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How to cure cancer: unbinding entrepreneurs in medicine

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Abstract

Purpose – Since the 1960s, experts have predicted that we are on the verge of curing cancer. The purpose of this paper is to explore the obstacles to progress, and to propose policies that will lead more quickly to more success.

Design/methodology/approach – To speed future cures, we need to look at the traits, and methods of those innovative medical entrepreneurs who achieved breakthroughs in the past, and learn what institutions and policies enabled, or blocked, their progress.

Findings – Breakthrough innovators tend to be less-credentialed outsiders who "see what others do not see," often by nimble and persistent pursuit of serendipitous discoveries or slow hunches. For example, Freireich and DeVita were less-credentialed outsiders. Freireich cured childhood leukemia and DeVita cured Hodgkin's lymphoma, by pursuing nimble trial-and-error experimentation in their anti-cancer chemotherapy cocktails. Min Chiu Li pursued his slow hunch that his patients would benefit from longer chemotherapy than the mandated National Cancer Institute protocol allowed. He was fired, but his patients were cured. Today, FDA-mandated regulatory protocols, often defended as applications of the precautionary principle, greatly restrict innovative medical entrepreneurs, thereby delaying cancer cures and costing lives.

Originality/value – The paper proposes a new approach to medical innovation, allowing cancer researchers to engage in trial-and-error experiments that follow up on serendipitous discoveries and plausible hunches. The result will be more cures and longer lives.

Keywords Cancer, Regulations, Serendipity, Medicine, Precautionary principle, Outsider, FDA, Cures, DeVita, Farber, Freireich, NCI

Paper type Conceptual paper

1. Introduction

> *In 2010, about six hundred thousand Americans, and more than 7 million humans around the world, will die of cancer. In the United States, one in three women and one in two men will develop cancer during their lifetime. A quarter of all American deaths, and about 15 percent of all deaths worldwide, will be attributed to cancer. In some nations, cancer will surpass heart disease to become the most common cause of death* (Mukherjee, 2010, p. xv; italics in original).

Health care and education are two of the areas of the economy that are most important to human well-being, and yet have seen the least institutional changes over the past several decades (Bush and Baker, 2014, pp. 61-62). Obstacles in both areas restrict innovative entrepreneurship, limiting the pace and scope of innovations. In this paper, I argue that reducing the obstacles to innovative medical entrepreneurship will result in quickening the pace of finding cures for more kinds of cancer. My method is to examine important examples of breakthrough innovations in medicine and ask what sort of people made those innovations, and what sort of conditions enabled or obstructed their innovations.

The stakes are high. Gennawey (2011) discusses what Walt Disney might have achieved at Epcot if he had lived several more years. And what creative new device would Steve Jobs have given us next? We all know someone who has cancer, and we all fear that it may happen to us. Cancer takes away from us life that we thought we would have, and that we ought to have had.

2. Sources of breakthrough innovations

Incremental innovations are important and often occur in large firm, university, or government labs staffed by highly credentialed scientists and engineers (Baumol, 2005).

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But major improvements in the quality and quantity of life depend at least as much on breakthrough innovations as on incremental innovations. Breakthrough innovations are not inevitable and do not automatically increase when governments and firms increase their spending on research and development. Rather, the agents of breakthrough innovations are almost always innovative entrepreneurs (Baumol, 2005). If we want more breakthrough innovations, including more cures for cancers, we need to better understand how innovative entrepreneurs think and act, and what obstacles prevent them from bringing their innovations to the world.

Breakthrough innovations figuratively fly in the face of received theories and expert opinions (Diamond, 2012). Wilbur and Orville Wright's breakthrough innovation literally flew in the face of received theories and expert opinions. The innovative entrepreneurs are usually outsiders – "outside" either because of their ignorance of received theories and expert opinions, or "outside" because their willingness to ignore received theories and expert opinions leaves them shunned by the theorists and experts (see e.g. Wang *et al*., 2017). At a key early stage of a breakthrough innovation, the innovative entrepreneur sees what others do not see. Sometimes a serendipitous event helps the entrepreneur see what others do not see. Sometimes a different way of thinking, call it "cognitive diversity," helps the entrepreneur see what others do not see. And sometimes it is mainly courage that helps the entrepreneur see what others do not see.

