The Practice *of* Medicine *is in the* Interactions

A Day with Robert A. Lindberg, M.D.

by

Arvind Singhal[i]

On the second floor of a plain-looking office building on 1500 Post Road in Darien, Connecticut, an unremarkable door announces the medical practice of Robert A. Lindberg, M.D. In the small reception area, a courteous employee sitting behind the counter extends a greeting as she signs a patient in. Soon, a patient — a Mr. Rodriguez, or a Mrs. Crawford – is ushered from the reception area, through a door, and into a long corridor lined with several examining rooms.

To any observer, Dr. Robert (Bob) Lindberg's practice looks like any other internal medicine practice in the United States, complete with rows and rows of color-coded patient files tightly packed together, competing for every millimeter of shelf space. Glossy anatomical charts hang on the walls of examination rooms which house the usual — a reclining, retractable examination bed, a small doctor's table on the side, a couple of chairs, a stool on wheels, a mirror, a wall hook for hanging a coat, an anti-bacterial soap dispenser, a wash basin, and two trash disposers — one for regular trash; the other for used syringes, latex gloves, and the like.

When one spends a full day with Dr. Lindberg (or Bob), including observing his patient interactions, as I had the opportunity to do on a warm summer day, one realizes – rather quickly – that

Dr. Lindberg's medical practice is qualitatively quite different than other internal medicine practices. In what way, one might ask?

The simple answer: It is inspired by principles of complexity science.

Books, Biology, and Medicine

The third child in a family of five children, Bob Lindberg, from his early years was in love with books. His eldest brother, Curt, remembers Bob "as a serious student, upstairs in the bunk bed, reading books." "I read history, biography, literature, science….everything," noted Bob.

After earning a BA degree in Biology from Dartmouth, Bob completed his MD from New York Medical College, and then enrolled for a surgical internship at the Medical College of Virginia. "My dream, at that time, was to be an orthopedic surgeon," noted Bob. However, barely a year into the surgical internship Bob moved to Jasper, Florida to serve as a primary care physician as part of the National Health Service. In Jasper, Bob realized that "it was intellectually more challenging to be a generalist [than to be a specialist], and also that the practice of internal medicine allowed opportunities to develop long-term relationships with patients." So, after a two-year stint in Jasper, Bob underwent a three-year residency program in Internal Medicine at The Stamford Hospital in Connecticut. Since 1986, Bob has been in private medical practice in Darien, CT. Additionally, he holds clinical teaching appointments at Columbia University and the New York Medical College, and serves as a Member of the Science Advisory Board of the Plexus Institute.

One notes on Bob's vita that, since 2002, he has been listed in *Best Doctors in America* and, since 2003, in *Guide to Americas Top Physicians.*

A Doctor with Relationships

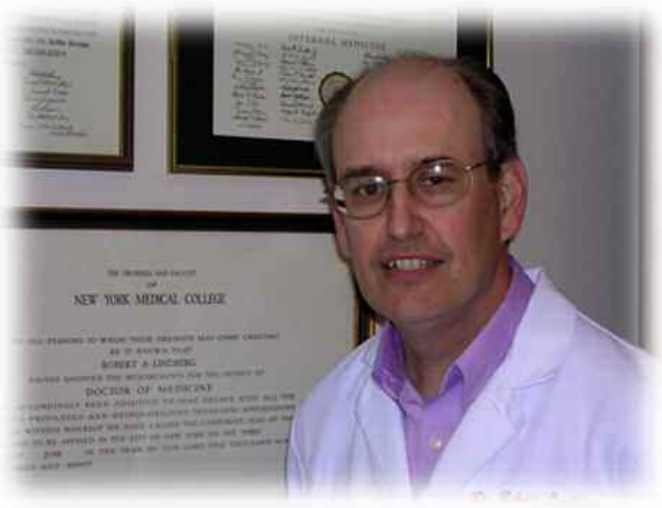
While Bob sits upright at his desk studying a patient file, his white doctor's coat bathed in the sun's summer rays as they seep through the window, I ask: "How has complexity science inspired your medical practice?"

In a measured and assured tone, he replies: "Complexity science has taught me that the practice of medicine is in the interactions."

Further probing reveals that complexity science has provided Bob not just a new holistic way to look at disease as a function of interactions within a patient's body, but, more importantly it has influenced the way Bob interacts with his patients and co-workers. In the past five to six years, since Bob consciously adopted principles of complexity science in his practice, he connects with his patients in a different way, noting "I am no longer just the doctor with prescriptions; I strive to be the doctor with relationships."

"How do you approach your patient interactions differently," I ask.

Bob replies: "The primary purpose of the patient interaction is to build a relationship. And I never miss an opportunity to do so."



Dr. Bob Lindberg is committed to a different kind of medical practice that emphasizes interractions.

Bob notes that now he gives his patients an opportunity to tell their stories. Previously, before he came in contact with complexity science, his orientation toward his patients was: "I know your story. I know what is wrong with you. I would have them shut up."

Now things are different. "I let them tell their stories. And, I listen empathically. There are therapeutic effects of telling. People, in part, heal themselves by the telling."

Verbal therapy, I mused.

"Is it possible for me to observe some of your patient interactions?" I ask.

"Sure," he replies.

Over the next six to seven hours, I observe Bob's interactions with ten patients, seeking permission from each one to sit in on the conversation. Bob's interactions seem non-rushed, averaging 15 to 20 minutes per patient.

"Do you have anything more to tell me?" After what seemed like a long pause, the patient asked: "Doctor, could I be depressed?"

