Medicine and Miracles: Cancer and Cures

Michael A. Birbeck and Douglas A. Lauffenburger

Michael A. Birbeck

Douglas A. Lauffenburger

Among the complicated interfaces of science and faith is the question of the relationship between human medical practice and transcendent actions of God in the treatment of disease and injury. As Christians, we pray in faith to our Creator and Lord for his providential intervention to bring about healing. At the same time, we generally trust that there can be benefit from efforts to heal by physicians, and that investment in research might usefully develop improved methods for medical practice. While there need not be conflict between these two approaches, their relationship often is not considered explicitly. Our article here offers some basic thoughts about how prayer and medicine can be concomitant partners in a Christian's perspective on one of the central health problems in contemporary society, that of cancer and its treatment. (Note: This article has its origins in a lecture given by one of the authors at the Faraday Institute [Cambridge, UK] in November 2014.)

Albert Einstein offered an insightful metaphor to describe his view of the relationship between science and religion: "Science without religion is lame; religion without science is blind."[1] While this metaphor does not resolve all the difficulties of integrating science and religion, it nevertheless affirms a cooperative relationship between these realms of approach to understanding our world and our lives. In the long-standing dialogue between science and religion, an abundance of attention has been devoted to topics in which historical and philosophical realms of approach to understanding our world and our lives meet. Among popular examples can be found the origin of the universe, the emergence of humankind, the source of knowledge, and the nature of free will.

In our own work and conversations, we two authors—one a pastor and one an academic biomedical researcher/teacher—have frequently landed on a more contemporary topic of mutual interest as scientifically interested believers of the Christian faith: the relationship between the human science endeavor of medicine and the human faith endeavor of prayer. There seems to be a much thinner body of literature delving into this area of dialogue. Our hope here is to offer several ideas from our personal viewpoints, especially as refined by valuable discussion. We will focus on a limited sector of human disease, that of cancer, for contemplating how Christians might usefully consider the integrated roles of medicine and prayer in the hope of overcoming this oft-tragic malady.

Receiving the diagnosis of cancer is a common experience for vast numbers of us. Almost everyone has a loved one who has suffered, or is suffering from, cancer of one kind or another. And we all trust in modern medical practice for the most effective possible treatment, yet at the

Michael A. Birbeck *serves as the Lead Pastor at the First Presbyterian Church, Wellsboro, Pennsylvania. He received his BS in biblical studies from Cairn University, Langhorne, Pennsylvania, and his MDiv from Gordon-Conwell Theological Seminary, South Hamilton, Massachusetts.*

Douglas A. Lauffenburger *is Ford Professor of Biological Engineering, Chemical Engineering, and Biology; and Head of the Department of Biological Engineering at the Massachusetts Institute of Technology, Cambridge, Massachusetts. He received his BS in chemical engineering from the University of Illinois and his PhD in chemical engineering from the University of Minnesota.*

same time we pray to our Lord God for a favorable outcome. The specific question we aim to address in this article is, How do we reconcile, integrate, or at least comprehend concomitant roles for human medicine and for providential intervention in the treatment of cancer patients?

It is worth explicitly noting here what we leave beyond the purview of this article. We do not aim to analyze efficacy of prayer per se in a meta-data manner, for that is a separate topic clearly meriting its own consideration. Instead, we focus on how potential efficacy of prayer in any individual instance may be understood, as it is surely appreciated as a vital aspect of Christian faith in all circumstances, including cancer treatment. That being said, it is heartening to remember an enriching insight from Reverend Martha Giltinan, who taught that "God always heals but does not always cure."[2]

Motivation: The Medicine/Faith Interface

From our perspective, modern medicine can be understood as an extension of humankind being made in the image of God. Genesis 1:27–28 says,

> So God created humankind in *his image*, in the *image of God* he created them … God blessed them, and God said to them, "Be fruitful and multiply, and fill the earth and *subdue* it; and *have dominion* over the fish of the sea and over the birds of the air and over every living thing that moves upon the earth." (NRSV, emphasis added)