Because, at the key early stage, the often-inchoate breakthrough innovation will seem indefensible to all but the innovator, the early stage will usually be self-funded (or funded by family or friends who have blind faith in, or affection for, the innovator). As a result, policies that enable self-funding, such as low individual income tax rates, are crucial for enabling entrepreneurs to achieve breakthrough innovations. High tax rates concentrate funds to be spent according to the judgments of the theorists and experts who advise the government. Low tax rates leave more funds widely distributed among the diverse outsiders who have the potential to achieve breakthrough innovations.

3. Examples of medical entrepreneurship

Schumpeter saw the key role of the innovative entrepreneur as being the overcomer of obstacles to innovations, which could come in a variety of forms, and from a variety of sources (Schumpeter, 1950, pp. 132-133). In this section, I briefly examine a variety of examples in which major medical advances occurred, to see what obstacles were most binding on the medical innovators. The goal will be to see which obstacles can be reduced, in order to enable medical innovators to bring us innovations more quickly and in greater number.

Since our ultimate goal here is to speed cancer cures, many of the examples will be important cancer advances, as identified in Siddhartha Mukherjee's acclaimed and Pulitzer-Prize-winning *The Emperor of All Maladies*. But a few examples will come from non-cancer medical advances that were selected either because of their importance in saving lives (the inoculation example) or in revealing the obstacles faced by medical innovators (the ulcer example). These examples are helpful in learning how to speed cancer cures on the plausible assumption that obstacles that impede one kind of medical innovation will be similar to obstacles that impede other kinds of medical innovation.

Histories of medical innovations in general (Meyers, 2007) and medical innovations in fighting heart disease (Miller, 2000) and cancer (Mukherjee, 2010) in particular show that the innovators frequently resemble Schumpeterian entrepreneurs. They are outsiders from the mainstream, who have the courage and persistence to continue to pursue their innovations in the face of sustained opposition from powerful incumbent medical institutions. Several examples will be briefly discussed.

At the start of the Boston smallpox epidemic of 1721, it is surprising that it was Cotton Mather, of Salem witch trial fame, who wrote a letter to all of the physicians of Boston, suggesting that they start the practice of inoculating the healthy by exposing them to

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smallpox matter from the infected. Mather had published a small report in the *Philosophical Transactions* of the Royal Society in London, which at the time was one of the world's most distinguished scientific associations (Coss, 2016). In the same issue as his report had been an article by a Greek physician, of Italian descent, reporting his success at performing smallpox inoculations in Constantinople (Coss, 2016). Mather also discovered that one of his slaves had been successfully inoculated in Africa, which led him to seek, and to find, several other slaves in Boston who had been successfully inoculated in Africa.

Mather sent letters to the physicians of Boston, making his case, and urging that they conduct an inoculation experiment. Mather's task was difficult. The only university-educated physician in Boston, and the most influential, was William Douglass, who disdained Mather as a minister unqualified to make serious contributions to science (Coss, 2016, p. 77). The physicians also may have doubted the testimony of Boston's slaves who had been inoculated in Africa. And everyone found it far-fetched that the worst effects of smallpox could be avoided by an inoculation that exposed a patient to pus from a recent patient with smallpox (Coss, 2016, p. 85). With one exception, the entire medical community of the city rejected Mather's evidence and suggestion.