Before we go into the examination room, Bob tells me that the patient we will see is a 60-something woman, who is concerned about congestion and chest pain. Bob has never seen this woman before. "A new patient," he notes.

"Hi, I am Dr. Lindberg. You look worried." Bob extends his hand.

"Yes, things are not going right. Where do I begin, doctor? There is so much going on. I have this congestion in my chest and some pain….It's been a couple of weeks….Could something be wrong with my heart?"

As Bob listens to her heart and lungs, checks her blood pressure, he learns that she is a real estate agent.

"Sounds like you lead a very fast-paced life," Bob notes empathically.

"Oh, yes, doctor. I have this house to close, and this house to show, and..." she goes on for several minutes. She ends her response by saying, "...and my 85-year old mother is sick, and lives alone, and I am her only care-giver."

Bob listens patiently. "Do you feel that you do not have much time to take care of yourself?" he asks.

"Yes, I have no time to take care of myself," she begins. "My mother-in-law died three months ago…..my uncle, who was my god father, died six weeks ago….. And my daughter has just had a baby…..I've been running from pillar to post," she sighs. "And, then, doctor, last week, my mother fell and fractured her pelvis."

"There is a lot going on," notes Bob.

"Yes, doctor. What do I do? You know…. I am the sandwich generation." She talked at length about being caught between the obligations of caring for her daughter (with a newborn) and her old mother (with a fractured pelvis). Further, she added: "…and my mother has a geriatric dog…she is very fond of it… but he urinates all over the place. It is just awful… awful… awful."

While Bob writes her a prescription for the chest congestion, she notes:

"Doctor, I am feeling better already. Thank you for listening."

Back in his office, Bob tells me "I hear such stories every day. For this patient, the comment about her sick mother and her hectic lifestyle was a side, off-the-cuff remark, but my ears picked that up. After examining her, I concluded that her body system was under stress from her being so overextended. So, the therapy was twofold: First, allowing her to tell her story. Second, helping her

see that there was a direct connection between her emotional duress and the chest pain."

"How would you have treated her seven or eight years ago?," I asked.

"Eight years ago, I might have sent her for a stress test. Or I would have been dismissive – that it was nothing really. I would have been the doctor with prescriptions, trying hard to fix her broken part. Today, the real therapy was allowing her to tell her story, validate that it was understandable how she was feeling, and to let her go home feeling relieved."

As the day moves on, I see Bob with other patients. We break for lunch and then I see some more patient interactions. In between, Bob tells me more about how his practice was some years ago, and how it is different today.

Out With the Manual, In with Simple Rules

Until 2000, Bob tells me that his practice was run by a hospital, with which Bob had made a contractual agreement. Bob would see patients, and the hospital administered the paperwork and coordinated patient admissions. The hospital put an office manager in Bob's clinic, a "real task master," Bob noted. There was also a thick employee manual.

"We went through a lot of people in those two to three years. A lot of turnover," noted Bob. We were making money, but it was not a nice place to be." However, after being exposed to complexity science thinking, Bob let the office manager go.

"We threw out the thick employee manual and instituted three simple rules: First, treat the patient as we like to be treated. Second, make more money then we spend. And third, there are no other rules."

"Was this a period of flux, of anxiety," I ask.

"Yes, certainly," noted Bob. "It was a big leap in terms of how to manage one's practice….a definite gamble."

Since 2000, Bob's medical practice has no rules about lunch hours, how to answer the phone, or about when one becomes eligible for vacations. More free-flowing conversations between Bob and his staff have boosted trust and mutual respect, eliminating employee turnover. Bob notes: "Now, we don't have any titles here, no hierarchy. Everybody does everything, except, of course, things which need a license."

The medical practice is also financially healthy. Barbara Richardson, an employee, who commutes every day from the Bronx in New York (about 50 miles each way) noted over lunch: "I love coming to work."

Patients notice that things are different. They routinely tell Bob how nice the staff is, and how well the office is well-run.

"The office runs itself," Bob chuckles.

The Interaction Has Changed[ii]

Notwithstanding the increased crush of demands on physicians by HMOs, rising insurance costs, and malpractice claims, Bob notes: "I am in love with the practice of medicine again."

Fundamentally, Bob's perspective on practicing medicine has changed: "Previously I was programmed to direct, prescribe, fix a broken part." Now Bob worries less about his lack of control over things. "I constantly think about how I can hand over the control to my patients. Now I focus more on how to make my patients more resilient."

As I observe Bob's interactions with his patients, and as we talk about them, additional insights emerge about what's different about Bob's complexity-inspired practice.

1. **Bob creates a comfortable space for interaction in the examination room.** When a new patient, with a scarlet rash near his eyelids, tells Bob that he has a four-month old baby, and has just moved to Darien from New York City, Bob banters with him

about raising children in the City versus the suburbs. With the patient at ease, Bob gently says: "Welcome to the neighborhood." Using thoughtful quips, including banter, Bob creates a comfortable space for his patients

2. **Bob listens carefully to the patients stories and remembers the details**. Bob charts snippets from the patient's stories in their medical records — along with their EKGs, X-rays, and blood reports. "Now I chart more relational and conversational pointers," he noted, such as "I love to dance." "I play golf." "I am going to Machu Pichu." And, "my flower beds are blooming."

