Health care is modern day's equivalent of the pre-Internet era in the 1980s—innovation is slow and expensive, and largely driven by large, well-heeled corporations. Medicine is a resistant, reticent field, taking on average 17 years to translate significant discoveries into standard practice.[1] The benefits of Internet era seem to now, ironically about 17 years later, finally percolate through the field of medicine: the rate of adoption of medical technologies seems to be following Moore's law;[2] wireless technologies have propelled forward digital medicine; cheap genotyping and wireless sensors are facilitating the shift from population-based to personal medicine; the internet and social networking has enabled patient connect communities, and empowered patients with information about their disease and health, reshaping the patient-doctor dynamic from one of paternalism to one of involvement (which will require educating physicians); finally, we are only at the early stages of accepting smartphones' medical potential. This is—as mobile health guru Eric Topol has proclaimed in *The Creative Destruction of Medicine*—"the biggest shakeup… [and] most exciting time in the history of medicine."

Consumers of medicine—people—are almost surgically attached to their smartphones, noticing its absence within 15 minutes, and taking an hour to register a misplaced wallet.[3] This phenomenon and their pervasive use leaves smartphones poised to become the center of many people's lives, as many believe it will, but also the center of medical technology. Digital medicine is just taking off, with the invention of genuinely useful yet compact devices like the VScan by GE, a handheld device allowing instant ultrasound, a recent deluge of consumer biosensors and medical apps, and forward-looking agendas, such as the announcement of the Star-Trek-inspired tri-corder X-Prize. The iPhone already can: take an ECG via an AliveCor case,[4] determine the appropriate contact prescription by taking a few pictures of an eye, determine if a skin lesion is likely

cancerous in minutes and refer a doctor,[5] and as of last week, act as a standalone spirometer to detect a possible asthma attack with nearly the same accuracy as a $3,000 commercial device.[6] Several inventions are surely in the works, which may augment the iPhone or continue the push into digital consumerism, such as a smartphone camera attachment to check for ear infections, or a wireless contact lens to follow a patient's glaucoma. In short, translational medicine is transmogrifying the smartphone into a digital hub, and ultimately, your phone, your wallet, your DNA, your health.

Medicine catering to the median—population medicine—leads to mismatched drugs and doses, general inefficiencies, and often causes harm. As the cost of genetic sequencing continues decreasing (at a rate greater than Moore's law would predict), the shift toward individualizing treatments becomes attainable to rectify these maladies, though medicine presently remains largely population-based. For example, three of the most commonly prescribed drugs are only effective in a specific subpopulation, which has been determined through genotyping—30% of patients prescribed Plavix for stents require a high dose due to a specific enzymatic insufficiency, and 20% of metformin regiments for type II diabetics are entirely ineffective due to a pathway abnormality. There are 370 million diabetics on the planet, so these numbers add up. In the largest clinical trials of statins (Lipitor, Crestor) for primary prevention (pre-emptive care), the FDA deemed the drug effective, resulting in its widespread prescription, even though benefits were only seen in 1 of 100 people. A worse example is that of Tegretol, in which 1 of 1000 patients with a *known* gene variant have a severe immune reaction,[7] and while Taiwan screens for it, the U.S. does not; we are condoning medical Russian roulette. High prices of medical equipment has driven the corporatization of medicine, whereby large hospitals render small practices impractical. A similar trend is developing in ge-

nomics and sequencing, as companies posture for their space in medicine driven by potential profits; in the past week, 23andMe announced an API to access their genomics data, at their discretion, clearly in attempt to establish their presence.

Biosensors, iPhone add-ons, and genomics will increasingly provide the deluge of data that will augment medicine to truly allow pre-emptive, personal medicine. Big data will become applicable to genomics and medicine as a whole, as will transformative technologies such as cloud computing. We will soon be able to define individuals with great granularity at biological, physiological, anatomical, and even external levels. Patient driven change and care will accelerate the incentive for frugal healthcare innovation, as has been seen by patients who bypass the $3000 laboratory sleep disorder diagnosis by purchasing their own monitor for about $100.[8] Patients will be armed with their own data and likely soon be given access to their health records. What drugs like Viagra pioneered through direct-to-consumer marketing can be built upon in marketing diagnostics to consumers. As in advertising, medicine will cater to the needs of the individual; patient social networks like PatientsLikeMe will be transformed into ones which are data-driven, allowing for genuine, individualized guidance and data-driven patient matching.

With advances in seemingly disparate fields, several technologies have melded to generate a progressively greater number of significant and unique innovations each year, adding new arms to medical diagnostics. In the short term, there are several opportunities to get into this space, even through just incremental improvements. In particular, cheap at-home genotyping would allow consumers to know whether a drug, such as Plavix or Lipitor, would be effective for them. Alternatively, a well-designed data-driven patient community will only become more useful over time.