The exception was a young surgeon named Zabdiel Boylston, whose father had been a physician who had observed the success of some American Indian therapies, and so may have been more open than most to possible cures arising from non-European sources (Coss, 2016). On June 26, 1721, Boylston inoculated his first three patients. Among them was Thomas, his youngest son. Boylston was ridiculed and threatened with bodily harm and possible imprisonment. Mather's house was fire-bombed, though the wick from the bomb fortunately fell out before the bomb could ignite. Boylston proceeded to inoculate those who sought inoculation. All those who started the procedure in good health, and without previous exposure to the smallpox, survived, suffered mild cases of smallpox, and were immune to the current and future epidemics of the disease. The handful of those who died after inoculation from Boylston, either were already in the early stages of natural infection from smallpox, or were already frail or infirm from age or other diseases. It would have been easier for Boylston to have refused inoculation to these patients, since he knew that he, and inoculation, would be blamed for their death. But he allowed the patient to decide what risk was worth taking with their life. Boylston's most vitriolic opponent was William Douglass, who viewed himself as the only true "physician" in Boston, since he was the only one who received his medical training at a European medical school, instead of through a then-more-common apprenticeship. To Douglass, his inferior colleagues were "practitioners," not "physicians."

Sidney Farber is credited as a founder of chemotherapy for showing that aminopterin could produce temporary remission in childhood leukemia. His path was difficult. He knew that folic acid had succeeded in allowing patients who lacked key nutrients, to return to normal production of blood. So, he speculated that maybe folic acid could have a similar effect on children with leukemia. Farber obtained synthetic folic acid from his friend, the heavily accented, nocturnal introvert Yellapragada Subbarao (pronounced SubbaRow), who had skill and experience at synthesizing vitamins. But instead of slowing leukemia, injections of Subbarao's folic acid accelerated it, and shortened the lives of the injected children, which infuriated Farber's pediatrician colleagues (Mukherjee, 2010, pp. 29-30).

Facing the fury, Farber did not give up. He speculated that if folic acid accelerated leukemia, maybe a drug that blocked folic acid from the cancer cells would slow leukemia. Farber returned to his friend Subbarao, who had been denied tenure at Harvard, and asked him if he could synthesize a chemical to block folic acid. Serendipitously, it turned out that some small variations in the process to create folic acid resulted in "antagonists," chemicals that could block folic acid. One of these was aminopterin. In the clinical trials of aminopterin, the fury of Farber's colleagues continued. He had to scrounge clinic space in a back room

near the bathrooms, with his staff assigned to back rooms and stairwell shafts (Mukherjee, 2010, pp. 34-35). The incumbent medical cancer establishment banned pediatric interns from assisting in Farber's unit (Mukherjee, 2010, p. 34). The clinical trials often resulted in remission that extended the lives of the children by a few months, though the leukemia always returned. Farber had not found a cure, but he had found a proof of concept: chemicals could be effective against cancer (Mukherjee, 2010, p. 36). This eventually would lead to chemotherapies for a wide variety of cancers, therapies that often would significantly extend lives, and sometimes even cure.

Min Chiu Li was fired by the US National Cancer Institute (NCI) for continuing to administer chemotherapy after all tumors of cancer of the placenta had disappeared, but before a key marker (the hCG level) had reached zero (Mukherjee, 2010, pp. 136-138). After several years, the NCI eventually noticed that as a result of Li bringing his patients' hCG levels to zero, another key marker had also reached zero: the number of Li's patients who suffered relapses of their cancer.

Paul Carbone, correctly believing that chemotherapy could aid in treating breast cancer, was caught in a surreal catch-22 situation. The medical establishment would not let him practice his treatment without first conducting a substantial double-blind study. But at that time, patients with breast cancer were primarily the patients of surgeons, and very few surgeons were willing to enroll their patients in such a study, perhaps because the likely results of the study would be to reduce the role of surgery in breast cancer treatment (Mukherjee, 2010, pp. 219-220). Such medical turf protection also occurred when Vincent DeVita, then head of the NCI, suggested that based on the evidence, post-operative radiation for breast cancer should be reduced, because it was not improving patient outcomes. A radiologist came up to him complaining that much of the radiologist's practice was post-operative breast cancer radiation, and if that was reduced, she[1] would have to fire one of her radiotherapy technicians (DeVita and DeVita-Raeburn, 2015, pp. 182-183).