A consensus on the meaning and significance of the *imago Dei* concept has not been reached. However, many agree that the concept expresses both humankind's unique relationship to God—in contrast to all the other creatures on Earth—and humankind's unique relationship to creation as a whole. Included in the manifest of imperatives God gives to humankind in Genesis 1 is the command to "subdue" the earth and to "have dominion" over what we might call a list of ancient taxonomic categories. Given the agrarian culture these words were originally communicated to, it makes sense for this message to be transmitted via concepts that made sense to that ancient culture. Biblical scholar Kenneth Mathews discusses the mandate to subjugate:

> This appointment by God gave the human family privilege but also responsibility as "caretakers" (2:15). The Hebrew love for life and emphasis on sacredness of all life assumed a linkage between righteousness and the welfare of the earth. In the agrarian economy of ancient Israel, this was best expressed in the care for its livestock.[3]

In our modernized, specialized culture, of course, caretaking as part of the *imago Dei* is different from what it was in that ancient culture. Hence, seeking to alleviate cancer and all other diseases is a type of God-honoring caretaking that we see flowing out of humankind. Modern medical practice can be seen as fulfilling God's mandates to subdue and have dominion over the created order.

A redemptive quality may also be perceived in medical practice. Not far from Douglas Lauffenburger's church in Cambridge, Massachusetts, the words of Revelation 21:4 are etched on the base of a forty-foot-tall monument that sits in the shade of overhanging tree branches in the verdant Boston Public Garden: "Neither shall there be any more pain." The monument commemorates the discovery that the inhaling of ether causes insensibility to pain; this was first proven to the world at the Massachusetts General Hospital. The monument implicitly connects the accomplishment of Dr. William Morton and Dr. John Warren, who performed the first painless surgery, using ether, in 1846, to the consummated new creation of Christ that is yet to be fully realized—as attested to in Revelation 21:4. Commonly referred to as the Ether Monument, it is also known as the Good Samaritan, because atop its capital the Good Samaritan from Jesus's well-beloved parable kneels down to care for an injured stranger. The stranger is propped up against the thigh of the Samaritan, who is holding a cloth, allegedly doused with ether, in his hand.

While we believe that ultimate redemption will occur only through Christ's second coming and the consummated new creation that will result, we also believe that Genesis 1:28 strongly affirms that our lives and work at present greatly matter. Medical researchers and practitioners strive toward the ideal of the consummated creation, when there will be no pain or illness (Rev. 21:4), by working against the disease and death that tragically grip our fallen world in this present age. A significant part of Jesus's ministry involved healing those afflicted with disease and congenital defects. In this vein, medical scientists and researchers join in Christ's earthly ministry and God's ultimate plan to redeem creation. We do this by identifying the observable and measurable laws

of nature and utilizing those findings to develop medical treatments that alleviate adverse medical conditions. This alleviation, from a theological perspective, is redemptive.

Admittedly, we aim to accomplish this God-honoring, human endeavor as imperfect and finite beings, with acknowledged dependence on him. This confession takes us to our second point. As Christians, we believe that God providentially works through prayer and calls us to pray for those who suffer from sickness. The gospel writers attest to a multitude of occasions when the prayers of Jesus and his disciples healed persons suffering from various diseases and congenital defects. A well-known scripture that urges Christians to pray for those who are sick is found toward the end of the Epistle of James.

> Are any among you sick? They should call for the elders of the church and have them pray over them, anointing them with oil in the name of the Lord. The prayer of faith will save the sick, and the Lord will raise them up … (5:14–15, NRSV)

Thus, on the one hand, the human science endeavor of medicine both fulfills the creation mandate to "subdue" and "have dominion" over the earth (Gen. 1:28), and joins with God in his ultimate plan to redeem all of creation (Rev. 21:4). Yet, on the other hand, Scripture commands us to pray for favorable outcomes for those facing adverse conditions, such as cancer. In scriptural words, we confess our humility, or possibly simply express our confusion or even our frustration: God's thoughts are not our thoughts, neither are God's ways ours (Isa. 55:8). Yet, is there a way to reconcile, integrate, or at least comprehend concomitant roles for human medicine and for providential intervention in the treatment of cancer patients? Is there a way to hold the two realms of approach together, without sacrificing one for the other?