   As I observed, he asked a woman patient about her summer trip to France, eliciting a response: "Oh, doctor, you have a good memory." To an 80-something couple, he asked how their recent cruise was to the Bahamas, and if the wheelchair worked well on the ship. To a young mother, he said: "You have a birthday coming up. Do you have plans?" To a 70-something woman, who had undergone knee replacement surgery and seemed concerned about her scars, Bob was reassuring: "The surgery was a good decision, for I know you love to dance." To a male machinist, a patient of many years, Bob asked if he had gotten his pictures developed from the family trip to the Grand Canyon.

   By charting and recalling events that are salient to his patients, Bob lightens the air, reducing the hierarchical distance between doctor and patient.

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3. **Bob consciously opens conversations with patients, as opposed to closing them with an opinion, a judgment, or a prescription**. As I observed, Bob, in talking with a new patient from Colombia, learned that she was self-medicating to treat a bladder infection. He listened empathically, acknowledging the low costs of prescription medications in Colombia. When the patient asked if she was "doing the right thing," Bob avoided the urge to pass a judgment. Instead he smiled and said: "Do you have anything more to tell me?" After what seemed like a long pause, she asked: "Doctor could I be depressed?"

   Because he gives them air time, Bob's patients feel comfortable revealing what is bothering them.

4. **Bob gives his patients "permission" to do what they love to do**. Many of Bob's patients complain of fatigue, stress, and constant tiredness. "Many of my patients believe that they have to keep going — without rest — from morning to night. They feel guilty about giving themselves a break, or indulging themselves even if once in a while." Bob consciously gives his patients "permission" for an afternoon nap. To an overworked executive, constantly on the road, he asked: "How can I get you on a golf course?" The patients, Bob notes, are more likely to follow such suggestions if they are prescribed by the doctor.

5. **Bob gives less directives and more feedback to his patients**. Bob is now increasingly comfortable with the notion that there are multiple ways in which a patient's health goals can be met. Sometimes his role is that of a straight "fixer," especially when someone comes in with a broken ankle, a sprained wrist, or a gaping wound. However, many a time, there is no clear broken part to fix. In those cases, Bob provides medical advice in the form of feedback and appropriate information so that patients feel empowered to work out what is best for them in their context, with their family members. Previously, Bob noted that he would even use implied threats such as "If you keep smoking, you will die of lung cancer." Now, he is more likely to say: "How can I help you cut down?"

The formal protocol associated with a traditional medical exam as interrogative – one that cuts off the patient when they go off into a tangent. However, tangents yield important insights for Dr. Lindberg.

6. **Bob uses more analogies, metaphors, and stories to convey key ideas to his patients.** To the extent possible, Bob simplifies the medical jargon to make his thoughts more accessible to his patients. For instance, he advocates a hunter-gatherer routine of diet and exercise for his patients (see Box). His patients, he notes, compliment him for giving them the one-page hunter-gatherer Simple Rules for Living handout. Bob's patients find the analogies, metaphors, and stories not only easy to understand, but also easy to remember and act upon. Many have told Bob that they have this hunter-gatherer (or "caveman") handout magnetically pinned on their refrigerators.

7. **Bob consciously engages in non-linear conversations**[iii]. Bob believes that when a doctor and a patient interact, it should result in a creative conversation – one that illuminates what otherwise is obscure. Over years of practice, Bob found the formal protocol associated with a traditional medical exam was interrogative – one that cuts off the patient when they go off into a tangent. However, tangents yield important insights for Bob.

To stimulate a creative conversation with a patient, Bob often says whatever first pops into his mind. For instance, "You look worried," or "What are you worried about," or "I like that red hat," or "That's a fancy digital organizer." And strangely enough, he has found, it encourages most patients to also voice whatever is on their mind. Interestingly, Bob's experience tells him that this non-linear conversation approach is more efficient than the deductive-analytic medical interrogation: "We cut to the chase more quickly. Free interchange of ideas leads to more rapid resolution of what is really at the bottom of that visit, the reason they are here."

"Things emerge in non-linear conversations," Bob notes. "There are surprises all the time."

8. **Bob consciously engages in more self-disclosure.** Often disclosure begets disclosure, and, as appropriate, Bob is not shy of sharing personal slices of life with his patients. "In moderation," he quickly adds. To a mother of three children, who talked of fatigue and stress, he recommended that she find a way to spend time in her cabin on the lake. He then talked about his wife Pam's cabin on the lake. With another patient, who talked about his daughter's graduation from high school, Bob disclosed

that his daughter was headed to an arts school in New England. Disclosure helps reduce the hierarchical distance between the doctor and patient. Bob's patients seemed to appreciate that the doctor was not afraid to let down his guard.

9. **Bob is more comfortable saying "I don't know" to patients.** "I am no longer delusional that I can fix everything," acknowledges Bob, and "I can more easily say I don't know." Bob shares the onus of addressing the health issue, and the accompanying accountability, with the patients. His patients, he believes, appreciate his honesty as also his willingness to co-think appropriate solutions.

"How do your patients react to the several conscious changes you have made in your interactional style?" I ask.

"Adopting principles of complexity has resulted in a tremendous boon to my practice, to my own personal satisfaction, and patients always uniformly give me good feedback." Bob notes that his patients tell him that he is a more "holistic" doctor. Bob's wife Pam, an artist who helps out in her husband's practice, notes: "His patients love him because he really listens. Also, he asks patients about their interests, their family, not just about their problem." Some of Bob's office staff have heard patients say: "What has happened to Dr. Lindberg? He has changed so much."