Turf protection also occurred when Bernard Fisher wanted to test whether radical mastectomy actually had better outcomes than more modest lumpectomies. His research was substantially delayed because of the resistance of American surgeons to allowing their patients to participate (Mukherjee, 2010, p. 200). After he finally completed his research, breast cancer surgeons almost succeeded in quashing publication of his article in which he presented evidence that lumpectomies were just as effective as radical mastectomies (DeVita and DeVita-Raeburn, 2015, pp. 182-183; see also pp. 222-223).

Emil Freireich was so aggressive in fighting cancer that he was threatened with firing, but he proceeded anyway. He said that he wouldn't want to work at a place that wouldn't let him do all he could do to save lives (DeVita and DeVita-Raeburn, 2015, pp. 55-56). Week-by-week his team (that one medical intern affectionately called the "Society of Jabbering Idiots") adjusted the dose and composition of the chemical mixture they were developing to fight childhood leukemia (DeVita and DeVita-Raeburn, 2015, pp. 63-64). Most advances in the treatment of cancer have been in terms of months or a few years of longer life. But their work resulted in a rare instance where a type of cancer can frequently and routinely be cured.

Vincent DeVita was a young member of Emil Freireich's team, who soon went on to use the same approach to develop a cure for the cancer known as Hodgkin's lymphoma. Early in his career, DeVita encountered entrenched medical incumbents at the prestigious Memorial Sloan Kettering hospital. The incumbents blasted DeVita's drug cocktail as ineffective against Hodgkin's lymphoma. When he quizzed them about how they had administered it, they admitted that they had cut back the levels of key ingredients, to reduce the possibility of patient nausea (DeVita and DeVita-Raeburn, 2015, p. 110). DeVita was appalled and angry. He said what should have been obvious: most patients would choose temporary nausea over permanent death (DeVita and DeVita-Raeburn, 2015, pp. 110-111). And the patients, not the physicians, have the right to make this choice[2].

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DeVita later tried to make changes in medical institutions to increase the pace of cancer innovation, first as head of the NCI, and eventually as physician in chief of the same Memorial Sloan Kettering where he had been blasted as a young researcher. He left the NCI in part from his frustration at having to fight the bureaucracy and special interests within the government (DeVita and DeVita-Raeburn, 2015, pp. 188-189). But he also experienced frustration in the quasi-governmental, non-profit hospital, where entrenched medical incumbents defended their turf against innovations that would save lives. When he was fired from that position, his boss told the hospital board: "the problem with Vince is that he wants to cure cancer" (DeVita and DeVita-Raeburn, 2015, pp. 227-228).

DeVita offers an extended critique of current medical institutions in the USA. He points out that incentives and regulations strongly constrain physicians to follow established protocols. But the kind of entrepreneurial medical innovation achieved by Freireich and his Society of Jabbering Idiots, was achieved through alert, extended trial and error, and could not have been achieved by following the then-mandated protocols. Freireich had been able to survive long enough to cure leukemia in part through the "umbrella" protection of the administrator Tom Frei, who had the courage and skill to sufficiently protect Freireich from the incumbent interests that wanted to rein him in (DeVita and DeVita-Raeburn, 2015, p. 94).

Today DeVita blames a dominant research methodology that says that research proposals need to be carried out as originally approved, even when (as should and does happen) the research process leads the researcher to conclude that the procedures need to be modified (DeVita and DeVita-Raeburn, 2015, pp. 196-197). This slows progress and loses lives. He also blames the FDA for restricting cancer researchers' ability to experiment with different drug and dose combinations, in the way that led Freireich and his Society to cure leukemia (DeVita and DeVita-Raeburn, 2015, pp. 8, 192, and 254)[3].