The words of the sixteenth-century theologian John Calvin give some insight into this question.

> It is very absurd … to dissuade men from prayer, by pretending the Divine Providence, which is always watching over the government of the universe is in vain importuned by our supplications, when, on the contrary, the Lord himself declares, that he is "nigh unto all that call upon him, to all that call upon him in truth" (Ps. 145:18). No better is the frivolous allegation of others, that it is superfluous to pray for things which the Lord is ready of his own accord to bestow; since it is his pleasure that those very things which flow from his spontaneous liberality should be acknowledged as conceded to our prayers.[4]

While medical scientists utilize observation of natural laws in their work to overcome adverse medical conditions, we believe that the God who established those laws can work through them with unparalleled power because he is the originator of the natural world and transcendent over it. As Calvin notes, God displays, through our prayers, his "spontaneous liberality."

Background: Cancer Biology and Treatment

Although our interest in learning how to integrate prayer and medicine should apply broadly across the entire range of human health problems, we will focus on cancer as a central example. It is unfortunately a highly prevalent and consequential disease; data from the American Cancer Society shows that, in the United States in this current decade, there are typically more than 1.5 million new cases each year and more than 500,000 deaths—nearly 25% of the fatalities in this nation.[5] It is important to note that cancer is not a monolithic disease, but rather it exhibits tremendous diversity with respect to type and underlying causes. Accordingly, there is a wide range of prospects for outcome, depending on the type of cancer. For instance, average 5-year survival rates for patients diagnosed with breast or prostate cancers are relatively more favorable, when compared to those for patients diagnosed with lung, pancreatic, ovarian, or brain cancers. And within each cancer type, outcome prospects can vary significantly among different subtypes. These subtypes are increasingly identified with disparate genetic characteristics, and their treatment approaches are similarly influenced by these specific associated molecular properties.

The critical role of specific genetic characteristics is a key feature of cancer, in that it is well established that mutations in chromosomal DNA are at the root of the dysregulation of cell functions that yield pathological behaviors of tumor cells. The "hallmarks" of cancer are generally agreed upon by bioscientists, and include a number of aberrant cell behaviors leading to tumor growth and spread: cell proliferation in contexts where it should not occur; resistance to

cell death in contexts where it should occur; migration of cells into contexts where they should not be; induction of growth-supporting contexts where they otherwise would not be extant; suppression of death-promoting immune responses where they otherwise would defend effectively.[6] Each of these aberrant behaviors arises from chromosomal mutations that result in operations of intracellular or extracellular protein gene products that are different from what they ought to be under healthy physiological conditions. The number of genetic mutations present in a given tumor may cover a wide range, from as few as a dozen in leukemia to as many as thousands in colon cancer. How the multiple mutations work together to cause aberrant cell behaviors is a vigorous research area in cancer biology, and how to ascertain the most-effective therapeutics corresponding to the particular set of mutations found in any given tumor is at the forefront of cancer treatment—representing the aspiration for "personalized medicine," or "precision medicine," in which molecular information characteristic of a certain patient helps determine treatment plans.

Turning to treatment, we noted earlier that prospects for outcomes may be viewed as "more favorable" or "less favorable," depending on the tumor type (as well as on the therapeutic approach). These prospects are generally estimated in terms of probabilities: for instance, the 5-year survival probability is based on prior clinical data for previous patients possessing at least categorically similar tumor types and who were provided with fairly comparable treatments. One might ask what the roots of this uncertain nature of outcome prospects are. We can offer four categories of issues underlying uncertainty in cancer patient treatment outcome prospects:

1. "Discovery"—Outcome uncertainty may derive either from lack of scientific knowledge concerning key currently unknown biological mechanisms involved in how tumors respond to various treatments, or from lack of technological knowledge about how to treat them more effectively. For instance, if a patient's tumor is characterized by dozens of genetic mutations, further complicated by heterogeneous distribution of those mutations within the primary tumor or across multiple metastatic secondary tumors, bioscience does not currently have complete information as to how these mutations integrate to yield aberrant cell behaviors nor what must be done therapeutically to ameliorate this aberrance.
2. "Wisdom"—Outcome uncertainty may derive from inadequate understanding by the physician/caregiver about the treatments available for the patient. Although not always, there often exist multiple alternative therapeutic options for a given type of cancer, and at the present time, the rules for selecting the best option are not generally well established. While key tumor characteristics are being increasingly identified for many types of cancer, and these discoveries have accelerated over the past decade-plus with the advent of genomic and proteomic technologies in clinical research, firm associations between these characteristics and effective treatments remain elusive.
3. "Accessibility"—Outcome uncertainty may derive from questioning whether the physician/caregiver can feasibly determine the most effective treatment. Whether due to limitations related to capabilities, cost, policy, or location, a given patient may not be in a position to have key tumor characteristics analyzed that may be decisive concerning the selection of the best treatment.
4. "Randomness"—Outcome uncertainty may derive from known biological mechanisms, in relation to available treatments, that respond in an unpredictable manner to a selected treatment. That is, even if/when we gain complete information concerning patient tumor mutation distribution along with therapeutics that perfectly correspond to address that particular genomic status (point 1, Discovery, above), we can imagine that the response of the tumor cells might nonetheless be stochastic and thus unpredictable in any specific case, even if probabilistic expectations can be quantified.

The first category must be considered largely a matter of time and human endeavor, for the pace of biomedical knowledge accumulation continues to become ever swifter. In the decades to come, information helpful to producing more and more effective treatments can be expected to grow inexorably. Nonetheless, the history of biological science is such that surprising new mechanisms involved in the processes of human pathophysiology arise regularly, and there is little reason to believe that we are anywhere near completing comprehension of tumor

cell dysregulation and how to decisively and safely overcome it in general or specific terms. The second and third categories derive mainly from human cognitive abilities and human cultural contexts, thus residing at a relatively ambiguous level with respect to expectations. From a scientific perspective, the fourth category is of greatest interest because it connects a fundamental phenomenological feature of our natural world to the practical understanding of medicine. Thus it is deserving of greater elaboration here in our discussion.

A Fundamental Principle: Stochasticity in Molecular Processes

In physics, the phenomenon of stochasticity is well known; one definition is that a stochastic process involves at least some effects operating randomly, such that the observed outcome of any individual instantiation cannot be predicted other than as a representative from a probabilistic distribution of numerous instantiations. We note that a stochastic process is not the same as a chaotic process. In the latter, if initial conditions were precisely known the outcome of an observation could be predicted. In the former, the outcome remains uncertain even with precise knowledge concerning the initial conditions.

An example commonly used for illustration purposes is that of radioactive decay of an elemental atomic particle. For instance, a Carbon-14 atom possesses a nucleus of 6 protons and 8 neutrons, but when one of the neutrons transitions to become a proton (via "beta particle decay") a Nitrogen-14 atom is produced. Observations of large numbers of Carbon-14 atoms produce a firm scientific law that the decay "half-time" is 5,730 years. Thus, for any particular individual Carbon-14 atom, there is a probabilistic expectation of approximately 10^{-4} that within the next year it will decay to a Nitrogen-14 atom—but we cannot predict with certainty whether it will or not. If we follow a large number of atoms, the time at which they decay will form a distribution characterized by some decaying relatively swiftly and others decaying relatively slowly, with a tiny proportion decaying exceptionally swiftly and another tiny proportion decaying exceptionally slowly—but averaged all together producing the established half-time law.

Another example is the diffusive motion of an object, due to forces acting on it. Observations of large numbers of objects of any given size produce a firm scientific law for the expectation of how far a distance half the objects will have moved from their original locations within a specified time-period—but, for any particular individual among these objects, we cannot predict with certainty how far it will have moved in that period. It is important to emphasize that, with respect to both of these simple examples and others, and for discussion to ensue later in this article, that these unpredictable individual entity events transpire within an associated scientific law that reliably characterizes the average behavior of a very large number of entities and events. Nonetheless, a behavior influenced by a fairly small number of events can be observed as a low-probability outcome yielded by those events happening in a sufficiently skewed sampling (e.g., faster vs. slower) from within the large-number distribution.