Bob's complexity science-inspired practice of medicine is consistent with The Institute of Medicine's (IOM's) 2001 Report, *Crossing the Quality Chasm*, which advocated sweeping changes in delivery of health care in the U.S. in the 21st Century. In the IOM Report, which draws upon the science of complex adaptive systems, no single method, design, or strategy of health care delivery is recommended. It proposes a number of simple new rules that health care practitioners may follow. For instance, "Care is based on continuous healing relationships," "The patient is the source of control," and so on. A close examination of Table 1 suggests Dr. Bob Lindberg's practice in Darien, CT, effectively models the IOM's recommendations.

Lessons from a Hunter-Gatherer's Lifestyle

After doing a physical on new patients, it is customary for Bob to hand them a photocopied, double-sided sheet of paper titled Simple Rules for Healthy Living. Bob estimates that by 2005, he had handed out some 3,000 sheets. The Dos and

Table 1. Complexity-Inspired Changes in Dr. Robert (Bob) A. Lindberg's Practice [iv]

Past Perspective	Present Complexity-Inspired Perspective
The body is a machine	The body is an interconnected biological system
Sickness occurs in isolation	Everything influences everything else
Fix broken parts in the body	Make the body's system more resilient
Minimize chronic illness through symptomatic treatment	Minimize chronic illness by making the rest of the body healthier
The patient is sick or healthy	The patient is sick and healthy
Provide detailed instructions to patients	Suggest simple rules
Explain complex physiology	Tell stories
Interrogate through a formal protocol	Explore through non-linear conversations
Motivate through implied fear and threats	Provide information and feedback
Try to control everything	Foster flexibility

Don'ts in this simple guide are derived from the analogy of a hunter-gatherer's lifestyle.

Bob explains that humans were hunter-gatherers for four million years, and DNA studies suggest that genetically we have not changed for the past 35 thousand years. So, genetically humans are still suited for the hunter-gatherer lifestyle.

Since humans began farming some 10 thousand years ago, peoples' lifestyles changed dramatically. While our lifestyles and environment have continued to change at a frenetic pace, our biology has remained the same. Bob explains that most of the modern diseases — heart disease, diabetes, cancer, high blood pressure — are "new" diseases of the industrial age, a result of discordance between our stone age genetics and our space age lifestyles.

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What constituted a hunter-gatherer lifestyle? Hunter-gatherers walked a lot, sprinted in short bursts to chase an animal (or when chased by one), ate fruits and berries, fish, and lean meats, and drank water from natural springs or rivers. They woke up when the sun came out and slept when darkness descended.

What implications do our hunter-gatherer genetics have for nutrition, exercise, and lifestyles in today's world? Bob makes the following general[v] recommendations to his patients: [v]

For Exercise:

- walk outdoors on a daily basis
- sprint or engage in a high intensity exercise (biking, swimming, climbing stairs) for 30 seconds or so, followed by several minutes of rest, repeating this cycle four to five times, three times a week, three weeks out of four.
- use muscles to lift, dig, push, and climb several times a week

For Diet:

- Eat whole, natural, fresh foods – a diet high in fruits, vegetables, nuts, honey, and berries, and low in refined and processed foods.
- Increase consumption of lean protein – skinless poultry, fish, game meats and lean cuts of red meats.
- Avoid high-fat dairy and fatty, salty processed meats such as bacon, sausage, and deli meats.
- Let water be the drink of choice.

Bob further notes that sugar, salt, and fat (contributing causes of diabetes, high blood pressure, obesity, and cardiac problems) were eagerly sought by hunter-gatherers since these represented scarce commodities for them. Since we inherit the cravings of our ancestors, it is no accident that today's processed foods include a heavy dose of sugar, salt and fat. Further, Bob notes that humans are genetically programmed to put on weight in order to survive the lean times of the hunter-gatherer lifestyle. However, in today's world, for the well-to-do, there are no lean times.

For Lifestyle:

- Do what you love to do
- Be with people and nature
- Follow your circadian rhythm.

When I ask Bob "What is circadian rhythm?" he replies: "We have a biological clock in our

brain and many peripheral clocks throughout the body that keep time."

Steven Strogatz, a professor in the Department of Theoretical and Applied Mechanics and the Center for Applied Mathematics at Cornell University, wrote about the circadian clock in his book, *Sync*: "Millions of years of evolution have turned our bodies to harmonize automatically with the cycle of day and night... within each organ, suites of genes are active or idle at different times of the day, ensuring that the organ's characteristics proteins are manufactured on schedule."

"I am in love with the practice of medicine again."

Bob adds that the principle time giver for humans is exposure to sun, and as per the circadian clock, the human body should be in a state of rest or activity depending on the position of the sun (that is, time of day) (Figure 1). The next most important time giver is food, especially the timing of when one eats. However, Bob notes that Thomas Edison, 120 years ago, turned our natural circadian rhythms upside down by inventing the light bulb. Now people are staying up late, drinking coffee, sleeping in, eating at midnight, and so on.

Bob tells his patients that simple lifestyle changes can help the body follow its natural circadian rhythms. So, if someone spends a lot of time indoors, or are not eating at proper times, they can start having trouble. So, as opposed to simply handing out sleeping pills, Bob encourages his patients to expose themselves to the sun in the morning, and eat breakfast, lunch, and dinner close to dawn, noon and dusk.

Understanding Health and Disease as Interactions

"The practice of medicine is in the interactions," Bob repeats a few times during the day I spend with him at his clinic. And, not just in terms of how Bob interacts with his patients, but also the way in which he looks at health and disease — as a function of interactions occurring within and outside a patient's body.

