

THE WOMAN  
WITH A WORM IN  
HER HEAD

AND OTHER TRUE STORIES OF  
INFECTIOUS DISEASE

PAMELA NAGAMI, M. D.

FOREWORD BY  
F. GONZALEZ-CRUSSI



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To Glenn

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# acknowledgments

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And to the patients and families of *The Woman with a Worm in Her Head*.

With the exception of the late Dr. Rasoul Soudmand, the patients, nurses, and doctors in my hospital who appear in *The Woman with a Worm in Her Head* have been given pseudonyms. Outside consultants appear under their own names.

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# foreword

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That many physicians feel compelled to express themselves through literary writing is generally known. Nor should this be a cause for wonderment or surprise. Physicians are placed on the front line, so to speak, of the mighty clash between forces that sustain human life and those that oppose it. By the very nature, their job forces them daily to canvass the conflict at the closest possible range. What they see is far from trivial: on the one hand, the will to live—the dumb striving, the unyielding impetus to survive; on the other, the frost that withers life, the ills that wear it down, the tempests that scathe it. And the physician stands in the midst of it all, a privileged spectator of every phase of this conflict. It is natural that he or she would feel the urge to describe, to record what is occurring. What for? To bear witness; to inform us; to spread hope and to console others, since this is, after all, a physician's calling. Sometimes to convey his/her genuine admiration for the unsurpassed magnificence of the observed phenomena. For the virtuosity of Nature may reveal itself unexpectedly in disease and appear no less admirable when perturbed than when sound. But the physician also writes as catharsis to alleviate his own anguish. For all we know, this may be his main motive: a means to hold in suspense the misery that comes from glancing too intently on the chaos of the world.

The narratives developed in the present work reflect the experience of a physician who happens to be a specialist in infectious diseases. Her vantage point casts a light on all perceptions. But it is apparent that she is a physician first, and this in the most fundamental acceptance of the term: her professional life is spent in combat in the front line of the mighty struggle. The foe that she faces is overwhelmingly powerful. Bacteria, viruses, and fungi have a history of resiliency and survival that ought to humble the omnipresent pride of our species, if we so much as fleetingly consider the fact that Bacteria were present billions of years before there was any intimation of a human race, and it is a safe wager that they will be around long after the last trace of mankind has vanished.

Nothing in our technology can match this infrangible sturdiness, this amazing invulnerability tested over eons of evolution. Against this foe, our efforts are powerless and our clever devices nugatory. We are forced to own that, in the long run, we shall lose the battle. But the physician, who is all except “defeatist,” is unfazed by this, and does not adopt such a sweeping, philosophical viewpoint. He, or she, is not concerned with the destiny of the human race as a nameless, faceless, all-embracing totality. Or with what will happen in a future that is measured in the geological time scale. His concern is with human beings, here and now. Patients have names, and fears, and joys, and aspirations, and all these form part of the disease. Moreover, diseases never develop in a vacuum. At least of all infectious diseases, whose contagiousness best epitomizes the social structure of human suffering. But transmissibility is only one among many factors through which suffering manages to reveal our ties to the community. Doctor Nagami knows this well, and she tells us about her frustration in having to take into consideration such things as the availability of long-term disabili-

benefits for patients who badly need them. Were the physician to consider only the harmful bacteria, fungi, and viruses, his most fundamental role would be subverted. Social and economic conditions have a lot to do with causing the disease and spreading it to the population. For the infectious disease specialist, who bears the responsibility for the detection and control of epidemics, these factors acquire particular relevance.

At a grandiose scale, in the fullness of time, the microbes shall win the battle. And we know that we are going to win it, too, in the brief span of our individual lives. For the latter must ineluctably come to an end, and often the proximate cause is an infection that might have been trivial but that the ravages of old age or other circumstances render lethal. By whatever means, in the end we shall be microbial fodder; consumed, perhaps, inside the earth, which has long been the rightful property of the ubiquitous Microbe. Agricultural fields are said to host over a billion bacterial cells per gram of soil. These microbes run the risk of turning the medical specialist into a detached, unfeeling observer; that is, a skeptic, if not a cynic.

And yet, how rewarding it is to confirm that the spirit that breathes in Dr. Nagami's pages evinces none of these claudicating attitudes. The vigor of hope is preserved, even in the face of the final incapacity. The depth of a humane vision is maintained to the end. The physician's own failings and shortcomings (for there is a limit to medical skills, despite the much-vaunted progress) are made in a route of escape from a ruinous sense of superiority. Death cannot be abolished, but the doctor's ministrations can now retard it more effectively than ever before. Suffering cannot be deleted, but the current means to lessen its pangs exceed any previous measure.

And this is why we all enjoy the physician's chronicle of the mighty struggle. It is a war that concerns us all, whose episodes are always fascinating. All the more so when told, as in these pages directly, truthfully, and clearly, by a front-line veteran.

—F. Gonzalez-Crus  
Emeritus Professor of Pathology  
Chicago, IL, August 2000



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# introduction

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I know things about the human body because I've looked at what lucky people never see.

In a lot of ways, my world of sense memories is like yours. Both of us can close our eyes and remember the softness of a baby's skin, the sweet, sharp smell of an orange being peeled, the feeling of the breath that dries the back of the throat in the middle of a run, the way the heart begins to pound. But because I'm a doctor who specializes in infectious diseases—a bugs and drugs doc—I also know the particular geography of the body under siege.