Other approaches, besides variations of chemotherapy, may turn out to be of equal or greater effectiveness against some cancers. We do not understand cancer well enough to foreclose these approaches. One approach that some have considered promising is Judah Folkman's angiogenesis theory. Folkman's research while serving on a submarine led to his insight on developing drugs to cut off blood vessels to tumors (Cooke, 2001; Kounios and Beeman, 2015, pp. 20 and 135-136; Ashton, 2015, pp. 60-65). For a long time, many of Folkman's papers and grant applications were rejected by the medical establishment. Eventually, his angiogenesis theory was recognized as plausible and promising, though DeVita suggests that Folkman was too slow to acknowledge that what worked in mice was not working so well in humans (DeVita and DeVita-Raeburn, 2015, pp. 279-280). Folkman's entrepreneurial perseverance and independence may have contributed to his taking a chance on hiring the under-credentialed Robert Langer, who later established an MIT lab, where he made major advances, including polymers to aid targeted drug delivery (Wilkinson, 2015, pp. 169-170).

Another increasingly promising approach is immunotherapy, where some promising results have been achieved by efforts to harness the body's immune system against cancer. Steven Rosenberg is famous for pursuing this approach. He is blunt in discussing how government regulations have slowed down, and discouraged his progress, especially regulations from the FDA. He was kept from doing the kind of quick, nimble adjustments that Jobs did with the iPhone, and that Freireich's Society of Jabbering Idiots did to cure childhood leukemia. The need to constantly seek approval from the FDA took him away from the total immersion that would have best served his medical innovation (Rosenberg and Barr, 1992, p. 288). Entrepreneur Jimbo Wales urges his Wikipedians to "be bold" and Rosenberg says that "defeating cancer requires boldness" (Rosenberg and Barr, 1992,p. 325).

4. Generalizations and implications for policy

From prominent cases of medical breakthroughs, I highlight four generalizations and policy implications that are suggested by these generalizations.

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Breakthrough innovators are outsiders

George Gilder (1990) observes that most innovative entrepreneurs are not successful credentialed insiders, but are unproven, uncredentialed outsiders (pp. 113-114). Gilder's point is re-affirmed in the history of advances of medicine, where breakthrough medical innovations are frequently achieved by outsiders to the incumbent medical establishment. Examples of outsiders in medical innovation include Zabdiel Boylston, Emil Freireich, Jonas Salk, Barry Marshall, and Vincent DeVita. These outsiders have fewer and less prestigious past credentials, and have less funded and less prestigious current positions. Sometimes they are not even in the incumbent disciplines the experts have assigned to the problem.

These claims can be illustrated by many examples. Emil Freireich had been a street kid (Gladwell, 2013). Vincent DeVita had not attended a prestigious medical school (DeVita and DeVita-Raeburn, 2015). In the cancer realm, there are many other examples (Mukherjee, 2010). Ditto for Jonas Salk, whose first independent lab, where he did most of his research to develop the polio vaccine, was not prestigious (Jacobs, 2015). John Hill, who documented that tobacco use increases the chances of cancer, was viewed as a "buffoon" by the medical establishment (Mukherjee, 2010, pp. 239-240). Zabdiel Boylston was ridiculed by William Douglass for being a "practitioner" instead of a physician, since Boylston had received his medical knowledge through the apprenticeship method rather than by attending a European medical school, as Douglass had (Coss, 2016). Australian Barry Marshall was ridiculed by the medical establishment for pointing out evidence that ulcers were caused by bacteria; the ridicule ceased when he swallowed a vial of the bacteria, and developed an ulcer (Meyers, 2007, pp. 103-113; Klein, 2013, pp. 52-56).

The contributions of outsiders are often prominent, not just for practical therapies, but also for fundamental advances in biological knowledge. One of the most fundamental advances in our genetic understanding was first established by the modest monk Gregor Mendel, publishing in a modest regional publication, and long ignored by the biology establishment (Wagner, 2014). Antoine van Leeuwenhoek who first identified microbes, was a cloth merchant and minor city official, not an academic (Snyder, 2015, p. 1). Galileo was supported by Medici bankers, not by incumbent academics (Westfall, 1985). Craig Venter was viewed as an under-credentialed eccentric, as compared to his government-sponsored rival, the Nobel Prize winner James Watson (Shreeve, 2004).

