

# The History of Machupo Virus in Bolivia: Arenavirus Hemorrhagic Fever

Tiffany Y. Strauchs

*Yambuku* is what the Africans called the Ebola virus that struck hundreds of victims in Sub-Sahara Africa in 1993 and received so much notoriety in the American news media. What most people do not know is that an outbreak of a "sister" virus to Ebola occurred in a small community in the Amazon Basin in Bolivia about one year later. Similar to its deadly and highly-infectious relative, the Bolivian virus killed mostly the poor indigenous people. *El Typho Negro* and *Machupo* are the names given to the virus by the Bolivians. Just as with the Ebola virus, the Machupo virus is also named after the river in the region of the outbreak. This hemorrhagic fever virus appeared in the town of Magdalena in July, 1994. During the first few weeks of July, the Machupo virus woke from its dormancy and emerged from the jungle. Señor Bismar Monasterio, father of three and a cattle rancher on the *Campo Alegre* ranch, was herding the cattle with the other cowboys. On July 10th, Bismar checked into the primitive hospital in Magdalena. He was experiencing symptoms of dehydration from vomiting and a high temperature. (The doctors suspected that he had salmonella, gave him infusions of an antibacterial drug, and released him.) Three weeks later he returned. This time, he was hemorrhaging blood.

That is the background of my visit to Magdalena. I had received a small undergraduate research grant (SURG) from Carnegie Mellon University to travel to Bolivia to hunt down the origins of this virus and speak to survivors. I did not know at the time that a recent outbreak had occurred just a few weeks before my arrival. I did not understand that the cutting down of the earth's rain forests may have deadly ramifications that most of us have never considered.

When I arrived in Magdalena, Bolivia, children greeted me, asking if they could carry my bags to the hotel. They loaded my suitcases into a wooden cart and pushed it a mile into town. I hopped on the back of a motorcycle taxi. No matter what anyone had previously told me about the living conditions and health of the people in Magdalena, I was unprepared for what I saw during that first week. Local doctors took me to several villages in the region where the poor people lived in mud or grass huts with no running water or electricity. Many were very ill and presumed that I was an American doctor with miracle cures for severe parasitic infections, meningitis, crippling arthritis, and other illnesses which are manageable in the United States. I was shocked when doctors told me that immunizations were too

expensive to administer in these very poor villages. I was saddened to learn that yellow fever and malaria continue to kill many people each year because they do not have the money to purchase mosquito netting. When I told the local doctors that I was here to do research on *El Typhus Negro*, a somber groan emerged from my erudite "tour guides" and they took me directly to the hospital where the Machupo patients were treated. When I saw the green, dilapidated, one-story building surrounded by a broken fence and crosses in the front courtyard, I tried to suspend my judgement about the medical treatment given to patients within the building. In the foyer, a large statue of the Catholic saint of healing, St. Ignatius, was adorned by fresh flowers. There were offerings of gifts at his feet—presumably, these were gifts presented by the people who hoped that they could appease the Saint Ignatius who would, therefore, heal their relatives of parasites—maybe even cure them of the dreaded Machupo virus.

I set to work for the next week translating the medical records of the largest previous outbreak that occurred in July, 1994. The translation of the medical histories was tedious work. The medical records office was in a small stucco room with poor ventilation. I sat there, sweating profusely for three days, hoping that the bugs hanging from the ceiling were not the *Vincuca* bugs carrying a parasitic disease that would infect me if they dropped down onto my neck and injected their parasites through their bite. I could only conduct my research during daylight hours because the town has only limited periods of electricity. A few days later, a man came to visit me. At first, he was embarrassed to approach me. He would not face me when he spoke and avoided eye contact. I finally approached him. I told him that I was a researcher from the United States and that I came to Bolivia to study the Machupo virus and that I would be appreciative if he had any information regarding the virus. He replied, "I am Señor Bismar Monasterio. I am the sole survivor of the virus and I will assist you in any way possible because *El Typhus Negro* took away my entire family. Please, help us." The month that followed this shocking first week was filled with many more questions asked, but few answered. Similar to the researchers in Magdalena that preceded me by three decades, I was puzzled by the modes of transmission and location of the epicenter of the outbreak. "The Black Typhus" was what two young American doctors, Drs. Karl Johnson and Ron MacKenzie, saw in 1962 when they arrived in the city which was in panic due to an outbreak of an unknown virus—a ruthless killer. This virus was one of the first "new" classes of arenaviruses known as hemorrhagic fevers. Was this virus really "new" or did the doctors stumble upon an ancient virus that was recently "stirred-up" by the increasing growth of the human population and its impact upon the environment? The loss of the rain forest in South America may have greater repercussions than most people realize. To fully understand the threat and to find possible answers to these questions, it is important to first understand the history of the emergence of this "new" virus and modern medicine's efforts to eradicate it so it would not become a world-wide epidemic.

