movitz has both specific and general reservations regarding my comments on using God's commandments as the foundation for our ethical beliefs. Specifically, he writes that almost all the limiting rules and regulations and punishments of Exodus 22 and the five books of Moses apply to Jews only. That is a matter of perspective. I have certainly known Jews who would not agree that all the rules, etc. apply to them and I have encountered many Christians who believe the five books of Moses are the word of God and that God's commandments in those books unquestionably apply to them. In fact, I have even heard speakers state, without knowing my religious beliefs, that many of these rules and regulations also apply to me. Perhaps they should. The issue I was addressing in my essay, however, was the search for ethical truth. What are the foundations that tell me which commandments and moral rules and regulations I should follow?

Examples were chosen from the Judeo-Christian tradition because I thought these examples would bring the issues into sharper focus for the western reader than would examples from less familiar sources. According to the Bible, Samuel 1:15, it was God, not some king or military commander, who commanded the systematic slaughter of Amelekite babies. Dr. Chamovitz replies that almost every primitive religion at the time of the Amelekites practiced human sacrifice, especially of babies and young children. Certainly, that was a barbaric time, although it might be difficult to argue that our century is much improved. Nevertheless, the issue is not the barbarism of the past or present, but whether we can find a foundation for our ethics based on God's commandments. Would our behavior automatically be ethical if we followed practices agreed upon by all the world's religions? Agreement does not imply ethical truth. Even if all the religions at the time of the Amelekites agreed that human sacrifice was right, very few of us are likely to agree that this unanimity of belief made it right. Furthermore, if God's commandments define right and wrong, the slaughter of the Amelikite babies is right simply because God commanded it and ethics becomes an arbitrary expression of God's will. Alternatively, if God commands a particular action *because it is right*, then there is a right and wrong, an ethical foundation, independent of God's will.

I do not want to take the space here to repeat points already made; nevertheless, I did expect this issue to be the most controversial aspect of the essay because many people genuinely do believe that God's commandments (their religious beliefs) can serve as an unshakable foundation for their ethics. While the problems associated with a God-based ethic are not necessarily insurmountable, they do need to be addressed as Dr. Chamovitz has begun to do when he points out the problems of the English translation of the Hebrew.

One of the two quotations that began the essay was taken from an article by Dr. Ingelfinger (*2*).

> . . . What special insight or superior moral sensitivity gives me the license not only to accuse but to judge? . . . It is far too easy to be ethically self-righteous.

Michael Servetus was a brilliant, eccentric and somewhat rash Spanish physician who, among other things, wrote a book challenging the doctrine of the Trinity (*3*). For this offense, the French inquisition condemned him to be burned alive. He escaped from Lyons and reached Protestant Geneva where he was recognized, arrested and tried for blasphemy (rejecting the Trinity). His chief accuser was John Calvin who justified the death sentence by appeals to God's decrees in Deuteronomy 13:5-15, 17:2-5, Exodus 22:20 and Leviticus 24:16. Servetus was comdemned to burn at the stake. There is a story, probably apocryphal, that after the fire was lit, a great wind blew through Geneva and flattened the flames to the ground slowly roasting Michael Servetus. In his pain, he cried out and begged Calvin to kill him quickly. Calvin is said to have responded, "It is God who makes the wind to blow, not I."

In this story, Calvin was certainly self-righteous. More disturbing, though, was his denial of his own ethical responsibility. The suffering of Michael Servetus was the responsibility of God. When we act as agents of God, it is too easy to absolve ourselves of any moral responsibility for our actions. The consequences of our actions become simply expressions of God's will, not our own choices. As history so amply demonstrates, very unethical behavior is often justified by an appeal to God's commandments.

In response to the question, "Who decides which parts of sacred literature are literal fact, misrecorded, symbolic or no longer applicable," Dr. Chamovitz suggests that we should look for the answer in the continuing tradition of the religious group whose sacred literature is in question. This approach has elements in common with my comments on page 301 of the essay. Certainly, such a tradition may provide profound ethical insights and even a consensus regarding certain ethical issues, but it is difficult to use tradition and consensus as a *foundation* for our ethics. The Aztecs had their traditions, the Popul Vuh and other sacred literature, yet they practiced a dramatic form of human sacrifice, cutting the beating hearts out of their victims and rolling the bleeding bodies down the temple steps. The simple existence of a tradition and sacred literature is not sufficient to provide ethical truth. Certainly, there may be considerable overlap between religions in their practices or ethical beliefs, but the foundations for these beliefs are often quite different and under times of stress may be used to justify very divergent behavior. The answers do not come easy and the quotation by Albert Einstein that began the essay is worth repeating:

> The most important human endeavor is the striving for morality in our actions (*4*).

REFERENCES

1. Taylor A. Don't confuse me with ethics: I already know what's right. *J Nucl Med* 1992;33:296–303.
2. Ingelfinger FJ. The unethical in medical ethics. *Ann Intern Med* 1975;83: 254–269.
3. Durant W. *The reformation: a history of European civilization from Wyclif to Calvin: 1300–1564.* New York: Simon and Schuster; 1957:479–490.
4. Einstein A. In: Dukas H, Hoffman B, eds. *The human side. New glimpses from his archives.* Princeton: Princeton University Press; 1979;95.

Andrew Taylor, Jr.
Emory University Hospital
Atlanta, Georgia

First-Pass Versus Gated Equilibrium Radioangiography

TO THE EDITOR: In an article published recently in the *Journal (1)*, Green et al. referred to the few theoretical notes regarding comparative performances of gated first-pass versus equilibrium gated radioangiography, specifically the corresponding statistical precision of the two methods. We would like to comment on some of the methodological issues utilized in the cited article.