Bob notes that medical schools train doctors to be reductionists, as if the body parts truly could be independent. Reductionism is the undergirding paradigm of most practicing internists, and also of micro biologists, who tend to look for one gene or protein as the sole cause of disease. He is dismayed that physicians are often taught very little about sleep, nutrition, and exercise, and about the incongruence between our hunter-gatherer genes and our fast-paced lifestyles.

Until the late 1990s, Bob was primarily influenced by the reductionist approach to assessing

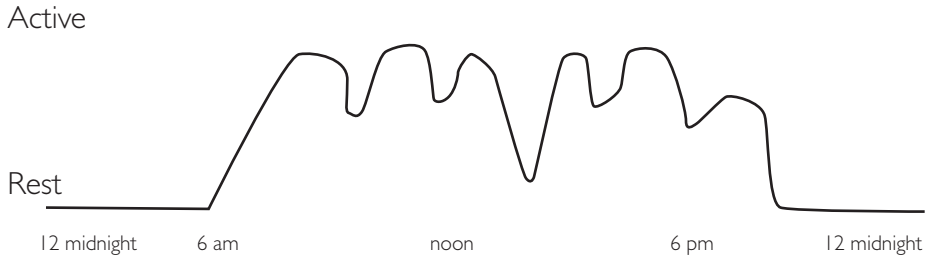

Figure 1. Our Inborn Circadian Rhythm Over a 24 Hour Cycle Showing Periods of Rest and Activity.

patients' health problems, that is, isolating and identifying the individual ibody part that was broken, and trying to fix it. "I have not given up the reductionist perspective," emphasizes Bob. "It is a powerful approach for understanding and treating certain ailments." However, Bob is grateful to complexity science for providing him with the additional perspective of understanding complex interactions within the human body, and seeing how this dynamic interactional state (a) leads to self-organizing relationships between the various body parts, and (b) survives over time. "The complexity perspective has made me understand my limitations as a 'fixing'-doctor; that is, not everything can be fixed with a magic pill or potion," noted Bob. The complexity perspective helps explain why the sum of the human body is greater than the parts.

In this realm, Bob is also highly intrigued by the pioneering work of two physicians – Drs. Ary Goldberger and Irving Dardik — who also take a complex interactional perspective to understanding health, wellness, and disease (See Box).

Heart Rate Variability as Interactions

When Bob becomes the primary physician of a new patient, one of the first things he does is to put a simple heart monitor (comprised of a chest band and a runner's watch) on the patient, and download the heart rate pattern on a computer. The routine includes plotting the heart rate of a patient while he/she engages in a minute or so of intense exercise, followed by a period of rest.

When one looks at the plot of a heart rate over time, it looks much like a plot of seasonal rainfall, or temperature, or a stock market chart, oscillating over time, up and down, reflecting the many different interactions occurring simultaneously among a complex array of underlying factors. The Framingham Heart Study, started in 1948 and now conducted by the National Heart, Lung, and Blood Institute in collaboration with

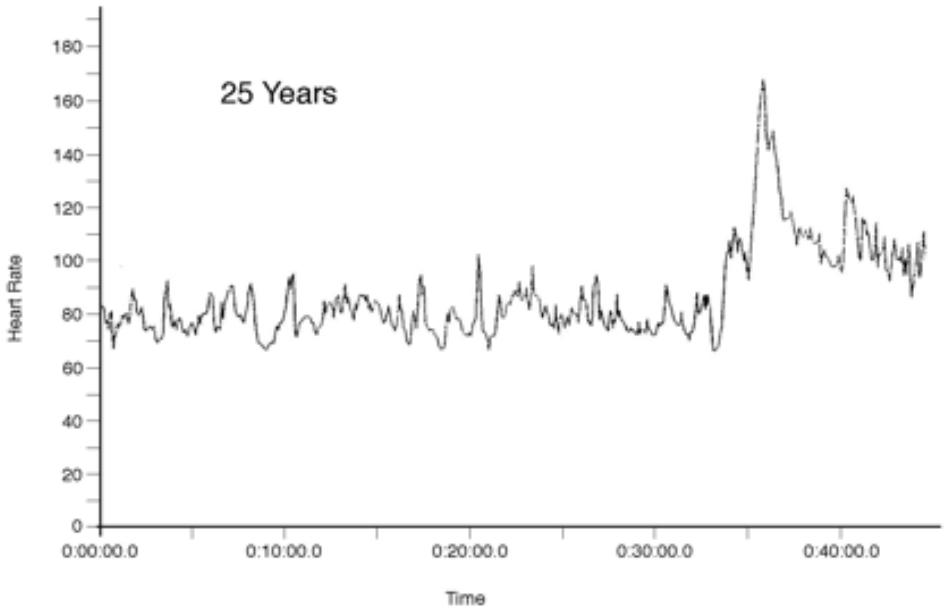

Figure 2. Heart Rate Variability Plot for a Healthy 25 Year Old Shows a High Degree of Complex Variability.

Boston University, illustrated that heart rate variability offers a reflection of the person's overall health. That is, as a diagnostic tool, a person's heart rate variability provides important clues to the interactions occurring between a person's physical, emotional, neurological, immunological, and other states. Thus, in studying the patient's heart rate pattern, Bob's focus is on assessing the overall health of a system rather than of any individual component.