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The two young doctors who were about to challenge an invisible, virulent enemy, able to attack everything in its path, were Dr. Johnson, who had recently been working in the Middle America Research Unit (MARU) and was a virologist for the National Institutes of Health (N.I.H.) in Bethesda, Maryland, and Dr. MacKenzie, a doctor from the Department of Defense (D.O.D.).<sup>1</sup> Neither of them was prepared for what they found in San Joaquin. Hemorrhagic fever viruses, such as the one they discovered, are unique in the destruction they do to their victims. Most of the victims mistake their initial symptoms of fever, sweating, and muscle pains for the flu when, in fact, they have one of the most deadly viruses known to the planet. After the virus has begun to replicate and begins to infiltrate its host with its own RNA, the flu-like symptoms escalate to severe paralytic muscle contractions and physical exhaustion in the patient. Soon the involuntary blood-letting begins, as the body's capillaries, which act as tributaries to and from the veins, develop microscopic holes that allow the blood to flow into the cavities and tissues of the body. Out of these holes flows water and blood proteins which are important to maintain the body's electrolyte balance. Even the patient's eyes fill with blood, making them look like half-crimson moons. Around day-five of the infection, the patient's esophageal lining begins to bleed and he or she is unable to eat and must be fed intravenously. Due to the severe internal bleeding, the patient's body begins to swell and turns slightly pink in color. The spleen and liver swell and lymph nodes empty lymphocytes into the blood stream to attempt to combat the virus. It is not long until the patient begins to bleed from every orifice of his or her body. Death occurs only when the victim either bleeds to death or falls into a coma after seizures due to dehydration.

It was in this state that Drs. Johnson and MacKenzie found their patients in the city of San Joaquin. Johnson and MacKenzie left the scene of the epidemic and flew directly to the MARU to convince the director that they were facing a dangerous epidemic. "It is probably just the flu," said the director and the N.I.H. officials, even after the doctors had told him that the patients were vomiting blood. Without any support from the N.I.H. or the D.O.D., Dr. Johnson flew to Fort Detrick in Frederick, Maryland. In the 1960s, Fort Detrick was doing research into biological warfare agents, and the scientists there knew a great deal about viral agents and took the greatest precautions when handling them. Fort Detrick is one the two centers in the United States that has a Maximum Containment Facilities for handling dangerous pathogens, otherwise known as the Level Four Hot Zones (The Center for Disease Control [CDC] in Atlanta, Georgia, is the second facility in the United States). Drs. Johnson and MacKenzie thought that the disease they saw in San Joaquin was similar to two arenaviruses recently discovered in 1958 along the Junin River in Argentina.<sup>2</sup> The first of the two viruses they suspected was Tacaribe. Tacaribe is a hemorrhagic fever virus that may exist in bats and rodents, but there was not any evidence that it was contagious to humans. The second hemorrhagic fever virus that had recently emerged from

the tropical jungles in Argentina is named Junin. Junin is lethal to humans. Its outbreak was found among men working in the corn harvests. The victims of Junin had disrupted capillaries and bled to death. It was unknown whether Junin was airborne. With this risk in mind, Dr. Johnson went to Fort Detrick to study their virus containment facilities. While he was there, he invented the first portable negative pressure glove box—air flows into the box instead of out of it.<sup>3</sup>

Dr. Johnson flew back to Bolivia to the city of Magdalena which was the site of the initial infection of “patient zero.” He was surprised to find that nobody was actually becoming infected there. They were, instead, being infected in San Joaquin which is fifty miles from Magdalena. Johnson’s team questioned how the virus could travel that distance. Since the virus incapacitates its victims quickly, it would be very unlikely that the carriers of the virus were walking this great distance while ill. Was some type of rodent or bat carrying the virus? Was the virus spread through bat or rodent dung? These are some of the questions that the team set out to research.

During the month of May in 1963, Johnson’s team set up their labs in the foothills of the Andes mountains on the tributary of the Machupo River. Dr. Kuns flew in from the N.I.H. to assist. The three doctors hauled ten thousand pounds of equipment into the town of Joaquin on mules. When the doctors arrived, the epidemic had been raging for fourteen months. The people mourned every day when the church bell tolled another death and fresh graves filled the cemetery.<sup>4</sup> The team began its research by painting numbers on all of the doorways to people’s adobes. They then questioned the town’s people. The questions they asked are:<sup>5</sup>

- 1) “How many people in your house have had the disease?”
- 2) “How many died and how many recovered?”
- 3) “What were they doing in the days before they got sick?”
- 4) “Is there any chance one family member gave the disease to another?”
- 5) “Have any animals been sick?”