Peter Thiel observes that the most important ingredient for successful entrepreneurship is not intelligence, but courage (Thiel and Masters, 2014, p. 5). Since the medical establishment protects its own turf (Bush and Baker 2014; DeVita and DeVita-Raeburn, 2015; Topol, 2012), the success of the less-credentialed has frequently required persistence and courage.

Implications: we should not give too much power to the prestigiously credentialed gate-keepers. We should not marshal resources in a centrally organized plan.

Breakthrough innovations are often achieved by "Seeing What Others Don't"[4]

You might say that it was serendipitous that Robin Warren saw the bacteria that cause ulcers. But it is his co-author Barry Marshall who is perhaps better remembered for the discovery. It was he who drank the cocktail of the bacteria, and developed an ulcer. But if "serendipity" implies the good luck to experience a rare event, then that is not quite right for the ulcer case. The bacteria were there for others to see too, and there are published pre-Warren-and-Marshall photographs where we now can identify them, but they were not "seen" by the photographers (Marshall, 2001). Daniel Kahneman (2011) has noted that we see what we expect to see. One example is what he calls "theory-induced blindness" (pp. 277, 280, 286-287, and 290). Gastroenterologists widely believed the theory that bacteria could not survive in the acidic environment of the stomach. So they did not "see" the bacteria in photos of the stomach because their theory blinded them. "Serendipity" involves

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seeing the unexpected. But it involves more. It involves seeing and remembering and having the resources and courage to stick with it, while others are denying it.

Starting in 1891, William Halsted was a tireless advocate of the theory that cancers could be cured by cutting them out (Mukherjee, 2010, pp. 64-69). When surgery often failed to cure, Halsted and his followers blamed the surgeon, not the surgery theory. As failures continued, Halsted and his followers advocated cutting out more and more adjacent lymph nodes, and then more and more adjacent muscles, which increasingly disfigured and disabled patients, but still too often left them dying from the cancer. Halsted was intense and well-intentioned (Mukherjee, 2010, pp. 5-6, 64-66, and 218), but his theory that surgery could cure cancer blinded him to the growing evidence that cancer often spreads in ways that surgery could not stop.

When Galileo argued for his views of the heavens with the clerical and academic incumbents of his day, he invited some of them to look through his telescope to see for themselves. Some did not look (Bucciantini *et al.*, 2015, pp. 101-102). What was radical about Galilean science was not the individual assertions about the heavens, but that they were to be judged by one's own eyes rather than by the authority of the credentialed. The Royal Society's motto "Nullius in Verba" embraces this method: belief should be based on evidence, not on the words of authorities (Rosen, 2010, p. 68). Breakthrough medical entrepreneurs are frequently in a similar situation. They have the courage and persistence to look, sometimes in straightforward ways, sometimes in non-mainstream ways.

Implications: opportunities for longer-term projects, and multiple funding sources and self-funding, are desirable. When tax rates are low, medical entrepreneurs can more easily accumulate the wealth that enables them to be a funding source for others, or to self-fund. Another implication is that we should tolerate and maybe even value, cognitive diversity.

Breakthrough innovations often come from nimble trial and error

Outside of medicine, Walter Isaacson's (2011) book *Steve Jobs* documents the importance of nimble trial and error in the development of his signature innovations such as the iPhone. He frequently would have his team present him with four or five versions of a particular product. He then would evaluate them and pick the best for further development. When he was dying of cancer, he was having trouble breathing and the medical staff tried to put an oxygen mask over his face. He stopped them, gasping that he did not like the design of the mask. He then went on to gasp that they should bring him four or five versions of the mask, and he would pick the best. In the area of cancer research, Min Chiu Li was fired from the NCI because he believed that elevated levels of something called hCG indicated that cancer was still lurking at low levels not evidenced by cancer symptoms. His patients did not suffer relapses of their cancers, and he is now viewed as the first to have shown that chemotherapy can cure cancer. Vincent DeVita feels regret that he once stuck with the protocol even though he had learned that the chemotherapy needed to be applied longer than the protocol allowed. His patient died. Is that good science? Is that how to treat our fellow human beings?