I've seen the way tissue killed by gas-producing bacteria crackles under the finger like a ball of cellophane. I know the smell of a staph infection (mousy, musty, rancid), and how to see the gaps that tell me there's a parasite living in your brain: gaps in words you want to say, gaps in a movement of your hand, gaps in your gait. I can tell some diseases by touch. If there's a lesion on your skin, I close my eyes and pet it with the flat part of my right index fingertip, the finger that can tell me what lies below is alive or dead, patient or invader. As I stand beside a surgeon who's unwrapping an infected foot, I know that the tissue is dead around the edges if it's dark and dry, and I get close and sniff the whole thing inch by inch like a dog for the telltale smell of hidden pus. "Cut here," I say, "this part's fine."

To know the body this way, changed by some of the deadliest infections on the planet, means entering it with my brain and my senses. My work takes me into the midst of the agents that carry diseases, ancient and new, and my job is to disarm or kill them before they kill you, or me. Some are very small, like HIV, the chickenpox virus, or the encephalitis viruses, like West Nile. Or larger, like the bacteria staph or strep. Some are big enough to see with the naked eye, like the fuzzy fungus that when inhaled, causes Valley Fever. And some would be hard to miss, if only you knew you were looking for them, like the pork tapeworms that riddle the brain with holes.

Keeping this kind of company is scary at first. People don't line up in medical school to get intimate with AIDS, parasitic worms, and flesh-eating bacteria. The natural human impulse is to put away and protect ourselves, and to think we're safe because we're not in some jungle, waiting for the next Ebola outbreak. But the truth is, in the big-city HMO where I work, I often get paged twenty or thirty times a day to size up infectious diseases that come from what we eat, what we breathe, what we touch, and where we go. The rare and mysterious cases I see walk into my hospital every day.

I wear purple high-tops for speed, and up to four beepers to keep me wired to the departments that need me. I talk fast because there's no time not to. If a patient is critically ill, I dispense instant advice on how to start treatment. Often I work like a detective, sifting through the evidence other doctors give me: the patients' symptoms, their lab tests, where they went on vacation. I ask dozens of questions: When exactly did the pain start? Were there chills? Did they eat a rare delicacy in a foreign country? Is their parakeet sick? I examine them like a crime scene, looking for clues: a pattern of do

on the skin, a whooshing sound in the heart, an enlarged spleen, a pale spot on the back of the eye, read lists of blood test results, look for shadows on x-ray film, and see what grows in culture dishes.

The doctors who ask for my help don't expect me to perform an operation, or even a procedure, but they do want me to think. If a heart valve is infected, I try to think like a cardiologist. If someone has a brain worm, I pretend I'm a neurologist and track the worm by studying its habits and preferences. Often, I know the diagnosis from the first sentence of the patient's history. And sometimes I can figure it out even after years of study.

Some of the patients I see are so sick that there are days I feel as though death is making rounds with me. And there's always the nagging fear that I could bring something dangerous home and spread it to my husband or my children. In our house, my stethoscope wasn't a toy the kids were allowed to play with. We understood that the barrier between home and my work is flimsy. When I took my toddler to the clinic with fever, she didn't just get an ear check and some amoxicillin like everybody else's kid. She got her blood drawn to make sure she didn't have the same bug my patient had in the ICU.

Through the years I've tried to play all this down because every member of my family, except me, has some symptoms of obsessive compulsive disorder. It's the ultimate irony for me to have gone into infectious diseases in a family prone to fear of germs. So I try to be casual: I eat stuff that falls on the floor and I'm not compulsive about hand washing.

Of course, I can't hide everything from them. They notice that I won't hike in the hills on certain days in the fall when the Valley Fever winds are up. And one spring, when there was a little epidemic of spinal meningitis, my kids had to line up in the kitchen and get vaccinated for a disease most people hadn't even heard of. Like it or not, a bracing amount of fear comes with the job.

But just beyond the fear is the fascination of solving the mystery of a sudden illness that's tearing its way through a body. I can't save all my patients, but I have not forgotten a single name, or failed to add the telling details of their cases to the running list of facts I keep in my brain to help me see the next case more clearly, and diagnose it more quickly.

We live with the illusion that technology has put a safety zone between us and the diseases I see every day, but we're all vulnerable. And because we're afraid to look, we don't learn to see the signs that can save us and the people we love.

I'd like to show you how I learned to look and, finally, understand some of the most dangerous infections we know. It's a process that started with a childhood worm hunt and led me to hundreds of cases I'll never forget, infections that have changed my patients and me in ways none of us could have imagined.

As you join me in the ER, the OR, and the ICU, you'll learn to see the way I do, and feel the reality of the people who decipher the cryptic traces that infections leave in the body. And if I'm lucky, you might even decide to take a simple action that could save a life—get a chickenpox shot, take malaria pills before a trip, or get an infected family member to the hospital while there's still time for someone like me to help them.

## worm hunt

“Do you have time to listen to a case? It’s my husband. I am very worried about him.” It was a young internist from Vietnam, Dr. Vy Tran.

I had been in my office doing paperwork on a quiet afternoon in early March 1999 when my phone rang. Now I leaned back in my swivel chair and said, “Absolutely. Go ahead.”

“You know we went home to Vietnam for three weeks last month; we got back on February 1. About four days later, Hanh came home from work sick. He didn’t eat very much dinner, and he went to bed early. I put my hand on his forehead and he felt hot. So I took his temperature and it was 103.”

Dr. Tran went on to tell me that every morning Hanh felt better and went to work, but every night the sickness came. One night he had hives all over his feet; another he was doubled over with pain and pressure in his liver. And there was always fever. He asked Vy to turn up the heat; he crawled under the covers; he wanted extra blankets.

Dr. Tran gave her husband antibiotics without effect. She checked his white blood cell count which was only slightly elevated. Then she decided to consult her father in Maryland, who had been a doctor in Vietnam.

“You must run tests for malaria,” he said.

So Dr. Tran brought Hanh back to the lab for a thick and thin blood smear for malaria and for another complete blood count.

“The malaria smear was negative, Pam, but the white blood count was twenty-six thousand, and over half the white cells were eosinophils!” she said.