The question then is how this general principle of stochasticity might be relevant to cancer treatment. It is well appreciated that the key cell behaviors involved in the established hallmarks of cancer (e.g., proliferation, apoptotic death, migration) appear random across individual cells within a population. Some cells might divide into two cells sooner or later than other cells under the same conditions, while other cells in that population will not divide at all. Similarly, some cells within a population might be killed by a drug sooner than or later than other cells, whereas others are not killed in the very same treatment. Tumor spread via invasive migration and metastasis is likewise random, with a small proportion of cells departing the primary tissue location, and subsequently only a fraction of these surviving in a new tissue site elsewhere in the body.

Contemporary research in all of these areas of cell biology not only recognizes the phenomenon of stochasticity in the respective cell behaviors, but is also giving increasing attention to its study in normal cell function as well as in cancer-associated dysregulated cell function. Indeed, investigators have been able to elucidate explanations for how disparities in behavioral responses among cells in a population may yield benefit to robust organism physiological function.[7]

As one highly germane example, the behavioral process known as apoptosis, or programmed cell death, has been subject to numerous experimental studies over the past few decades. A number of reagents,

both natural (factors produced in an inflammation, for instance) and synthetic (such as cancer chemotherapeutic drugs), can induce cell death via enzymatic degradation of cellular components crucial to maintaining viability; these components include chromosomal DNA and structural proteins. These degradative enzymes are activated by biochemical and biophysical reaction pathways within the cell, elicited by the stimulatory reagents. Whether a given cell undergoes the death process, or instead recovers from it by means of mitigative biochemical and biophysical mechanisms, is governed by this myriad of actors and actions with respect to their amounts and rates. Using any of a battery of experimental methods, following a given treatment condition, some fraction of a treated cell population can be observed to undergo apoptosis whereas the remaining fraction is not.[8] Moreover, even for the subpopulation that does die, the timing at which the death execution transpires for any particular cell can vary widely across a time period of many hours following treatment.

In the same manner as the radioactive decay and particle diffusion processes described above, average apoptotic response properties can be quantified for the population; thus, this cell biological phenomenon reliably follows a scientific law derived from observation. Similarly, an observer cannot predict for any individual cell whether, or when, that cell might die in response to the treatment. The reader should readily appreciate the relevance of this randomness to the uncertainty concerning the outcome of cancer therapy used to destroy tumor cells, and then multiply this in additional dimensions for each of the other cancer hallmark cell processes as they are comparably stochastic.[9]

What is the source of this randomness in biological cell behaviors? A partial answer is that there is heterogeneity among the cells within a tumor population (or, for that matter, within any population of normal, healthy cells), as all studies of cellular protein levels consistently demonstrate. This heterogeneity can generally be characterized by cell-to-cell variation in the numbers of any of the myriad proteins governing cell behavior, such as proliferation or death or migration. This number variation may arise from mutations present in some cells but not in others. Even if the genome sequence is absolutely identical across all cells in the population, the mechanistic processes of expressing those genes into their corresponding proteins can operate in stochastic fashion, with some expression processes taking place faster in certain cells than in others. And, of course, the presence or absence of any particular genetic mutation among cells in a population is stochastic, due to the nature of the molecular processes giving rise to changes in any given DNA site in a chromosome. Not surprisingly, then, exhibition or acquisition of resistance to an anti-cancer drug is similarly stochastic, whether due to gene expression heterogeneities and/or gene mutation heterogeneities—both of which are subject to the underlying mechanistic process of stochasticity.

Accordingly, in our view, it is inescapable that the prospective outcome of therapeutic treatment of cancer will ever remain unpredictable for any given patient, regardless of how far biomedical science continues to progress in knowledge about cancer biology and in capabilities for therapeutic approaches. It is not a matter of incomplete knowledge on the part of human beings, but instead a matter of the fundamental nature of our natural world.