Many advances were not made following the mainstream mandatory method of medicine, the double-blind method. We know some truths through methods other than double-blind. We have already seen above that sometimes doctors committed to an incumbent method may not enroll their patients in a double-blind study that might challenge that method. A *reductio ad absurdum* argument has refuted the belief that all medical knowledge must flow from randomized double-blind experiments: no one has ever conducted a randomized double-blind experiment to test the efficacy of parachutes (Smith and Pell, 2003). So, until such an experiment is done, we cannot know that we should wear a parachute when jumping out of an airplane?

Implication: we should not fund or regulate on the basis of rigid adherence to pre-established protocols, and we should not declare a centrally planned "war on cancer" or a centrally planned "cancer moonshot."

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Breakthrough innovations are often achieved at great risk, sometimes even of injury and death

A few died from Boylston's smallpox inoculations, and even from the later and safer smallpox vaccinations. But many more lives were saved than lost. And, at least with the inoculation cases, the risks mainly were taken voluntarily.

A growing obstacle to medical innovation has been the growing advocacy and implementation of the "precautionary principle," which states that new innovations should not be allowed to proceed until it has been shown that they cause no harm (Sunstein, 2005; Thierer, 2016, p. 1). Perhaps one reason that medical advances have sometimes arisen in war theaters or emergency medicine is that the precautionary principle is not implemented in those settings. For instance, Nobel Prize winner Alexis Carrel honed his technique for re-attaching small blood vessels in the crucible of WWI[5] (Friedman, 2007). Examples of medical innovations that were developed under emergency or extreme conditions can be found in Fong (2014).

Such cases show that exemption from the precautionary principle allows for quick and substantial experimental trial and error that can speed innovation. They do not provide a justification for war, but they do suggest the pursuit of other ways to counter the precautionary principle. These might include patients voluntarily signing waivers to accept experimental treatments, either because they know that no other treatment is available to them, or because they have made a conscious decision to accept risk for the goal of advancing medicine (DeVita and DeVita-Raeburn, 2015). If we allow extreme athletes to accept risks for the sake of "flow" or the adrenaline rush (Kotler, 2014), should we not also allow thoughtful patients to accept risks for the sake of advancing medical knowledge?

Implication: we should reject the precautionary principle that is increasingly cited to justify the regulation of innovations.

5. How to cure cancer

President Richard Nixon predicted in the 1960s that cancer could be eliminated within a generation. He and others declared a "war" on cancer. In the USA after the Second World War, science and technology policy were heavily influenced by Vannevar Bush, who believed that science and technology should be funded by the government, but that decisions on what research to pursue should be left mainly to academics. Among those who wanted the government to more actively central plan was Mary Lasker, who thought that since the government had succeeded in the centrally planned Manhattan Project, it could also succeed with central planning in other areas, such as in a war on cancer (Mukherjee, 2010, pp. 118-121). Lasker and Bush were each partly right and partly wrong. Lasker was right that progress would be enhanced if researchers were primed with problems – that way they might be alert to serendipitous solutions. But she was wrong to think that you could assign them problems and "plan" the solution of those problems. Bush was right that the Manhattan Project had succeeded because the basic, hard problems had already been solved. But he was wrong to think that scientists pursuing anything that they were randomly curious about would be the best way to reach rapid progress.

The "war" analogy may be useful in arguing for a high intensity of effort and funding. But often it is taken further to suggest that the effort to cure a disease should be commanded by a centrally planned hierarchy, based on the common assumption that real war is best fought by hierarchies that centrally plan. (This common assumption has actually been disputed, in different ways, by books such as "Corps Business" (Freedman, 2000), "Start-up Nation" (Senor and Singer, 2011), and "The Generals" (Ricks, 2012)).