I sat up straight in my chair. The white blood cells called eosinophils are the gaudy outriders of the blood stream. Their name means “fond of the red dye eosin.” When a drop of blood is stained with that dye and viewed under the microscope, the eosinophils sparkle against the pale pink background of the red cells. Scarlet granules fill the entire eosinophil. The granules contain tissue-destroying enzymes and act like hand grenades. Eosinophils attack anything foreign that gets into the body, like pollen grains and cat dander. They move into the tissues, stick to the foreign substance, and explode their granules against it. If this happens in the airways, the patient gets red runny eyes and starts sneezing and wheezing. In the United States, it’s the eosinophils that put the BMWs in the allergist’s driveways.

But eosinophils did not evolve over millions of years just to make our noses run. They are ancient worm hunters, specialized to defend the body against parasites like roundworms and flukes. In the developed world, where sanitation is good, eosinophils are usually peacetime warriors. They rarely number more than three hundred per cubic millimeter of blood. But Hanh Le had more than thirteen

thousand. It was the highest count I had ever seen.

The army of eosinophils pouring out of his bone marrow had to be after worms, I thought; nothing else would bring them out in such numbers. And that meant I had to hunt worms, too.

“Vy,” I said, “Don’t worry. We’re going to figure this out and take care of Hanh. But I need to go over your trip step by step.” And that’s what I did, by talking with Vy and then with her husband, the sifting their stories for clues that might lead to worms: raw food that might incubate them, contact with water or people who might carry them. To track a worm, you have to find the place where the life cycle of the worm becomes part of the life cycle of the human host.

\* \* \*

It was a familiar process for me because worms, and worm hunting, had been part of my own life cycle since my parents sent me to Camp Wing-a-Roo, on the shores of Lake Erie, when I was eight years old. There was a grassy compound with a natural creek that was small enough to jump over. You took a running start, and we explored it in maroon shorts and white tee shirts with the camp name scripted on the front. There were all the usual activities: archery, horseback riding, arts and crafts—and one or two things that were not in the brochure. Worm hunting was one of them.

The counselors had planned a fishing trip, and when they gathered the evening before to collect night crawlers, they asked me, alone among the campers, to join them. I don’t really know why they singled me out. Perhaps it was because I was a gangly tomboy who brought them tadpoles and water boatmen from the creek. I asked a lot of questions. Whatever it was they saw, they got it right. I was thrilled by their invitation.

We gathered up flashlights, screwdrivers, and jars of mustard powder and water, and headed into the dark, feeling for the little heaped up mounds of dirt under the grass at the tops of the earth-worm burrows. Then we pried off the turf with a screwdriver and poured mustard water into the holes.

Soon the worms began to emerge from their dens—long, glistening, and fat, the tiny bristles on their sides grabbing the earth one last time as we pulled them away and into a waiting can. Whether or not we caught any fish I don’t remember, but after that I was hooked on worms—and though it seems odd, they’ve touched my life at key points. My first real kiss took place in the shrubbery of a botanical garden when a boy in junior high, knowing my weakness, lured me there under the pretext of finding flatworms in the stream. In high school, I dabbled in art—only instead of people or landscapes I sketched snails.

By the time I got to college I was headed for a life of field work and laboratory research. I spent countless hours at the seashore at low tide wading through the fetid black mud of the flats, below the lair of the innkeeper worm, *Urechis caupo*, searching for its elusive burrow while my shoes slipped off because of the powerful sucking muck. At nineteen, I received a grant to study hibernation in Maltese snails. For two months I sat alone on a high stool in a damp fifty-degree cool room taking the temperatures of my sleeping snails. And it slowly dawned on me that if this was life as a research scientist, it was not for me. As my grant money ran out, taking my food money with it, I had to admit

that eight weeks of shivering—and now hungry—solitude had been more than enough. I was too much of an extrovert to hole up in a lab.

So the next summer I worked as a waitress. At Calvin's Coffee Shop I had my morning regular and loyal lunch crowd at my own six feet of counter. People seemed to feel comfortable with me right away. And I liked waiting on them in my white sneakers and my green cotton uniform with the buttoned pocket in front for the tips. I had the salesladies from Bullocks during the lunchtime rush and in the late afternoon, the retired Filipino gardener who came in with his dead employer's dog. (The garden had coffee; the little dog sat on the floor next to the counter stool and licked vanilla ice cream out of a Styrofoam cup cut in half). I talked to my customers and listened to the latest installments of the radio stories. I realized that being a waitress and being a doctor were not all that different.

So I put my tide tables and specimen jars away and decided to go into medicine.

Early on I realized that surgery wasn't a serious option for me. I was hopelessly clumsy, and I couldn't visualize anatomy in two dimensions, let alone in three. Pediatrics didn't appeal, nor did obstetrics. I tried pathology, but after ten autopsies, I wasn't sure I wanted to spend all my time with the dead. Then, during my internship, I found myself unexpectedly circling back to worms.

After a grueling night on call during which I had broken a sandal strap running up and down stairs to various emergencies, my boss told me to report to the office of the associate chief of staff for research, Dr. Lucien Guze. He wanted me to see Dr. Guze because he'd heard that when I'd called him the day before, to ask permission to use a drug in a novel way, I'd come across as surly and abrupt. What did I think I was doing treating his beloved mentor this way? I was to go over there immediately and apologize.

I walked into Dr. Guze's office with rumpled hair, grungy breath, and blood-shot eyes, punctuated by the flip-flop sound of my sandals with each step. Before I even got all the way in, I felt my right hand being warmly shaken and my whole face being embraced by the kindest pair of eyes I'd ever seen. He was a lean man in his early fifties, in a three-piece suit of light wool, looking natty and professorial at the same time. I sat down on an old leather couch near the bookshelves and Dr. Guze sat opposite me in an armchair with a low coffee table between us. He leaned forward and started getting to know me with the assurance of a man who had taken thousands of medical histories. I knew I was being deftly dissected but all I felt was a warm glow. Like my boss, Dr. Guze was an infectious disease specialist, and from that day on he was my mentor, too.