Analysis: Transcendence and Chance

We have already identified four categories of issues underlying uncertainty in cancer patient treatment outcome prospects: discovery, wisdom, access, and randomness. We want to see a favorable outcome for loved ones who suffer from cancer. It is easy enough to see how Christians can pray for such an outcome in regard to the first three categories:

1. "Discovery"—While this category likely will not help a loved one diagnosed with cancer today, we can certainly pray that medical and scientific discovery would continue to advance and new and better treatments emerge for future cancer patients.
2. "Wisdom"—We can recall times when we found ourselves in a hospital room praying for wisdom to guide our loved one, and for the physician and medical team to make wise decisions concerning medical treatment, utilizing the best resources available.
3. "Accessibility"—We can pray both on a personal and societal level that access to the very best cancer treatment would be made available to those suffering from cancer.

This brings us to our fourth category, randomness, which we will now discuss in greater depth. Louis Berkhof, in *Systematic Theology*, writes,

> Providence may be defined as that continued exercise of the divine energy whereby the Creator preserves all His creatures, is operative in all that comes to pass in the world, and directs all things to their appointed end.[10]

The Laplacian determinism of enlightenment thought aided in strengthening a view that there must be a sharp division within God's providence, specifically between what has been called the natural and the supernatural. God's providence sustaining the natural world through natural law was seen as categorically different from God's special providence that violated, suspended, or otherwise manipulated those laws.

Advances in quantum physics, particularly the discovery of randomness or stochastic mechanisms, allowed for a flexible universe with a built-in potentiality allowing for the probability of anomalous divine action. William Pollard was among the first to fully articulate this view in his *Chance and Providence*, published in 1958.[11] John Polkinghorne in *Science and Providence* expressed how this view of the natural world accommodated providence:

> … recent advances in science point to an openness and flexibility within physical process—not only at the microscopic level of quantum theory but also at the macroscopic level of large systems—that began to offer hope of some understanding of how both we ourselves, and also God, can exercise our wills in the physical world.[12]

Since there is no sharp division within God's providence when providence is reconciled with this more accurate understanding of the natural world, this is not a God of the gaps theory; there are no gaps. God is active within the totality of the natural world. Speaking of quantum events, Polkinghorne went on to say, "Individual events are characterized by a radical randomness and are even spoken of as being 'uncaused.'"[13] Although beyond the scope of this article, this uncausedness inherent to the natural world would conclude that even an event as highly unlikely as the resurrection would have a very low, but non-zero probability rate.[14]

We contend, with sound scientific evidence, that stochasticity is part of the fundamental nature of our natural world. Stochasticity can be seen as a locus for God's providence where we as Christians can pray for God's influence. Taking stochasticity and providence as givens, it is on the level of stochastic molecular cellular processes that we see an area ripe for discussion about Christian prayer.

It has long been thought that chance and randomness are antithetical to purpose, thus invalidating providence. However, this need not be the case. John Hall analyzed a variety of stochastic processes in several diverse systems, including biological evolution, and demonstrated that these stochastic processes serve a global purpose within the global systems in which they occur.[15] "Local" or "subsidiary" purposes within these systems may or may not be served by any of the vast set of possible outcome prospects in the given stochastic process, but the global purpose is. Because stochasticity serves the global purpose of the global system, Hall contends that stochasticity is consistent with a Christian understanding of providence. This agrees with David Wilcox's conclusion, after he explored the unique bio-evolutionary neurological development of the human brain:

> The evidence of "random" events does not exclude providence—in fact, the meaning can be viewed as quite the opposite … However, such perception requires the acceptance of the specifying assumption that God governs natural events (the doctrine of providence) … Consequently, it is rational to hold this view, but it is not necessarily statistically demonstrable to those who cannot perceive it.[16]

Hall identifies two ways in which "God can be thought of as acting" in regard to providence:

> First, he achieves his general purposes by his uniform divine action in sustaining its orderly, coherent processes. Second, he achieves particular purposes through his special divine action.[17]

This harmonizes well with the classical distinction of general providence and special providences. General providence refers to God's guidance of the whole of creation. Special providences are "special combinations in order of events, as in the answer of prayer, in deliverance out of trouble, and in all instances in which grace and help come in critical circumstances."[18] These are not two different types of providence, but two features of providence as a whole.

