
By Jamie Wells, M.D. — December 18, 2017

Recently, I had the pleasure of filming a segment on the top medical, science and technology innovations of 2017 at Reuters TV in Times Square, New York with host of CCTV Bianca Chen.

Here, I discuss the remaining developments on the list, having addressed the top 4 in Top 8 Medical & Tech Innovations of 2017 [1] (click here [1]). And, make my prediction for what innovation could be truly disruptive in the future.

It was a very exciting year in the pursuit of the once impossible when it comes to medical developments. Here are some top picks that truly are changing the landscape:

5) Invisible Diseases

As a society, we understand a broken arm or the wasted appearance of a body overrun by cancer. But, often there are more silent and invisible conditions provoking a physical, emotional and psychological fury.

Advances in therapies in these types of conditions are not to be underestimated. They lead to profound changes in the lives of those afflicted and their loved ones.

Thankfully, we have seen a lot of progress this year and the future looks bright.

- Type 1 Diabetes:
  - In The Many Invisible Faces of Type 1 Diabetes [2], I discuss the many promising
paths being explored when it comes to a cure: continuous glucose monitoring, encapsulated beta cell replacement therapies, closed loop pumps (aka artificial pancreas), stem cells, immunotherapy, pancreatic/islet transplantation.

6) Gene Therapy

In Did Gene Therapy Cure Sickle Cell Disease? [3], I talk about a hopeful case study published in the New England Journal of Medicine [4]. In it, the team proved their concept of using gene therapy in sickle cell disease which is a big deal given the limited progress there has been in management of this condition. At this point, promising with cautious optimism is the most apt description.

Sickle Cell Disease is an inherited condition that causes a mutated hemoglobin—the protein within red blood cells (RBCs) that carries oxygen for delivery to vital tissues. Oxygen feeds our organs so they can stay healthy and perform their respective jobs. This Hemoglobin S (aka Sickle Hemoglobin) polymerizes on deoxygenation, their new rigidity reduces the RBCs' malleability. As a result, these stiffened, malformed sickled cells clump together thereby occluding vessels which results in organ damage (e.g. strokes, Acute Chest Syndrome, vaso-occlusive crises).

Given the limited progress in management of this condition, a team of researchers sought to examine whether “therapeutic ex vivo gene transfer into autologous hematopoietic stem cells referred to as gene therapy, may provide a long-term and potentially curative treatment for sickle cell disease.” (See here [3]).

What does this mean? They took samples from the bone marrow of a patient with severe disease. The cells here provide the origins of our blood components which includes our red blood cells. For patients with Sickle Cell Disease, it is these stem cells that have the genetic flaw. This is where the problem begins in generating the sickling. A cancer drug, busulfan, was used to condition the body—expected adverse effects from this occurred which resolved with standard care (e.g. anemia, low platelets, neutropenia and so on). Using a lentiviral vector, they transferred an anti-sickling gene into the patient’s stem cells (retrieved from the bone marrow) and transferred these treated stem cells back into the patient in the hope that they would multiply and replace the patient's own cells - those with the defective gene. The patient had “complete clinical remission.” Furthermore, after fifteen months the anti-sickling protein remained elevated at approximately 50% and the patient had no crises or hospitalizations.

Beta-thalessemia, a genetic condition impacting hemoglobin and resulting in significant destruction of RBCs and subsequent anemia, is another illness currently undergoing similar clinical trials. (See here on recent success with Hemophilia B [5]).

7). Delivery-Focused Technology
The use of unmanned aerial systems, aka drones, to deliver life-saving equipment or perhaps one day medications to remote areas is replete with fascinating, even unlimited potential. A research letter published in the Journal of the American Medical Association (JAMA) by a Swedish team explored the possibilities with out-of-hospital cardiac arrests (OHCA) in *Time to Delivery of an Automated External Defibrillator (AED) Using a Drone for Simulated Out-of-Hospital Cardiac Arrests vs Emergency Medical Services* [6].

Their findings [6] after comparing data of GPS-enabled drones to actual ambulance response times to areas without medical access demonstrated a median reduction in response time of 16 minutes and 39 seconds. Granted, these were not real-time scenarios.

But, what if, after more thorough and comprehensive investigations, they could be? OHCAs have a very poor prognosis, time to treatment is literally a matter of life or death and permanent disability.

Early and swift intervention with an automated external defibrillator (AED) amidst sudden OHCA during bystander cardiopulmonary resuscitation (CPR) saves lives—in fact, doubles the likelihood of survival. But there are problems including: cost, availability and high variability of place and time of OHCA occurrence, and the presence and willingness of bystander intervention.

Learn more about strategic AED placement strategies here, *Can Starbucks And Pizza Shops Prevent Deaths?* [7]. To understand the barriers to whether an individual is able and willing to intervene, review *During Sex, In Public - Why Are We So Afraid Of CPR?* [8]. To understand cardiac arrest, read *Tom Petty, Mainstay Rocker, Dies At 66 After Cardiac Arrest* [9]. And, why we need everyone to learn CPR here [10].

Given this is all computer generated data [6], much more needs to be studied in terms of weather challenges, ability to integrate with 911 dispatch centers and survival with EMS versus bystander intervention, to name a few.

But, this along with possible drug delivery of EpiPens or on the battlefield for supplies like wound care, for example, could be a whole new avenue for reducing barriers to access. When done responsibly and in a targeted manner, refining the apparent issues could hold great promise.

8). Telemedicine

Designed to create two-way, real-time communication between patient and physician, not all developments in this arena are profound or possess great utility. Nonetheless, it is a bustling space that can provide particular usefulness in rural areas where there is no access to care.

Wearable sensors and new technology is exploding in this arena. Of great promise to clinical health implications, would be the success of products that are leadless and could obtain accurate and reliable 12-lead electrocardiograms (EKGs). The ability for this data to be obtained and transmitted to a provider as it occurs would, in certain situations, obviate the need to go to the emergency room, guide when an office visit is warranted or be helpful in medication adjustment.

While not a full replacement for an in-person physical examination, telemedicine is improving its adjunctive efforts and expanding its value.
My prediction for what innovation in the future would be truly disruptive:

Early diagnostics in infection. Currently, identifying what bug is the culprit in a patient’s illness typically takes a few days. That’s how long we need to grow a bacteria in culture and while we wait a patient is placed on a broad spectrum antibiotic till the identity is affirmed. Once that happens, the therapy can be tailored to the specific bug. This status quo impedes our ability to get a jump on optimizing the most effective antibiotic treatment, when bacterial, rapidly containing its spread and contributes to the major problem of antibiotic resistance.

If we can more expeditiously identify the cause with a test-- preferably one less invasive than a blood draw, then this can be done in a doctor’s office as well as the ER. Antibiotic resistance would improve, earlier initiation of treatment would curtail outbreaks and patients could be more optimally cohorted in hospital setting so as not to pose great risk to the more vulnerable patients. To appreciate the scope of this type of invention, read Committee To Reduce Infection Deaths Hosts Forum Of Public Health Leaders [11].

Next year should be very exciting for science. Enjoy the holidays!

(To review items 1-4 of this list, go to Top 8 Medical & Tech Innovations of 2017 by clicking on this link [1]).