In medical school I had taken a zoologist's interest in infectious diseases, and it was the only section of my big medicine textbook I had read word for word. But in my residency I had never seriously considered the specialty because the infectious disease fellows in training at our hospital seemed so unimaginative and dull, obsessed with gathering data for clinical studies of antibiotics, and focused on tabulating every detail of blood tests and cultures. In fact, I was thinking about going into rheumatology, the study of bones, joints, and autoimmune diseases like lupus.

But when I told Dr. Guze about rheumatology he quipped, "You could learn all of rheumatology in six months." This was, of course, untrue, but I knew what he meant. In infectious diseases I would

have to master both the plant and animal kingdoms, investigating a rash from the smallest virus to the infected bite of the largest lion.

He had me pegged as a worm hunter, and a year later I was studying infectious diseases under him. I learned that the free-living forms I used to study have their parasitic counterparts. The little cross-eyed planaria flatworms that grow into two-headed worms if you cut their heads in half have swarms of parasitic cousins: the liver and lung flukes, the schistosomes, and the tapeworms. The tiny free-living roundworms visible under a hand lens in a pinch of moist soil are represented in patients by the parasitic filaria, the tiny roundworms that cause elephantiasis and the intestinal ascaris worms.

And twenty years later, one of these varieties was likely causing the fevers, hives, and liver pain in my Vietnamese patient, Hanh.

\* \* \*

Finding out where Hanh had met his worm was first a matter of retracing his steps. He had left Vietnam when he was eighteen in 1983, and now at thirty-three, he had made his first trip back. His plane landed in Ho Chi Minh City (formerly Saigon) where his uncle, aunt, and cousins met him and Vy at the airport and took them home. For four days they toured the city.

“The city was as I remembered it,” Hanh told me, “the park in the middle, the Catholic basilica, the post office were all the same, only everything seemed smaller, including the people. They looked short and thin compared to us.” During their four days in Ho Chi Minh City, Vy and Hanh ate traditional Vietnamese food, but everything was well cooked.

Their next stop was the old imperial capital, Hue, midway between Ho Chi Minh City and Hanoi. In addition to the usual rice and noodles, they ate land snails and crab, which are known carriers of parasitic worms. But again, all of their food was well cooked.

From Hue the couple flew to Hanoi, seven hundred miles to the north. They walked all over the city and they visited Huong, the mountain pagoda whose name means perfume. At Ha Long Bay they saw battlefields where the Vietnamese had repulsed Chinese invaders for two thousand years, and they explored the secret places where the people hid their weapons.

“Did you swim in the water there?” I asked, thinking of the fluke disease schistosomiasis.

“No, it was too cold up north to swim at that time of year.”

Then they came south to the Nah Trang coast, where Hanh’s uncle is a math instructor at the local college. They took a boat trip to fishing villages on nearby islands. Here Vy and Hanh ate *goi tom*, an appetizer of raw shrimp in a sweet sauce.

“Did you eat the same number of shrimp as your wife or more?” I asked.

“I ate more, and also,” he added, anticipating my next question, “I went swimming there. I jumped off a boat about a mile from shore.”

Finally the couple returned to Ho Chi Minh City. It was the lunar New Year. While Vy went out with her friends, Hanh’s cousin, Chanh, an architect, invited him out to a farewell dinner at a restaurant that served exotic items to executives and their guests. They ate frogs, lizards, field mice

and, the *pièce de résistance*, an entire cobra. All of these dishes were deliciously seasoned and were cooked, all except the gall bladder of the cobra and its heart.

“How big was the snake?” I interrupted.

“About eight hundred grams,” he replied. “That is one and a half pounds.”

“The gall bladder was served raw in a little wine,” he went on. “The heart was just served raw. My cousin said, ‘These are for you.’ I knew my brother had eaten these things during his visit, and now it was my turn.”

“It was a kind of dare?” I asked.

“Yes,” he replied.

I had heard about the health- and virility-enhancing powers that these cobra organs were thought to possess, but I didn’t press Hanh with questions on this point. “How did they taste?”

“Pretty awful,” he said.

\* \* \*

I had gathered all my clues and I also knew the results of additional blood tests of muscle and liver. Now I had to match the m.o. of the various parasites against the particulars of Hanh’s illness and come up with some likely suspects. I got out a piece of scratch paper and started making a list. I didn’t waste time on the common tropical fevers, malaria and typhoid. Hanh’s blood film was negative for malaria. If he had contracted typhoid he should have already responded to the antibiotics his wife had given him.

I went right to the worms because they cause the extremely high eosinophil counts, particularly when they move out of the intestines and into the tissues. Hanh didn’t mention mosquito bites, but of course he and his wife were bitten. They expected to be; that’s why they both took pills to prevent malaria. At least four species of filaria are transmitted by the bites of mosquitoes. Although not common in Vietnam, at least two of them may be found there. The larval roundworms pass into the host’s body when the female mosquito feeds and make their way to the lymph nodes, where they mature over the next few months into white, threadlike worms that can be over an inch long. The adult worms discharge thousands of larval worms into the blood stream during the day or night to match the feeding time of local mosquitoes, and the cycle of infection between mosquito and man continues. It is the adult worms that obstruct the lymphatic system and cause the bizarre swelling of the legs (and the scrotum in males) called elephantiasis. It was possible that Hanh was suffering from the first stages of filariasis, called acute filarial fever, which the GIs got in the Pacific Theater during World War II. Hanh had the fever and chills and high eosinophil counts that go with the syndrome, but he lacked the inflamed and painful lymph nodes that the soldiers got. It was possible that Hanh had filariasis, but it seemed unlikely.

