Bob Lux Responses to Questions from Galen and Fred
May/June, 2006

GALEN: I spoke with Fred today, and he, of course, is disappointed that you cannot participate in person. He asked what is the status of your work using the epicardial sock electrode to compare epicardial and surface recordings? Fred remembered you work reducing the surface map to 32 leads, and then expand by means of 216 coefficients. Did you ever do this same kind of approach with epicardial recordings? ...

BOB: The epicardial potential (EG) body surface potential (ECG) idea is one that I am pursuing with a lot of our tank data. I published a paper on this (ISCE 2002) in which I documented the correlation structure between epicardial and body surface sites. The clear picture and high correlation indicates that for regions of the precordium close to the heart (2-6 cm) body surface ECGs (and body surface potential distributions) are a very close surrogate of the underlying (most proximal) epicardial EGs (and potential distributions) - both in terms of P-QRS-T morphology and timing of peaks and inflections in the waveforms. Of course the ECG is a "smoothed" version since the EG contains all the local (rapid) inflections, whereas the ECG is driven by broad field currents. The importance of this finding is that precordial (not just 12 lead, but much of the upper left, anterior/lateral quadrant) ECGs can be interpreted as EGs from the epicardium.
Additional evidence for the above conclusion is the well documented observation of epicardial RV breakthrough observed at the body surface and easily seen from epicardial maps. So precordial BSPMs are a distorted view of epicardial potential maps.

FRED: Do you expect specific difficulties in applying you temporal-spatial BSPM data reduction scheme on epicardial potentials?

BOB: One can apply the K-L representation to epicardial waveforms and potential distributions, but it really isn't appropriate, given that there isn't much redundancy on the epicardial surface, i.e., epicardial EGs, activation sequences, potential distributions are much more complex, from an information content perspective, than are body surface ECGs and potential distributions. I do not see an immediate need/application for applying statistical reduction to direct (myocardial) EGs or distributions, with the possible exception of applying local characterization to fiber structure - something I pursued in an NIH grant several years ago.

FRED: if you repeat the procedures at various distances from epicardium to the surface (as simulated in tank experiments),the closure you get to the surface, the more the patterns will simplify and resemble those from the surface,::the question is: at what distance from the epicadium do the patterns start getting similar to those recorded at the surface
Put a bit differently, if you were to compute eigenleads and eigenmaps and superimpose them at various distances from epicardium from surface, at what point do they start to overlap (with or without rotation of the corresponding matrices)

BOB: These two points relate to my previous comment - yes, the studies that Mary Jo did with Giorgio Arisi in Parma in 1982-83 showed that one could interpret activation and recovery times at the level of the epicardium in terms of "body" (tank) surface ECGs and measurements from them. My contention is that one need not go to the trouble of exploring the distance over which the relationship (interpretation) holds but rather focus on directly using the information that is "pretty good" to begin with!

FRED: and last: we know that, from an anatomical point of view, one cannot unequivocally relate surface patterns with underlying anatomy; this is easier to achieve with epicardial distributions: at what point (again in terms of distance from epicardium to surface) is this anatomical correlation lost or smeared out.

BOB: Again, my "gut feeling" is that the interpretation of precordial region (upper-left-antero-lateral quadrant) potential distributions and ECGs are reasonable surrogates for underlying epicardial EGs and potential distributions. So... what about the back? Because of the greater distance between the posterior surface of the heart and the posterior torso surface, the relationship still holds, but WEAKLY. Also the information is much less local, i.e., correlation between posterior epi and posterior torso is much lower than on the anterior surface, because of the greater distance of the heart (more of a global picture) and greater separation of the surfaces.