If EDC(i) is the left ventricular (LV) count rate at i-th end-diastole following the bolus arrival and LVEF, then, according to Green et al. (*1*), the total indicator dose is given by:

$$\text{dose} = \text{LVEF}\cdot(\text{ECD}(1) + \text{EDC}(2) + \text{EDC}(3) + \ldots\ldots). \quad \text{Eq. 1}$$

The above equation was derived after some preliminary calculations. It referred to the ideal case when the transit of indicator bolus is completed before the onset of systemic recirculation. The authors then state without proof that the relationship still holds during LV regurgitation, but then LVEF denotes the forward component of total the LVEF. They also imposed the constraint that regurgitant activity originating from each systole fully returns to the ventricle in the subsequent diastole. The latter implicates that in instances of mitral valve insufficiency, due to fractional reinputs of each regurgitant activity from the left atrium, Equation 1 is not exactly valid.

The above relationship, however, can be obtained much more directly and in a more general form to allow for eventual valve insufficiency, irrespective of its site.

To verify this, observe that LVEF·EDC(i) is simply the i-th LV indicator output. By neglecting systemic recirculation, the sum of all sequential LV outputs equals the total indicator dose. In instances of LV regurgitation, the total indicator dose is recovered by summing the parts of LV outputs that irreversibly leave the left ventricle via the aorta, or eventual septal defect. Clearly, LVEF in Equation 1 is the forward component of the total LVEF, which is equally valid for mitral and aortic regurgitation.

Atrial smearing of the regurgitant indicator in mitral valve insufficiency poses additional problems in some deconvolution analyses of first-pass indicator histograms, which are not present in aortic regurgitation (*2*, *3*), but it does not violate Equation 1. The only obstacle to validating Equation 1 is right-to-left ventricular shunting. This would affect LVEF·EDC(i), in that only a portion of LV it-h output, i.e., that part which originated from the previous diastolic input, would be represented. Systolic input to the left ventricle from the right ventricle is the other part of LV single-beat output.

The methodological difference between the two approaches is that Green et al. considered sequential inputs in the left ventricle, whereas we featured consecutive indicator outputs. The advantages of the latter are obvious.

Still, the reader may find valuable information in the relationships that Green et al. utilized in arriving at Equation 1. For example, the following recursive relationship (*1*, see Appendix):

$$\text{EDC}(i+1) = (1 - \text{LVEF})\cdot\text{EDC}(i) + \text{i-th diastolic input to LV}$$

can be used to calculate LVEF from pulmonary and LV indicator first-pass curves (*3*).

Finally, we would like to point out that a mere statistical comparison between first-pass and equilibrium gated methods underestimates the overall performance of the former. This is particularly true because of the lower background level typically present in the first-pass studies. Since background subtraction only imitates the true background activity, which is not known, the result of this maneuver would greatly affect the accuracy of the output parameters of the equilibrium study. Thus, both precision and accuracy of the study results should be considered when comparing the two methods.

REFERENCES

1. Green MV, Bacharach SL, Borer JS, Bonow RO. A theoretical comparison of first-pass and gated equilibrium methods in the measurement of systolic left ventricular function. *J Nucl Med* 1991;32:1801–1807.
2. Eterović D. A model to evaluate ventricular insufficiency utilizing first-pass radioventriculogram component analysis [Letter]. *J Nucl Med* 1989; 30:417–419.
3. Eterović D, Tukić A, Tocilj J, Čapkun V. Perfect-mixer retention function by analytical deconvolution of tracer histograms: application to evaluation of left-ventricular contractility and competence. *Phys Med Biol* 1991;36: 1585–1597.

Davor Eterović
Clinical Hospital Split
Split, Republic of Croatia

Željko Dujić
Zagreb University Medical School
Split, Republic of Croatia

REPLY: In our paper (*1*), we derived an expression for total cumulative left ventricular (LV) end-diastolic activity when a tracer dose Q passes once and only once through the left ventricle and no ejected activity reenters the ventricle by regurgitation:

$$\text{Total cumulative LV end-diastolic activity} = Q/EF, \quad \text{Eq. 1}$$

where EF is the total ejection fraction. At the end of the Appendix to our work, we stated, but did not prove, that when regurgitation is present, Equation 1 should be modified by replacing the total EF with the forward ejection fraction, EF_f. Thus, both we and Dr. Eterović agree that the correct expression for the general, regurgitant case is:

$$\text{Total cumulative LV end-diastolic activity} = Q/EF_f. \quad \text{Eq. 2}$$

At the end of the Appendix, however, we stated that for this expression to be true, a constant fraction of ventricular activity at the beginning of a given beat must reappear as input to the ventricle during diastole of the same beat. We introduced this requirement to allow certain simplifications in the method that we used to derive Equation 2. Dr. Eterović's comments have spurred us to re-examine this method of derivation and, hence, the need for this constraint. Although the results of our analysis are correct, it is true, as Dr. Eterović suggests, that the constraint is unnecessary. All that is required is that all of the regurgitated activity eventually pass through and out of the ventricle. The way in which this activity is regurgitated is not important. In our original paper, we did not treat the regurgitant case at length because it was not central to the issues we addressed in the paper, namely how the first-pass and gated equilibrium methods compare when some objective and intrinsic criteria are used as the basis for comparison. Dr. Eterović's remarks suggest, however, that it would be useful to explicitly derive the general expression for total cumulative LV end-diastolic activity when regurgitation is present. We do so below.

Imagine a ventricle without regurgitation. After passage of a tracer bolus of magnitude Q through the ventricle, the cumulative LV end-diastolic activity will be, by Equation 1:

$$Q/EF.$$

If no regurgitation is present, as we have assumed, this will be the final value for total cumulative activity. On the other hand, imagine that some fraction of this cumulative activity is re-cycled