Next I considered trichinosis, a roundworm disease contracted by eating undercooked pork. Very high eosinophil counts occur in this disease as the larval worms exit the meat, penetrate the gut, and begin migrating to the muscle of the host. But in patients as sick as Hanh was, these worms always

cause enough muscle damage to elevate an enzyme called CPK. Hanh's CPK level was normal, ruling out trichinosis.

The third item on my list was schistosomiasis, the blood fluke that infects more than 200 million people worldwide. Schistosomes are quarter- to half-inch long flatworms with complex life cycles in which fresh water snails are intermediate hosts. People don't get schistosomiasis from snails directly. The infective larvae leave the snail host and burrow through the human skin of a swimmer, or a rice farmer standing in the water. Hanh had gone swimming in Vietnam, but he'd been in the ocean far enough from shore to dilute the fresh water flowing in. He probably hadn't encountered any schistosomes.

But there could've been some kind of worms in those raw shrimp Hanh and his wife had eaten on the Nah Trang coast. Here I drew a blank, although I wondered about *Paragonimus*, the lung fluke which one catches by eating undercooked crabs and crayfish. Because of the disease caused by the lung fluke, millions of people in the Far East cough up blood, sometimes every day for years. But if Hanh had paragonimiasis he should have been coughing by now.

What I had generated so far is called a differential diagnosis, a list of disease suspects doctors make when confronted with a difficult patient. Like a detective, I was analyzing motive, means, and opportunity for each worm. But my differential diagnosis so far had left out the most important clue: Hanh was the only one on the trip who became ill; his wife and his cousins remained well. People do have varying immunity to parasites, but in this case, I suspected the answer to this patient's illness depended on the one thing he did that was different from everyone else: He ate the raw cobra. So it was time to backtrack to the snake.

\* \* \*

I had no idea what a person could catch from eating a snake, but I suspected the answer was hiding somewhere in my office. I tipped my chair away from my cluttered desk and stared up at the pale green wall across from me, thinking. There was my children's art, a gold-framed picture of the wilds of upstate New York, my high school pencil sketch of a snail crawling up a twig, and my diploma. And somewhere in my oak bookcase, or in my credenza bookcase, or in my ten file drawers full of infectious disease articles, was Hanh's worm.

I stepped over the patient charts stacked on the floor, pulled my big infectious diseases textbook and my tropical medicine book off the shelves and laid them open on top of the stacks of lab and x-ray reports on my desk. I looked up "snake" and "cobra" in both books, but the only references were snakes biting people, not the other way around.

Then I noticed a slim paperback book, Elaine Jong's *Travel and Tropical Medicine Manual*, which I had ordered from a catalog but had never really used. I started leafing through it, and there in the last chapter, I found exactly what I needed, a table called "Animal Helminths Commonly Transmitted to Man." Here was a list of parasitic worms that, although adapted to animal hosts, could accidentally get into people.



There was the rat lungworm, the walrus roundworm, a worm that lives in the tissues of raccoons, and there were two worms one could catch from consuming raw snake: *Spirometra*, a tapeworm, and *Gnathostoma*, a roundworm. The natural hosts of these worms were dogs, cats, and other mammals.

*Spirometra* causes a bizarre eye disease called sparganosis. In the Far East people put poultices of raw frog or snake muscle directly on the eye for various ailments. Tapeworm larvae then migrate from the poultice into the tissues around the eye. Eating undercooked frog or snake can also cause infection. In these cases there's fever, along with high eosinophil counts, and eventually larval tapeworms migrate from the patient's intestine into the tissues, forming tender swellings.

I skipped down the page to the paragraph on diagnosis: Wait for the nodules to form under the skin, remove one surgically, look inside for a glistening, white, slowly undulating worm. No other diagnostic tests are available. The only known treatment is surgical excision of the nodules. *Spirometra* was a possibility, but if Hanh had this worm, there was nothing to do about diagnosis yet.

The final suspect on my list was the roundworm *Gnathostoma spinigerum*. To find out more about it, I had to turn to an old book put out by the Armed Forces Institute of Pathology titled *Pathology of Tropical and Extraordinary Diseases*. This is one of the most gruesome books in anyone's medical library, filled with photos of faces being eaten up by fungus and worms crawling across eyeballs.

In the book was a diagram of a gnathostome, anchored by its spiny head to the stomach wall of a leopard, tiger, dog, or cat. But the worm makes a circuitous journey to get there. The adult host passes eggs that are eaten by a tiny, one-eyed water bug called *Cyclops*. A fish, frog, or snake then eats the infected copepod. The larva escapes the *Cyclops* and the host's intestinal tract and forms a cyst in the muscles.

When Hanh ate the raw cobra heart, which is mostly muscle, one or more of these encysted larvae could have been liberated into his stomach by the processes of digestion. Since he wasn't a member of the dog or cat family, the larval worm would not mature to adulthood there, but instead, would burrow through his stomach wall into the abdominal cavity, penetrate the liver, and head for the muscle tissue under the skin. Hanh's symptoms fit the clinical description perfectly: fever, pain and pressure over the liver, hives, plus the highest eosinophil counts recorded in any infectious disease.

According to my book, Hanh's worm would reach the outer tissues in about a month, and then he would start to have swellings under his skin. But since man is an abnormal host for this parasite, he would not settle down in one muscle but would continue to restlessly wander through the body of the host for up to twelve years.

I read with horror that the tunneling worm sometimes finds its way into the brain. When that happens, fatal damage follows. At autopsy, worm trails zigzag the brain like they'd been made with a Etch A Sketch, and a tiny larva, still alive after the host's death, is found at the end of its last trail.