Hall goes on to say, "The latter includes anomalous actions that appear discontinuous with the

more prevalent orderly processes of the creation."[19] Although none of us can claim to know the thoughts of God, we can imagine that stochastic processes on a molecular level provide a particularly vital locus—although certainly not the only one—for the type of anomalous action that is often referred to as miracle, divine intervention, supernatural occurrence, et cetera.

Peculiarly, contemporary usage of these terms too often implies that God is less engaged when sustaining the universe than when effecting a "miracle." Pollard said,

> … the majority of the miracles of healing the physico-chemical, physiological, or psychological changes taking place in the body of the person healed could all have well occurred individually in full conformance with the scientific laws governing such processes. The healing resulted from the extreme improbable circumstance that they all occurred together in just the right way to produce the final result. No objective application of known medical or psychotherapeutic could have brought on the particular combination of process required for the healing, but this does not mean that any one of them violated any of the laws known to medicine or psychotherapy.[20]

As interventions at the micro level of stochastic mechanisms transpire, nonetheless the scientific laws derived from observations of myriad events at that level can remain undisturbed. In the case of medical cancer treatments, tumor cells may respond relatively favorably on the molecular level to anti-cancer drugs, resulting in a highly desired yet low- (but non-zero) probability outcome of tumor eradication.

The understanding of miracle we present above may be viewed in context of the common, secular usage of the term. In a newsletter from the highly regarded Dana-Farber Cancer Institute, we happened to come across the following quotes regarding two different cancer patients. Regarding patient A, it read, "In early 2013, she had exhausted standard treatment. What happened next some might call a *miracle*. Much to our surprise, after about six months, her tumor had almost completely disappeared."[21] Regarding patient B, it read, "She started feeling better very quickly, and we could see her tumor mass shrink. It was amazing and must have seemed like a *miracle* after everything she had gone through."[22] In the secular world, a "miracle" tends to mean an outcome that is exceedingly unlikely—yet nevertheless hoped for and gratefully received.

We opened this article by inquiring about the concomitant roles of human medicine and of providential intervention in the treatment of cancer patients. We have decided not only that stochasticity is consistent with providence, but also that stochastic mechanisms on the molecular level are likely to be a vital locus where we might expect God to act through anomalous action. We might conjecture that God works through providential intervention or special providence, of which prayer is a powerful feature, to produce anomalous activity, or miracles, or what Calvin calls "spontaneous liberality," to influence stochastic molecular mechanisms that affect the aberrant behavior of cancer cells and their potentially curative responses to therapeutic treatments. It is not so much that God breaks into nature; he has always been there. We might speak of an intervention, a miracle, or a supernatural event. But, from God's vantage point, it always was, always has been, and always will be. Just as we use the human science endeavor of medicine to aim toward favorable outcomes in medical cancer treatment, so also we can use the human faith endeavor of prayer to aim toward favorable outcomes in conjunction with anti-cancer drugs and treatments (or even outside of anti-cancer drugs and treatment, when the prognosis is dire and further medical interventions aimed toward a cure are deemed futile by a medical professional). Both of these endeavors are guided by providence and features of providence in which God invites us, the human lot, to join him.

Conclusions

We have contended that regardless of how far biomedical science continues to progress, the prospective outcome of therapeutic treatment of cancer will ever remain unpredictable for any given patient. Randomness or stochastic mechanisms are among the issues underlying uncertainty in cancer patient treatment outcome prospects. We have also argued that randomness can be perceived as an aspect of divine providence. Finally, we have posited that God uses the human faith endeavor of prayer as a feature in his providential guidance. Rightly as the human science endeavor of medicine can be utilized toward favorable outcomes in medical cancer treatment, so can the human faith endeavor of prayer be utilized

toward favorable outcomes in those treatments, particularly in regard to asking for God's influence over stochastic molecular mechanisms. ✠

