipid-lowering treatment. In contrast, knowledge of cholesterol may not lead to behavioral changes, and there are also doubts concerning the effectiveness and safety of statin treatment for primary prevention of CVD.

In conclusion, our results suggest that BMI may be a valuable alternative to cholesterol in CVD risk predic-
tion models. This finding needs to be validated in other populations.

**Figure.** Absolute 10-year risk of fatal cardiovascular disease (CVD) based on the model using body mass index (BMI). Each risk percentage is calculated using a combination of given risk factor values (eg, a man aged 60 years, who is a smoker and has a systolic blood pressure of 180 and a BMI of 35 [calculated as weight in kilograms divided by height in meters squared], has an absolute risk for fatal CVD of 4%). NRP1A indicates National Research Program 1A; MONICA, Monitoring of Trends and Determinants in Cardiovascular Disease.

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3. Jackson R, Lawes CM, Bennett DA, Milne RJ, Rodgers A. Treatment with drugs that modify the renin-angiotensin system and mortality and stroke in the first 5 years after screen for the presence of a MDE.

We appreciate the important articles by Granek et al and Shayne and Quill regarding grief in health care professionals (HCPs). Although HCPs can, and often do, experience grief over patient loss, this important issue has not received the attention it deserves. Physicians form meaningful connections with their patients and have human responses to their deaths, including grief reactions. The intensity of sadness, sense of loss, and possibly self-doubt varies, but even when intense and somewhat protracted, “normal” grief should not be confused with major depression.

However, the death of an emotionally meaningful patient may trigger more than a “normal” grief reaction. For some HCPs, especially those with unique vulnerabilities such as personal histories of mood disorders, bereavement may bring on the worsening of a preexisting depression or even a new-onset major depressive episode (MDE). When that occurs, not only is the grief more severe and persistent, but all the other malignant consequences of MDE, including the risk of suicidal behaviors, may ensue. Thus, any HCP whose grief over a dying or deceased patient is accompanied by depressed mood, present most of the time for several days, and/or has a markedly diminished interest and pleasure in all, or almost all, activities should be systematically screened for the presence of a MDE.

To meet MDE criteria, the symptoms should be present for at least 2 weeks and associated with significant distress or impairment. Generally speaking, some relatively specific features suggest the presence of a MDE in addition to grief: mood and ideation are mainly negative (in grief alone, positive thoughts about the deceased are often present, and the individual may retain his or her sense of humor); the agony is relatively persistent (in grief alone, painful feelings tend to come in bursts or waves); feelings of worthlessness and self-loathing are present (in grief alone, self-esteem is usually preserved); and suicidal ideas, psychomotor retardation, and severe impairment of functioning may be more likely.

Thus, we suggest that specific programs should be provided to HCPs, especially to those experiencing repeated losses of patients, such as oncologists and palliative care or emergency department HCPs. These programs should include education about MDE, its consequences and treatments, screening for MDE, and support for bereaved clinicians and staff. Finally, referral for treatment, all too often not provided to HCPs, can be lifesaving.

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