I'd gone as far as I could on my own, and now I needed to call a few experts.

Dr. Claire Panosian, at the University of California at Los Angeles, is an infectious disease doctor like me, but she studied at the famed London School of Tropical Medicine and has always had a special interest in parasitic diseases. I told her Hanh's whole story. She listened carefully, and, in her

usual methodical way, she reviewed all the diagnostic possibilities, which were the same ones I come up with.

“You know, Pam,” she added for completeness sake, “this could be eosinophilic leukemia.”

“I hope not,” I said, thanking her and promising to call her back with follow-up information.

I also tried Dr. Linda Croad, an infectious disease colleague at a sister facility within our HMO. Her hospital cares for a large immigrant population, so I thought she might have seen a patient like this. She agreed that the raw snake had to be the key to the diagnosis, but she didn't have any personal experience either with gnathostomiasis or with sparganosis.

Finally, I called the Centers for Disease Control and Prevention. An operator with a friendly Georgia accent answered, “CDC, Atlanta.” She connected me with Sue Partridge, a health education specialist in the parasitology branch. I identified myself as a physician infectious disease specialist and she invited me to present Hanh's case. Ms. Partridge was impressed by Hanh's eosinophil count and thought that my roundworm diagnosis, gnathostomiasis, was a real possibility. She recommended that I consider starting therapy with the new worm medicine, albendazole.

“Do you have any blood tests for gnathostomiasis at the CDC?” I asked.

“We don't, but one of our colleagues in Thailand does,” she said. “I can fax you information on how to send a specimen.”

I thanked her and promised to call her with follow-up information on Hanh. Later that afternoon the fax arrived. I was directed to send two milliliters of blood at room temperature with a check for forty-five dollars via airfreight to Dr. Wanpen Chaicumpa at the faculty of tropical medicine in Bangkok. Prior notification was important because someone would have to meet the specimen at the airport and move it through customs.

After reading this, I decided to wing it and trust my hunch. Albendazole is safe and easy to take. I called Vy, told her what the experts said, and asked her to pick up the prescription for albendazole that I was going to call in to the pharmacy.

Two days later Hanh came to my clinic for an appointment. He was a lean young man with bright brown eyes and a handsome grin. We reviewed his history, and then he climbed up on the exam table. His examination was almost entirely negative, and on the surface he looked well. But he had a fast pulse, a sign of some hidden commotion. I sent him down for a repeat blood count, and his eosinophil count had climbed to an astounding twenty-five thousand. Tests for dengue fever, amebiasis, and stool parasites were negative.

But Hanh was feeling steadily better on his albendazole tablets, and his fevers were less severe every night. I ordered a literature search on gnathostomiasis from the library. Then I turned my attention to other problems.

Linda Croad called for advice about a meningitis case. She thought it might be the very contagious meningococcus. Would I suggest that she treat an entire college dormitory for possible exposure right away or wait for the culture results? Also, she wanted to know how the “cobra heart guy” was doing. A bone marrow transplant patient went into respiratory failure from pneumonia. One of my HIV patients

got sick and was admitted to the hospital; another came to my clinic strung out on cocaine.

Then about two weeks later Vy called me again. “Hi, Vy,” I said with a sinking feeling. “How’s Hanh?”

“Oh, he’s feeling much better,” she said, “but he has a swelling on his abdomen for two days now.”

She told me it was on his left side, was the size of a small egg, and was tender and red. So, our worm was coming to the surface and, despite two weeks of albendazole, it was still alive.

“Vy,” I asked, “Do you think Hanh would agree to a minor surgical procedure? Maybe we can get rid of this worm, once and for all.”

“Yes, I think he will,” she said.

About a week later, I met Hanh and Vy in the minor surgery clinic. We watched while the physician’s assistant anesthetized Hanh’s skin and used a scalpel and scissors to remove a “two-centimeter long, very firm, non-mobile, cord-like” piece of tissue from Hanh’s abdominal wall. She picked it up with forceps and dropped it into a jar of formalin. Then she closed the incision with two layers of stitches and bandaged the wound.

A few days later I went down to the basement of the hospital, and the pathologist and I, using a double-headed microscope, examined stained slides of Hanh’s nodule. The tissue was filled with inflammatory cells, including the bright red eosinophils. Deep in the dermis was a tunnel of dead tissue, running through the entire specimen. The pathologist followed it from one slide to another but there was no worm, no head bulb with its four rows of spiny hooklets, no intestines, no sexual organs, no fragments of cuticle, nothing. Our quarter-inch worm had barreled a tunnel through Hanh’s tissue and gone elsewhere, trailing behind it a swarm of pursuing eosinophils.

Frustrated, I stood up from the microscope feeling guilty. I had cut out a piece of my patient’s body for nothing. I went to see the laboratory supervisor. It was time to send Hanh’s blood to Bangkok.

As I feared, the process of sending blood to Thailand was a bureaucratic nightmare. The most difficult part was arranging for the specimen to be picked up at the Bangkok airport. Hanh had to come in twice to have his blood drawn before the lab supervisor was able to successfully make all the arrangements and get the specimen off on its journey to the other side of the world.

I had absolutely no problem getting the results, however. One afternoon a few weeks later, I was sitting at my desk at work, and an e-mail message popped up on my screen. It was from Dr. Wanpen Chaicumpa. The serum specimen sent on the patient, Hanh Le, was unequivocally positive for *Gnathostoma* by Western Blot analysis. Our diagnosis was correct.

I’ve since learned that a gnathostome will flee to the surface of a patient being treated with albendazole, but the worm moves so quickly that it is hard to catch. By the time doctors remove the swelling like Hanh’s, the worm is usually long gone. The only exception is if a worm wanders into a dead end like a fingertip; then it is possible to remove it surgically before it has a chance to back out.

