Are Biomedical Engineers Doing Their Jobs?

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Medicine is a very complicated process that involves multiple diagnoses, courses of action, and more interactions than are commonly recognized. Indeed, when a patient complains to the physician about some conditions either real or imagined, the physician usually prescribes multiple tests to pinpoint the most likely medical scenario. In this intercourse, the physician can be hampered by the ability or inability of the patient to correctly describe the symptoms, his or her own experiences in dealing with similar circumstances, and time limits that preclude finding out all relevant patient histories. Indeed, each patient comes into this interchange as an individual, but leaves as part of a queue of patients with similar conditions.

Enter the biomedical engineer. Most biomedical engineers that I know, and virtually all who present at BMES meetings, have new instruments, materials, or diagnostic aids that they are developing. While each of these is a wonderful advancement of medical technologies, they can serve to compound the practices of medicine by offering more choices and more bits of information that must be carried in the physician's head. Whether they are more efficacious or not, whether they are more economical or not, whether they are more helpful or not, each of these new technologies is recognized as an improvement, if for no other reason than that it is new.

As our country debates national health care, there are heard many opinions about differing options, approaches, and methods. Clearly, we have a problem—no, many problems involving health care cost, the looming insolvency of Medicare, uninsured

patients, and political philosophies. The debates will go on, and compromises will be made such that no one will be completely satisfied.

As engineers we should be searching for answers—we are supposed to be problem-solvers, no? Nowhere in this whole debate do I hear reasoned arguments dealing with an overall assessment of the health care system and the ways in which technology can be used to improve patient care and decrease costs. This is where I believe biomedical engineers have not functioned as they should be capable. As we have become invested in our own specialties, we have lost appreciation for the big picture.

Liebman (2005) has said:

> "As clinical investigators, we stand to reap significant benefits on behalf of society by expanding our focus and viewing translational medicine not through the eyes of a scientist, but as an engineer might. Why an engineer? Because an engineer uses the fruits of science to feed the appetite of technology. Unlike scientists, who tend to approach problems from a "bottom-up" perspective by collecting data and seeking patterns, engineers take a "top-down" approach, probing a specific system for clues, taking it apart and considering how each component can be handled in a tailored solution. An engineer is a problem solver rather than a hypothesis generator."

Viewed from the outside looking in, this may be how the engineer is seen; looking from the inside, there is certainly a large question about how integrative biomedical engineers really are. A systems viewpoint often requires experiences, and so I would expect the best systems people to have worked in multiple scenarios and to be more mature.

We educators can help this process by being sure that our students are exposed to the widest possible range of knowledge, skills, and experiences that time and resources will permit. Instead of narrowing course choices to only those that directly reinforce technical competence, art, history, political science, and other liberal studies courses can

be just as valuable. Real life includes hard science, soft science, and nonscience, so a global perspective requires all of the above.

The result of all this, that is needed right now, is some model or decision-making process that can assist the policy makers in choosing the best course of action. Or, if not that course, at least some indication of the costs, both monetary and nonmonetary, of choosing other options.

A truly global approach would certainly include medical health care options, but would also include other conditions not normally considered as part of health care—conditions such as environment, occupation, family, nutritional habits, exercise, and frame of mind. I came across some interesting facts when I was researching my book Biology for Engineers. Some examples of those are fever therapy (where fever can be induced to strengthen immune responses to disease), helminth therapy (where parasitic worms are given to calm overactive immune systems), and quorum sensing (where microbes communicate among themselves by chemical means). Some of these could be very effective in maintaining health or treating disease, but will never be advocated because they are not new technology nor will they pay profits to any groups. The most likely ways in which these types of medical approaches will become widely accepted as legitimate medical choices is if they can be shown to be effective in a holistic approach to medical care and health maintenance.

We really need engineers who can take the larger view and demonstrate the likely consequences of different courses of action. Their results could benefit the medical community, policy makers, and the general public. Where will these engineers come from? In a world that rewards specialization, we know that there are few opportunities

for generalists. Exposure to information outside one's particular specialization is important, and BMES could contribute in ways to cross-specialty communication. To use an analogy, we need to plant some weed seeds among the vegetables of the garden of the mind.