Disease as Loss of Complex Variability[vi]

What is most interesting, as evidenced by numerous clinical studies, is that the complexity of heart rate variability declines with acute disease (sepsis, seizure, and arrhythmia), chronic disease (sleep apnea or diabetes), and aging. Bob notes that this reduced heart rate variability may represent a loss of interaction among our various parts. When a patient gets better through treatment, the interactions between their various bodily systems get better, and their heart rate variability improves.

Bob has a sheet of paper on his desk that has representative heart rate variability plots from patients in his own practice of ages 25, 35, 45, 55, 65, and 75 years (Figure 2 and Figure 3). Given that complex heart rate variability decreases with age and disease, a patient's plot gives Bob a window to his overall health. If the patient's heart rate pattern deviates from those of healthy individuals within the same age range, that provides useful information about a patient's systemic health status. If a 45 year old patient displays the heart rate variability pattern of a 25 year old, that is good news. If a 25 year old displays a heart rate variability pattern of a 45 year old, Bob is alerted that something may be wrong.

How might one explain diabetes from a complexity-inspired interactional perspective? Bob notes that diabetes (like many chronic diseases) is characterized by a loss of normal variability. The

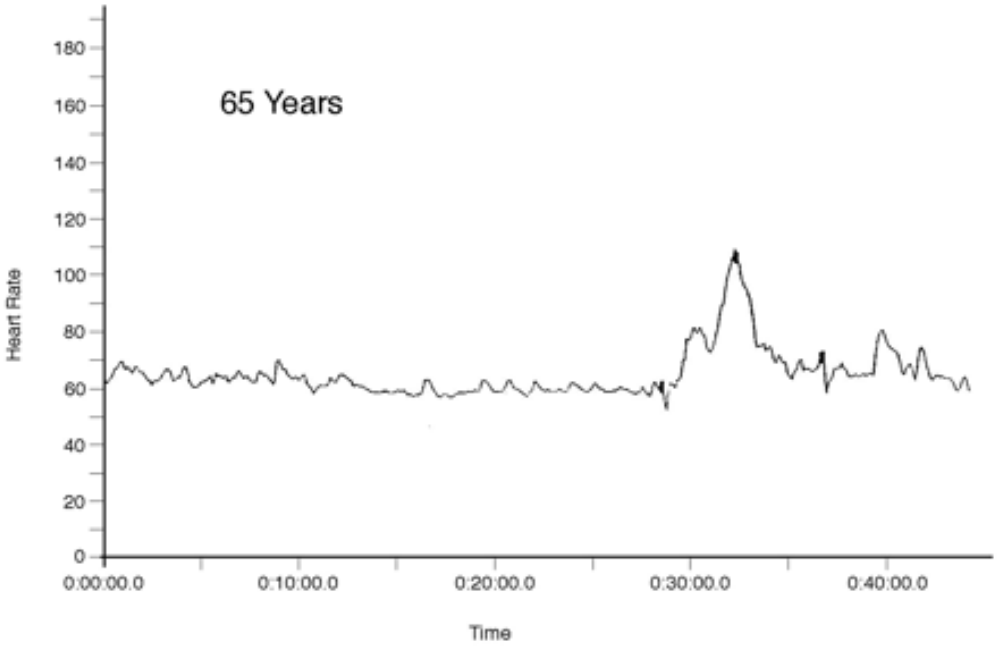

Figure 3. Heart Rate Variability Plot for a 65 Year Old Person Shows Decrease in Both Complexity and Variability.

insulin of a person who does not have diabetes pulses up and down in a rhythm. However, in a patient with type 2 diabetes the insulin is pretty much always on. It is stuck at a high range and is no longer varying up and down. So there is a loss of variability at the root of that disease. As opposed to thinking of diabetes as a carbohydrate-metabolism problem, Bob looks at diabetes "as a pulsatile disorder, a timing problem — where there is loss of coherence between the pulsation of the input of food that is metabolized to glucose and the release of insulin."

Similarly, the loss of variability in any part of the body's system can have deleterious ramifications. For example, Bob notes that with mood disorders very often "we are stuck in one emotion — anger or sadness — and that affects everything else. It has a dampening affect on the rest of our physiology." Normally we should be able to move and adapt quickly from one emotion to the other. However, if one is stuck in one emotion, the return of normal variability can be encouraged in multiple ways: Through cognitive therapy, medications, exposure to situations that bring out other emotions, massage, mediation, music, socializing, and the like.

In essence, Bob looks at heart rate variability as both a diagnostic test (to assess complex systemic interactions) as well as a therapeutic intervention. Bob notes that our space-age lifestyles have little variability. Temperatures inside a building with central heating and air-conditioning are about the same throughout the year. Lighting is now artificially controlled and invariant whether it is night or day. We sit on the same chair in front of a computer monitor for long periods of time. "Problems arise because our new lifestyle often reduces our innate physiologic variability," states Bob. So part of the therapy involves getting variability back into people's lives. If patients are not sleeping well, Bob may ask them to exercise. If they are stressed, Bob may encourage them to engage in meditation. For those who are fatigued, Bob may encourage them to go to saunas, hot and cold.

Goldberger, Dardik, and Complexity: The Science behind Heart Rate Variability

Bob's perspective on health and disease as a function of interactions among the body's multiple parts, and his looking at heart rate variability as a proxy of how the system as a whole is working, was inspired by his exposure to complexity science as well as the work of two medical doctors — Ary Goldberger and Irving Dardik. Bob's brother, Curt Lindberg, a long-term student of complexity science, one of the founders and President of Plexus Institute in Allentown, New Jersey,[vii] was instrumental in exposing Bob to the science of complexity and the works of Drs. Goldberger and Dardik.