As for Hanh’s worm, it just disappeared. My guess is that the albendazole killed it and that it dissolved. At any rate, after several months Hanh’s eosinophil count gradually returned to normal, and

he has been well ever since.

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I haven't seen any more patients with gnathostomiasis yet, but I expect to someday, because the disease is not rare. A species of it occurs in Mexico and is transmitted to people through undercooked fish. Remember that when you're ordering ceviche.

Human beings live and travel all over the earth, pushing native plants and animals aside wherever they go. Because we are among the largest and most powerful animals on the planet, we forget that we can put ourselves in grave danger by not respecting the smaller creatures that are part of the natural balance, too.

When we think of natural habitats, we think of the world around us. But every animal is also the natural habitat of the creatures adapted to live inside it. When Hanh ate the snake, he evicted the spirit little worm from its red velvet house and made it a restless wanderer in an alien place.

## wounded hearts

I threw the covers off and sat up.

My heart was pounding, and I felt like I was breathing in a vacuum. It was three o'clock in the morning in the call room at the Grace–New Haven Hospital in Connecticut, and in the next bed the pediatric resident was sound asleep. A big truck rattled down the highway and shook the windows of the old building. I jumped out of bed, put on my shoes, and pulled on my white lab coat. I ran down the hall, down three flights of stairs, and out of the building into the spring night.

The old houses surrounding the hospital were dark and quiet, and my lock and chain banged noisily as I unhooked my bike from the rack. I jumped on and headed for home, standing up to pump the two miles to my house as if something were after me. My white coat billowed back as I fled past houses and storefronts, across the highway bridge, past the New Haven common and its three white churches dimly lit, on to Orange Street and finally to tree-lined Edward. In thirty minutes I was safe in my own bed on the third floor of the wooden house where I lived with two classmates.

I had abandoned my patients and run away from everything I had worked for my entire life. I'd had an anxiety attack.

It was the clinical rotations, which started in the middle of the second year of med school, that had gradually unhinged me. Our early months had unfolded in the safe darkness of the amphitheater where we listened to lectures, looked at slides, and spent so much time with our one hundred classmates that we could recognize each other's silhouettes if we broke the beam of the projector.

Now, though, we were on our own. They sent us to the Fitkins, St. Raphael's, the Memorial Union, and the Veterans Hospital in groups of two, three, or four, but for all the camaraderie I felt, I could've been alone. In the classrooms there had been no examinations and no grades, but on the wards, our friends became grim competitors for the approval of the attending physicians. The evaluations we earned from these professors determined our future: who would win the best residencies and who would enter the coveted specialties. The single-minded drive that had gotten us into medical school in the first place surged to the surface and cut us off from each other.

Most mornings I was too nervous to eat. We had to draw blood and insert IVs into sick people. When we missed they sometimes got angry, or, far worse, they quietly cried. Then you knew that you weren't a healer; you were an inept, miniature version of their disease.

By the time I got to pediatrics in the spring I was nearing the end of my rope. What should have been a benign rotation filled with jovial pediatricians and cherubic babies became, instead, a season of hell on the adolescent ward. My partner, a confident and handsome former Yale jock, would have nothing to do with me. He had reached his stride, and the attending, a dry academic with an interest

pediatric neurology, loved him. So did the nurses. He had the trim, muscular grace of a water polo player and great “hands.” When he drew blood from the kids, he never seemed to miss.

I, on the other hand, was a lost soul.

Everything I saw and everything I was asked to do scared me. The residents assigned me to an eleven-year-old from South America whose chronic kidney disease had distorted the growth of all of his bones. His hands, his limbs, even his ribs were bent and dwarfed. I suffered to look at him because his disease seemed like such a terrible destiny for a child. He was just a gentle kid, but I was afraid of him—afraid of hurting him more by imposing my awkward, amateur “help” on him, and afraid of whatever it was in nature that caused such things.

The nurses could have pushed me along, as they did my golden boy partner, by asking me leading questions and by sharing their observations and jokes with me. But in those days, there was an unspoken competition between the nurses and the female med students. While they seemed to adore the males, they were cool to me. They wouldn’t tell me what to do, or how to do it.

So I hid out. I wandered the ward in my short white coat, tomboy khaki pants, and clunky Clarks or Trek shoes, helping a boy with leukemia put a few pieces into his puzzle, peeking into the microbiology lab at the end of the hall, and holing up in the call rooms or the library. The library, at least, was a legitimate place to be, because we were supposed to be studying, and I found out the South American boy had something called “rigger jersey vertebrae.” Incurable.

The culmination of this ghostly existence came the night Janine went off her rocker. She was a fourteen-year-old African-American girl from the neighborhood who had been admitted a few days before with a fever. As the medical student, I was supposed to examine Janine, write up my findings, read about her illness, and run scut. (Scut comprises miscellaneous chores that run downhill and land on the med student—drawing blood and taking it to the lab, checking results, arranging tests.) I was a poor scut runner, but I did read about Janine, who turned out to be a fascinoma from the get-go.

The word “fascinoma” is medical slang for fascinating plus “oma,” usually a tumor, but here applied to a patient. It’s a case where the diagnosis is obscure and the illness is severe. With a fascinoma everyone feels that the patient has a classic case of something, but no one can figure out what it is. Janine had been on the ward for about five days with a high fever. She was a fascinoma because cultures of her blood and urine were still negative, suggesting that she didn’t have an infection, and she didn’t seem to have one of the fever-causing collagen diseases, like rheumatoid arthritis, either.

