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Diabetes: Medical vs Surgical Disease?

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Abstract

The distinction between the medical and the surgical approach to disease has been a cornerstone of medical practice, and indeed with respect to the business and technology of medicine. It is common knowledge that diabetes is a medical disease—namely that drug therapy, whether it be via insulin or other medications, is the primary approach to therapy. This article argues that a reevaluation of the generalized (e.g., medication-based) approach to systemic blood sugar control may be in order. A consideration of the growing importance of interventional, device-based, or other surgical approaches to the primary management of diabetes has enormous implications for clinical practice as well as, of course, the business and technology of diabetes care.

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The distinction between the medical and the surgical approach to disease has been a cornerstone of medical practice, and indeed with respect to the business and technology of medicine. It has been common knowledge that diabetes mellitus is a medical disease—namely that drug therapy, whether it be via insulin or other medications, constitutes the primary approach to therapy. Of course, there are surgical aspects to diabetes. Amputations, for example, are a dreaded outcome. The main goal of this article is to point out that a reevaluation of the generalized (e.g., medication-based) approach to systemic blood sugar control may be in order and a closer look at localized (e.g., surgical) treatments be considered. A consideration of the growing importance of interventional, device-based, or other surgical approaches to the primary management of diabetes has enormous implications for clinical practice as well as, of course, the business and technology of diabetes care.

Medical vs Surgical Disease

One of the most important decisions a clinician makes is whether a patient's condition requires a medical or a surgical approach. This can often be a fairly dichotomous decision, as approaching the patient from either of these perspectives implies very different doctors (e.g., physicians vs surgeons), tools (drugs vs scalpels), and resources (clinic vs operating room).

The 13th century physician Gilbertus Anglicus once exclaimed: "Why in God's name is there such a great difference between a physician and a surgeon?" A simple definition would read:

> A surgical disease is one that requires some form of localized intervention such as, of course, surgery, although various vascular interventions and radiation techniques would also fall into this

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Abbreviations: (TB) tuberculosis

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category. A medical condition involves a more systemic, pharmaceutical approach to treatment.

Many diseases may actually share both medical and surgical manifestations. An infection, for example, might involve antibiotics (a medical approach). An infected abscess, however, would require a surgical approach to drain it and reduce the infectious load on the body. A dislocated shoulder typically requires an intervention (not necessarily surgical but at least some form of manual manipulation) as it is highly unlikely that taking a pill will do the trick. Cancer is another example that is treated either surgically or medically (or both). Earlier (or more localized) tumors are often excised surgically, whereas chemotherapy is generally indicated for more advanced diseases. Also, in many cases, the increasing realization that even localized disease can often harbor cancer stem cells throughout the body means that surgery is not uncommonly combined with more generalized medical therapies.

Some conditions, such as back pain, can have either surgical or medical treatment options in which it is not definitively clear which approach is necessarily superior. This concept was exemplified earlier this year with the pivotal Spine Patient Outcomes Research Trial (SPORT) where it appeared clear that patient choice was probably a more important factor in the selection of treatment modality than necessarily any hard evidence-based scientific criteria. Also, there are some diseases that have been historically surgical that are now medical and vice versa. Some may be surprised to learn that tuberculosis (TB) was once treated by surgically excising diseased lung tissue. TB is now, of course, mostly a medical disease. Diseases have also made the opposite switch from the medical to the surgical size. Before the advent of heart transplantation and other such circulatory support (such as left-ventricular assist devices), heart failure was largely a medically treated disease.

So what factors make a disease surgical vs medical? In general, a surgical disease has the following characteristics: (1) is local in extent, (2) requires rapid treatment, and (3) has a surgical intervention with a sufficiently favorable risk–benefit balance

These are not hard-and-fast rules as there are certainly medical diseases such as asthma that are local (e.g., affecting bronchi in the lungs) and in which medicine (such as an inhaled β2 agonist) is rapidly effective. Nonetheless, these basic criteria help explain how doctors make that all-important decision on whether to send a patient to the operating room or to manage the disease medically.

Is Diabetes Mellitus a Medical or a Surgical Disease?

Nearly everyone would correctly identify diabetes mellitus as a medical disease caused by a relative lack of insulin. The paucity (and in some cases complete lack) of insulin has many effects. The most important is an increase in blood sugar, which results from the fact that liver and muscle cells, which normally under the influence of insulin take up glucose, do not do so. It is predominantly the high blood glucose levels that lead to a diverse range of dangerous (and even potentially fatal) complications.

The discovery of insulin by Banting and Best in 1921/1922, and the development of replacement insulin therapy soon thereafter, has been one of the greatest achievements of modern medicine. It earned the two scientists the Nobel Prize and, more importantly, has saved and prolonged countless millions of lives throughout the world. By virtue of careful glucose checks and subcutaneous insulin injections, generations of diabetic individuals have been able to lead relatively normal lives, although admittedly encumbered somewhat by their regular injection regimens.