Dr. Ary L. Goldberger, Director of the Margret & H.A. Rey Institute for Nonlinear Dynamics and Professor of Medicine at the Harvard Medical School, is one of the world's leading authorities on electrocardiography, non-invasive electrophysiology, and non-linear dynamics.[viii] Goldberger's pioneering work was featured in the widely-acclaimed book by James Gleick, entitled *Chaos: Making a New Science* (Viking, 1987). Goldberger, who received his B.A. from Harvard College and his M.D. from Yale Medical School, has made important contributions to the understanding of disease from the perspective of loss of complex variability.

In a seminal article, Goldberger wrote: "Disease happens when there is loss of multiscale complexity and emergence of highly periodic single-scale behavior. If, for instance, there is single-scale order in heart rhythms – this 'pathogenic order' may serve as the basis for much of clinical diagnosis and has important implications for new approaches to disease detection and prognostic assessment."[ix] What Goldberger is saying

is that a healthy person's physiology is extraordinarily complex, and has the ability to do multiple tasks simultaneously, and can cope with, and adapt to, multiple stresses, multiple inputs, and multiple exigencies. Disease represents a breakdown of this complexity and variability, resulting in an undesirable "pathogenic" order.[x] Bob found Goldberger's ideas to be antithetical to the dominant reductionist perspective on understanding disease and, in his own words, "refreshing."

Around the late 1990s, Bob also became familiar with the maverick ideas of Dr. Irving Dardik, at one time a noted vascular surgeon, pioneer, and inventor,[xi] and also the founding Chairman of the U.S. Olympic Committee Sports Medicine Council. As a vascular surgeon dealing with patients with bad hearts and as an official of the Olympic Sports Medicine Council dealing with athletes whose hearts were in prime condition, Dardik had the unique opportunity to view the human heart in its worst and best conditions.[xii] After the unexpected exercise-induced death in 1985 of his close friend Jack Kelly, a former Olympic athlete and President of the U.S. Olympic Committee, Dardik resigned from both the Olympics and his surgical practice to devote himself to studying the connections between health and physiological variability.

Dardik — the subject of a newly-released 2005 book, *Making Waves*, by Roger Lewin — argued that the person with the most endurance, attained by performing long, steady exercise sessions, is not the one with the healthiest heart. That person, in fact, may be reducing their resilience by decreasing their heart-rate variability. Instead of linear aerobic fitness, which keeps the heart pegged in a narrow range and is designed to push the limits of oxygen consumption (oxidation), Dardik argues that training should expand the heart wave range by oscillating it between high and low pulse rates, placing equal emphasis on both exertion and recovery. Sprinting for short bursts and resting for long-periods, as the hunter-gatherers did (See Box) is, in principle, consistent with Dardik's ideas of expanding the heart wave range. Dardik designed an exercise program called LifeWaves,[xiii] based on these principles and claims to have cured himself of rheumatoid arthritis of the spine as a result.[xiv]

"While the practice of medicine treats the heart and the whole organism as two separate parallel entities, a "heart wave" represents the status of the heart as also the status of the whole organism."

Dardik argues that heart rate variability represents the single, simple "common denominator" to understand acute and chronic illnesses and diseases. He notes that a decrease in heart rate variability is akin to a pianist trying to play a piano concerto using only one octave of a piano's full range. Just as the decrease in heart wave range (decreased HRV) leads to decreased longevity and chronic disease, expanding the heart wave range (increased HRV) leads to increased longevity and health.[xv]

In essence, Dardik, much like Goldberger, takes an interactional, systemic view of the human body, questioning medicine's dominant stance of local, atomized, cause and effect.

He argues that while the practice of medicine treats the heart and the whole organism as two separate parallel entities, a "heart wave" represents the status of the heart as also the status of the whole organism: The heart wave "is the body's master wave that reflects and organizes the degree of synchronization of all behavioral waves from

those of the whole organism through molecular, biological, and genetic oscillations."[xvi]

While Dardik's ideas have not found their way into the mainstream scientific literature, the body of evidence suggesting that heart rate variability has important diagnostic, prognostic, and therapeutic value is mounting (see for instance, a recent 2005 article by Jouven et al. in the *New England Journal of Medicine)*.[xvii] Whether or not Dardik is a maverick innovator ahead of his time only time will tell.

Much like the field of astronomy makes deductions regarding the universe by analyzing information contained within electromagenetic waves, Bob, inspired by Dardik's ideas and complexity science principles, believes that the metaphor to visualize the complexity of human physiology is to look upon it as a set of interacting chemical waves (e.g. of calcium and glucose), sound waves (involving speech and hearing), fluid waves (e.g. blood circulation), light waves (involving sight and vision), muscle waves (e.g. heart and intestine function), and electric waves (e.g. neurologic activity). These waves, interacting with one another, create complex variability in a healthy human being. Acute and chronic disease, and also aging, reduces this complex variability.

"Problems arise because our new lifestyle often reduces our innate physiologic variability. Part of the therapy involves getting variability back into people's lives."

Explaining the Wave Metaphor

"Do your patients understand this interactional wave metaphor of health and disease? It seems complicated. How do you explain it to them," I ask.

"The wave metaphor is parsimonious and I use it a lot," notes Bob. "I point out that health [and disease] is a confluence of many interacting variables. And, rather than being an aberration, wave-like variability is an expected consequence of any biologic activity. Although we may be able to enhance it modestly, our main role is to not to interfere with the body's innate wave-like variability. Furthermore a change in the normal variability of energy, sleep, bodily functions, vital signs, or laboratory data is a reliable indicator of health problems."