Notes

[1]Albert Einstein, *Ideas and Opinions* (New York: Crown, 1954), 46.
[2]Linda L. Barnes and Susan S. Sered, *Religion and Healing in America* (New York: Oxford University Press, 2005), 95.
[3]Kenneth Mathews, *Genesis 1–11: An Exegetical and Theological Exposition of Holy Scripture,* vol. 1A of The New American Commentary (Nashville, TN: B&H Publishing, 1996), 174–75.
[4]John Calvin, *Institutes of the Christian Religion,* trans. Henry Beveridge (Edinburgh, Scotland: Calvin Translation Society, 1845), III.20.3.
[5]American Cancer Society, Cancer Facts & Figures 2016, http://www.cancer.org/research/cancerfactsstatistics/cancerfactsfigures2016/.
[6]D. Hanahan and R. A. Weinberg, "Hallmarks of Cancer: The Next Generation," *Cell* 144, no. 5 (2011): 646.
[7]P. Paszek, S. Ryan, L. Ashall, K. Sillitoe, C. V. Harper, D. G. Spiller, D. A. Rand, and M. R. H. White, "Population Robustness Arising from Cellular Heterogeneity," *Proceedings of the National Academy of Sciences USA* 107, no. 25 (2010): 11644.
[8]J. G. Albeck, J. M. Burke, B. B. Aldridge, M. Zhang, D. A. Lauffenburger, and P. K. Sorger, "Quantitative Analysis of Pathways Controlling Extrinsic Apoptosis in Single Cells," *Molecular Cell* 30, no. 1 (2008): 11.
[9]M. Niepel, S. L. Spencer, and P. K. Sorger, "Non-genetic Cell-to-Cell Variability and the Consequences for Pharmacology," *Current Opinion in Chemical Biology* 13, no. 5 (2009): 556.
[10]L. Berkhof, *Systematic Theology,* rev. ed. (Grand Rapids, MI: Eerdmans, 1996), 166.
[11]William G. Pollard, *Chance and Providence: God's Action in a World Governed by Scientific Law* (New York: Charles Scribner's Sons, 1958), 115.
[12]John C. Polkinghorne, *Science and Providence: God's Interaction with the World* (West Conshohocken, PA: Templeton Foundation Press, 2005), 17.
[13]Ibid., 33.
[14]For a discussion of the resurrection, see John C. Polkinghorne, *The Way the World Is: The Christian Perspective of a Scientist* (London, UK: Triangle, 1983).
[15]John W. Hall, "Chance for a Purpose," *Perspectives on Science and Christian Faith* 61, no. 1 (2009): 3–11.
[16]D. L. Wilcox, "Our Genetic Prehistory: Did Genes Make Us Human?," *Perspectives on Science and Christian Faith* 66, no. 2 (2014): 83.
[17]Hall, "Chance for a Purpose," 10.
[18]Berkhof, *Systematic Theology*, 168.
[19]Hall, "Chance for a Purpose," 10.
[20]Pollard, *Chance and Providence,* 115.
[21]R. Saltus, "Exceptional Responders: Finding Genetic Causes of Dramatic Cancer Drug Responses Could Have Broad Benefits," *Paths of Progress,* Dana-Farber Cancer Institute (Fall/Winter 2014): 26.
[22]Ibid.

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Addiction: Diseased Brain, Divided Will, or Restless Heart?

Judith Toronchuk (PhD, McGill) teaches physiological psychology at Trinity Western University. She has published on affective neuronal selection and on both the phylogeny and ontogeny of affective social behavior.

In her essay, "Addiction: Diseased Brain, Divided Will, or Restless Heart?," on the ASA and CSCA websites, she describes the latest developments and challenges in the science of addiction that confront our society and Christian faith. This focus calls for our attention to the opioid, marijuana, nicotine, gambling, pornography, and alcohol addictions staggering our society.

Toronchuk's essay is intended as an invitation. Readers are encouraged to take up one of the insights or questions, or maybe a related one that was not mentioned, and draft an article (typically about 5,000–8,000 words) that contributes to the conversation. These can be sent to her at toronchu@twu.ca.

Toronchuk will send the best essays on to peer review, and then we will select from those for publication in an addiction theme issue of *Perspectives on Science and Christian Faith*.

The lead editorial in the December 2013 issue of *PSCF* outlines what the journal looks for in article contributions.

For best consideration for inclusion in the theme issue, manuscripts should be received electronically before 31 October 2017.

Looking forward to your contributions,

James C. Peterson, *editor-in-chief*