Using the war analogy as a guide to medical policy for curing diseases is based on the idea that a centralized hierarchy can predict the right approach, and marshal resources to achieve it, like a conquering army. But a centralized approach will only work when there is

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clarity on how to solve the problem, and all that remains is to marshal resources to execute the solution. With cancer there have been a variety of approaches with varying degrees of success, including surgical excision, radiation therapy, chemotherapy, angiogenesis, and immunotherapy. Some have predicted that cancer would not be cured by a particular medical technology, but by restricting cancer-causing agents, such as tar in cigarettes, or certain viruses. This has had some success, but many cancers have no known external agents causing them.

One assumption of all of these approaches has been that cancer is one disease that can be cured by the successful pursuit of one common best technology, although there have been major differences on just what that one common best technology is. In contrast, a current approach, one that had not been predicted by the experts from decades past, is that what we call "cancer" may turn out to be several different diseases, with different medical technologies curing different variants.

Those advances against cancer, and other diseases that have occurred, have often been the result of serendipitous events observed by alert medical outsiders (Meyers, 2007; Root-Bernstein and Root-Bernstein, 1997). If the path to breakthrough innovations in medicine is in fact predictable, then centralized policies, such as President Richard Nixon's past declaration of a "war on cancer" or President Barack Obama's establishment of a "Cancer Moonshot" are plausible (Kolata and Harris, 2016, p. A17). If, on the other hand, breakthrough innovations are not predictable, and depend on alertness to serendipitous events, then it might be wiser to follow the policy attributed to Mao to "let a thousand flowers bloom" (Meyers, 2007, p. 173).

6. Conclusions

If we take these steps, how much will we speed up cures for cancer? That is impossible to predict because we do not know what breakthrough innovations innovative medical entrepreneurs will achieve. We do know, based on past experience, that the pace and number of breakthrough innovations will increase. And we do know that Vincent DeVita, who himself is in a position to know, says that if we allowed practicing physicians to act more entrepreneurially, the immediate effect would be that thousands of those who will otherwise die of cancer in the next year will live.

Prometheus was punished for bringing fire to humanity. In reality, as in myth, the medical benefactors of humanity often have been punished. They have been ridiculed, defunded, fired, and ignored. If we unbind the entrepreneurs of medical innovation, we will be treating our benefactors more justly, and we will be allowing them to achieve even greater innovations. We may expect that they will respond by bringing us better health and longer lives.

Walt Disney died of cancer at the age of 65. Steve Jobs died of cancer at the age of 56. When the cancer killed their bodies, it also killed their dreams. Cancer is now killing your neighbor, your friend, your co-worker, or your family member. Disney and Jobs had flourished as innovative entrepreneurs because we did not bind innovative dynamism in entertainment or computers. If we had unbound innovative dynamism in medicine, cancer could have been cured in time to save Jobs, and maybe even Disney. If we unbind innovative dynamism now, it may be in time to save your neighbor, your friend, your co-worker, your family member, or even you.

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Notes

1. DeVita does not specify the gender of the radiologist.
2. Some have plausibly argued that increased patient sovereignty will increase breakthrough innovations in medicine (Bhidé, 2017, pp. 23-25; Topol, 2012, 2015).
3. The FDA slows progress in another way, by refusing to approve drugs that slow aging, on the grounds that aging is not a disease, and that the only drugs that should be approved are those that are effective against disease (Anton, 2013; Pontin, 2007, p. 3).
4. This is the title of a fascinating book by Klein (2013).
5. Gerhard Domagk who discovered one of the first antibiotics became convinced of the importance of antibiotics through observing infections kill those operated on during the First World War. (But the war's contribution to his eventual innovation was more due to the building of motivation than from the building of relevant experiences.) (Hager, 2007, pp. 18-20).

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