"So, the wave metaphor is useful for patients in describing a diagnosis," I query.

"And also the wave metaphor is useful for conveying a prescription," Bob replies.

"How?" I ask.

"I had a patient who was suffering from a high degree of stress, and kept emphasizing that she could not get way from it. I told her that she had to do something she loved to do – anything — to get away emotionally. Finding down time from unrelenting stress is akin to reintroducing wave like variability."

Any other example?

"When I encourage a patient to go for a massage, I talk in terms of the introduction of pulsating muscle waves. When I encourage them to go for a hot or a cold sauna, I emphasize the waves of temperature. Through the wave metaphor, patients better understand the interactional relationships among the various components of their body system."

Practicing Complexity Outside the Clinic

As our day draws to a close, over dinner at a Fondue restaurant in Darien, I asked Bob: "How has complexity science influenced your personal life?"

"I've strived for richer, deeper interactions with friends and family members," Bob notes. "I am no longer trying to 'hyper-parent', to part the waters, to be in control."

Bob's wife, Pam, nods in agreement and states: "As parents, we have a simple rule for our two teenage daughters: Take care of yourself, Take care of your family."

Bob added: "I believe I now have a deeper, better, and closer relationship with my brother Curt than before." And quickly stated: "I thank Curt for introducing me to complexity science."

In Closing

As we eat dessert, I ask Bob if he has been able to share his complexity-inspired practices with other medical doctors in the neighborhood?

"No, I haven't yet found a 'soul mate' in this area. I have not converted anybody. Breaking ice on this topic with professional colleagues is not easy."

However, I know that Bob is active in the Complexity and Clinical Practice Learning of the Plexus Institute, where he regularly exchanges ideas with other complexity science-inspired physicians such as Drs. Patricia Rush, Tony Suchman, Eileen Hoffman, Suzana Makowski, Bethany Hays, Robert Steiner, Marshal Levine, Diane Pittman, and others. All of these physicians, in their own unique ways, have adopted principles of complexity science in their medical practice.

And, in closing, I ask Bob, how he foresees the role of complexity science in the practice of medicine.

Bob notes: "It will grow. I am astonished by how much the scientific literature has transformed in recent years. *Nature* and *Science* and the leading journals in physics, chemistry, and biology are all adopting the language and concepts of complexity, even if it is not advertised as such. As each year goes by, the field of medicine will follow."

As I position to get myself in the car, Bob shakes my hand vigorously. As we drive away, Bob and his wife Pam wave good bye.

"The practice of medicine lies in the interactions," I muse. ■

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Endnotes

[i] Arvind Singhal is Professor and Presidential Research Scholar in the School of Communication Studies, Ohio University, where he teaches and conducts research on the role of communication in social change and public health. He is author of several books, *including Organizing for Social Change: A Dialectic Journey of Theory and Practice* (Sage, 2006), *Combating AIDS: Communication Strategies in Action* (Sage, 2003), and *Entertainment-Education: A Communication Strategy for Social Change* (Lawrence Erlbaum, 1999). In recent years, Singhal has become a keen student of complexity science, and serves on the Science Advisory Board of the Plexus Institute in Allentown, New Jersey. In the past year, Singhal met with Dr. Bob Lindberg several times at various Plexus meetings, and then visited his medical practice for a full day in Darien, CT, in early June, 2005, accompanied by Bob's eldest brother Curt. Singhal is grateful to Bob and Curt Lindberg for detailed feedback on draft versions of this manuscript.

[ii] This section draws partially upon PlexusCalls (November 8, 2002) and PlexusCalls (December 13, 2002).

[iii] See also Lindberg, R.A. (2001).

[iv] Lindberg (no date), *Suggesting simple rules*.

[v] These recommendations, of course, are general recommendations, and are appropriately modified based on patients' age, gender, lifestyle, and health status.

[vi] This section also draws partially upon PlexusCalls (November 8, 2002) and PlexusCalls (December 13, 2002).

[vii] Plexus Institute's mission is to foster the health of individuals, families, communities, organizations, and our natural environment by helping people use concepts emerging from the new science of complexity.

[viii] See http://reylab.bidmc.harvard.edu/people /Ary.html

[ix] Goldberger (1997), p. 558.

[x] PlexusCalls (November 8, 2002).

[xi] Dardik's patent – the Dardik Biograft – won the AMA's highest award for research (Dardik, 1997); see also http://www.louschuler.com/ archives/2005/05/sudden_death.html.
Prior to attending medical school, Dardik undertook undergraduate work at the University of Pennsylvania, where he was a sprinter and captain of the track team.

[xii] This draws upon Dardik (1997).

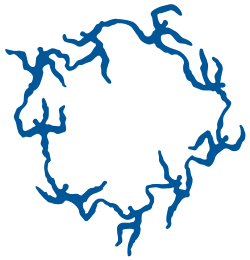
[xiii] The LifeWaves™ Program, based on Dardik's principles, is based on an understanding of how rhythms or waves work in the natural world. Much of our natural activity is rhythmic, from laughter to running. The Lifewaves Program is designed to create short periods of exertion, less than one minute long, followed by complete recovery.

[xiv] See http://dardikinstitute.org/index.html.

[xv] (Dardik, 1997).

[xvi] Dardik (1997), p. 30

[xvii] Jouven et al. (2005).



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