Despite this great accomplishment, the disease is by no means conquered. Due to lifestyle changes (some would say the clash of Neolithic genes with modern Western culture), the United States and indeed the entire world are experiencing an epidemic of diabetes. And while blood glucose levels can be controlled by insulin, the inexorable pace of complications still leads to very high levels of morbidity and mortality among these patients.

So with the Miracle Cure of Injected Insulin in Hand, How Can This Still Remain a Problem?

Clearly systemically administered medical treatment, effective as it is, does not fully address the problem. In this regard, a bit of anatomy is helpful to consider. The blood supply to and from most tissues in the body follows a relatively simple anatomic arrangement. Oxygen-rich arterial blood from the heart enters these organs, which then drain into veins that lead back to the heart. The pancreas, which is the organ that secretes insulin in response to glucose levels (and other factors), follows a variant of this simple paradigm. Blood flowing to the pancreas does, indeed, come from the heart, but the blood leaving the pancreas (now relatively enriched

with insulin) actually enters a special vein called the portal vein. Instead of leading directly back to the heart, the portal vein flows through the liver functioning as an intermediary on its way back to the heart. As with the pancreas, the blood from the intestines (glucose-rich after a meal) also enters the portal vein and likewise flows through the liver. The liver is the major organ for glucose storage and metabolism and, more importantly, this close anatomic/physiologic confluence of the glucose load with the glucose regulator insulin means that glucose levels can be controlled very precisely. This is not just a physiological mechanism, but a result of very specific anatomic relationships (more generally termed portal venous systems).

In the case of a diabetic patient whose subcutaneously injected insulin essentially enters the peripheral venous circulation and then takes a tour through the heart and then around the systemic arterial circulation before reaching the liver, the anatomic/physiologica relationship is broken. This dissociation between glucose load and glucose control becomes readily apparent. For a patient with diabetes to achieve normal glucose levels, the distribution of insulin throughout the tissues may very well be quite different from that of a person without diabetes whose insulin comes from the pancreas. This may imply (although not proven) that for diabetic patients some tissues could be essentially overmedicated with insulin while other tissues remain relatively undermedicated.

It should be stressed that this is largely conjectural. While based on well-known principles of pancreatic anatomy and physiology, this view has not necessarily been proven scientifically nor should it be considered as a basis for modifying any particular patient's treatment. Moreover, this discussion pertains to insulin-dependent diabetes, and important measures such as diet and exercise, which are critical for all diabetic patients, including those with noninsulin-dependent diabetes, remain, of course, entirely valid. Nonetheless, the point is that a surgical (namely more anatomically localized) approach to diabetes may be necessary to improve current treatment.

The Surgical Approach to Insulin-Dependent Diabetes

While still a hypothesis, the point, however, is that a surgical (namely more anatomically localized) approach to diabetes may be necessary in improving current treatments. Islet cell transplantation in which functioning β cells are transplanted into the pancreas (and presumably in proper anatomic position as well) hence represents not just a more complex insulin replacement regimen, but also a direct cure for the disease. More resources should be applied aggressively toward thi, and related, approaches.

Implantable, electronically controlled insulin pumps are also gaining ground as part of the treatment armamentarium. Current incarnations of these devices serve an important function in improving the quality of life for these patients (e.g., not having to do multiple, daily self-injections) yet still administer their insulin outside the pancreatic–portal axis. While enormously more convenient, smart insulin pumps—directed at peripheral delivery and however intelligent they may be—will likely not represent a definitive treatment for the future. In the future, further minimally invasive techniques may make it possible to have such devices placed within the portal vein, measuring postintestinal glucose levels as well as injecting the insulin directly into that flow. In this way, such a pump could truly be called an artificial pancreas.

Another, more space-age, possibility may be for a device to be implanted in the portal vein, which can convert an otherwise inactive, systemically administered insulin into its active form as it traverses the portal vein on the way to the liver.

Cultural Differences between Specialties

Like anything, technology breakthroughs alone will not be the only factor bringing these advances to the bedside (or, more accurately, inside the patient). The surgery/medicine divide is not just a scientific/technical issue but is also reflective of significant cultural differences among specialties. The Food and Drug Administration is also structured along these lines. For example, the Center for Drug Evaluation and Research (CDER) is a completely different organization from the Center for Devices and Radiological Health (CDRH). It is not surprising that the regulatory pathways for drugs (e.g., medicine) are quite different than those for devices (e.g., surgery).

Convergent (or combination) medical technologies will indeed require a closer interplay between these two very different ways of approaching the patient. Despite the technical and cultural challenges, we have seen (and will continue to see) more of such convergence—whether it be for cancer or even diabetes. Traditions may be at risk but ultimately it will be patients who will benefit.

To Summarize

Diabetes clearly involves local pathology and local effects of glucose regulation. To this extent, next-generation therapies for diabetes may increasingly involve more surgical approaches. Some may argue that there is no need for that. They would say that we definitely know that the problem lies with a relative lack of insulin and that we have identified the culprit molecule—insulin—and simply need to substitute for that the relative lack of that molecule. To that I would reply: why have we not yet cured the disease?

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