But Janine had a Roth spot. When we looked into her left eye with the ophthalmoscope we could see through the lens and beyond all the way to the retina, which makes up the eye’s back wall. The Roth spot was a little white area set in the retina’s pink field between the gold cables of the arteries and the flatter blue lines of the veins. The eye’s circulatory system had hurled something there, and we could see it as a tiny point of damage, like a meteor crater.

While we were still trying to figure out where they were coming from, those same little particles in her circulatory system started landing in her brain. I don’t remember at what hour of the night her delirium began, but I was on call. Janine was lying in bed in a pool of light, feverish and und

restraint. She was muttering and shouting incoherently. I had no idea what to do. Her mother and aunt, however, seemed remarkably calm and self-possessed as they quietly read to Janine from their Bible. I was out of the picture, without even a diagnosis to offer. They had taken over her care.

It was that night, or maybe the next call night, that I ran away. I was a green recruit under fire for the first time, and while I lay in the dark of the call room, some force of self-preservation decided to propel me all the way to California, if necessary. I know now that it was more than just a fear of failure. It was fear of what I would have to become to survive as a doctor. Every day I had to witness pain, and occasionally inflict it, and the clinical rotations were a traumatic initiation into a new way of being. I was changing forever, becoming different from people outside the world of medicine. In order to deal with suffering calmly, I was being forced to lose my emotional response to it. The choice, as I understood it, was to feel or to heal. And I wasn't sure who I'd be if I chose the path of healing over the fullness of feeling.

Yale Med wasn't unaware of what it was asking of us, and it dealt with my crisis gently. Everyone knows how hard it is to get into medical school, but few people realize how loath a school is to throw you out once you get there. I think the administrators saw us as high-strung thoroughbreds, skittish at the starting gate, but potentially fast as hell on the track. They gave one particularly brilliant student, my future husband, Glenn, a stereo system to cheer him up. They assigned me to a female psychiatric resident.

Dr. Slatkin had gone into medicine after having a family and was just the right person to take me in hand. She offered me heavy-duty tranquilizers, but I opted instead for three days off and a series of appointments with her, at Yale's expense. I spent those three days wandering over the New Haven green taking black-and-white pictures of sleeping drunks. They were outsiders like me, but they seemed oblivious to failure.

I recovered my nerve and went back to the hospital. I finished pediatrics and went on to neurosurgery, where I poked needles into the unanesthetized radial arteries of women with brain metastases from breast cancer.

"Why do you have to do this, Doctor?" frightened women whispered through their tears. I myself wasn't clear on the reason for the test. I only knew why *I* was doing it: because the resident told me to.

I held back livers with retractors until my arm ached, while the surgeon removed the patient's gall bladder. I scrubbed in on six-hour heart surgeries, at the end of which the patient's heart couldn't be restarted no matter how many times we made it jump with the paddles. I was completely overwhelmed the first two times I walked into surgery, and I backed out of the room as quickly as I entered to avoid throwing up in my mask.

Nowadays, medical students are offered much more emotional support than when I was going through these early clinical rotations in 1973. Back then many of us were trained by doctors who believed that our survival depended on our ability to lead with our heads instead of our hearts. The disconnect between facts and feelings was seared into us, sometimes in a most brutal way. During one of my early clinical rotations, the senior resident paged me to the bedside of the patient I was taking

care of at the VA. The old man, whom I had been talking to a few hours earlier, was dying, and the resident wanted me to see the agonal heart rhythms on the monitor. But I arrived a moment too late. Emil had just gone flat line. I stood behind the resident looking at the pale soles of that nice old man's feet.

"Ah, there you are!" the resident said, turning around. "You just missed an interesting heart rhythm. Maybe I can get him to do it again," he said, striking Emil's skinny chest with the flat part of his fist. But the green line stayed flat. "Too bad," he said and walked off. I just stood there feeling like a fool because nobody had told me that my patient was going to die. I looked around to make sure the resident was gone. Then I put my hand on his cooling chest and said, "Goodbye, Emil."

By the time I got to the abortion clinic and stood at the stirrup end of the procedure, I was numb almost everything. But it was in this clinic that I found out that my numbness was not yet covered by emotional insulation, a toughening process that would come later. My actual state was one of openness and vulnerability, and because of this a ray of light from an unexpected source was about to pierce my soul.

The neighborhood teenagers climbed up on the table in hospital gowns open in the back with a sheet wrapped around their waists. There was a flash of red in the suction tube, a yelp, and then they climbed down white-faced and shaky while the resident said, "Next." There was nothing for me to do but watch. Idly I turned around and looked down into one of the vacuum bottles.

At first all I saw was a pool of red and yellow glup. Then, as I was about to turn away, I saw a tiny hand that had been torn free. The light from the overhead surgical lamp shone through each pale pink finger. At first I just stood frozen. Then suddenly I was shot through and through with a joyful awe. In that moment, all of my fear and anxiety about my suitability as a doctor, my concern about the numbness that was stealing my sense of compassion, the emotional confusion and feelings of insecurity that had so troubled me during the past year, all seemed to make a strange kind of sense for that one moment. In those tiny translucent fingers, I knew for certain that what I was seeing was the hand of God. And it wasn't pointing at me or accusing me. It was reaching up past me toward something over my right shoulder from which it could not be separated.

Although I have never been formally religious, the vivid memory of this experience has never faded. Since then I have always been able to feel the spiritual side of things and to believe in divine and invisible powers. It was only by touching bottom in the weeks that proceeded that afternoon that I was able to see something much higher as well. Like Moses, who hid himself in the cleft of the rock, I was allowed a glimpse of something radiant. It was what I got in exchange for what I was losing.

What I lost as a result of all of my experiences that year was part of my emotional range. Since then I've never been able to cry in front of anyone who isn't a family member. But as a result of my training, I do have equanimity; I'm cool under fire. My feelings never make me panic or run away anymore, no matter how hopeless or depressing the patient's illness is.

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