The answers to the questions made the doctors suspect a virus. As it turned out, one-half of the people in the town had been infected. Of those who had been infected, one-half died. There are very few viruses in the world that have a morbidity rate of nearly fifty percent. With the results of their survey, the doctors understood how deadly the agent was that they were researching and took precautions to protect themselves by setting up safe laboratories and using Johnson’s negative pressure glove box. The first laboratory they built was only for animals and insects they caught and suspected of hosting the virus. The second laboratory that was built had windows with screens and tight doors. The lab was also rigged with rodent traps and doused with DDT to protect the scientists from their unknown predator.<sup>6</sup>

In the month of June, the local priest was finally convinced by the doctors to allow them to do an autopsy on a two year old boy who died of the



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disease. From this first autopsy the doctors were able to isolate a substance that they collected from brain and spleen tissues. It produced the disease when it was injected into hamsters. They passed the substance through filters of different sizes and were able to finally discern that they were, in fact, working with a virus. They were able to rule out the possibility that the disease was either parasitic or bacterial because it passed through all of the filters and was resistant to antibiotics.<sup>7</sup> Midway through an autopsy, a serious accident occurred. The scalpel of Dr. Hugo Garron slipped out of his hand and flew across the autopsy table and struck Dr. MacKenzie's hand.

A week had passed after the accident, and with MacKenzie remaining asymptomatic, the team continued their autopsies. The physiological and metamorphic changes that had taken place within the victim's bodies were drastic. When they autopsied the brains of victims, the areas in which there should have been cerebrospinal fluids was filled with crimson blood. All of the protective meningeal layers around the brain were blood-soaked. In addition, the team noticed that before a patient became a victim of the virus, all of his hair fell out.<sup>8</sup>

On July 3rd, MacKenzie fell ill to the virus and had to be flown by U.S. military transport to the MARU unit in Panama. Over the next four days Johnson fell ill, too, and wished that he had been on that plane to Panama. Johnson hitchhiked plane to plane across Bolivia, Peru, and Columbia to reach the Gorgas Hospital in Panama. There he lay beside his colleague—both bleeding to death. As the doctors lay there, they were tortured by their intimate knowledge of the virus. They knew that their deaths would be bloody and painful. The virus kills in two ways. The first way that it might kill them is from neurological complications. They would lose control of their muscles, have grand mal seizures, and die. The second way in which the virus claims its victims is through cardiac arrest. In this scenario, the patient's internal bleeding is so severe that the volume of blood hemorrhaged from capillaries causes the body to go into shock. In all hemorrhagic fever viruses, the capillaries leak out fluids and proteins and the chemical balance that maintains organs like the kidneys, liver, spleen, and heart are endangered. It is important to maintain electrolytes in the patients to minimize the risk of them going into shock.<sup>9</sup>

The doctor who was treating MacKenzie and Johnson was a veteran of hemorrhagic fever viruses. He had treated men who had another fever called Seoul Hantaan Virus during the Korean War. One-hundred-twenty-one trench-bound American soldiers in the Korean War died bloody deaths due to the virus. (Between the years 1951 and 1955, 2,500 U.S. soldiers suffered from the Hantaan virus.)<sup>10</sup> During the doctors' illnesses, Dr. Johnson's fiancée, Dr. Pat Web, visited him in Panama and she, too, fell ill with the virus. but it was not until she returned to America when she realized the severity of her illness. Dr. Web was treated at the N.I.H. in Bethesda, Maryland, and, fortunately, made a full recovery. Miraculously, all of them recovered. Since they now had antibodies to the virus they would now be immune to further infection.

Laurie Garret, author of *The Coming Plague*, wrote: "The men returned to San Joaquin. They had shared a powerful scientific curiosity that pushed both doubt and fear aside, replacing them with a sleuthing urge every bit as powerful as that of a detective hunting down a serial killer."<sup>11</sup> Over the next year the men captured 10,000 mammals of a dozen species and over 10,000 insects. Most of these specimens were collected by Dr. Kuns and a team of villagers whom he assembled to help him find and trap animals and insects. One of Dr. Kuns' volunteers, Einar Dorado, held a big grey mouse in his hands while Dr. Kuns tried to jab it with a needle to withdraw its blood. The mouse bit Dorado and urinated on his hands. Two weeks later, Dorado was dead.

The doctors now had a clue as to what was the carrier of the virus. The villager's houses were filled with dozens of these mice. Drs. Johnson and MacKenzie offered to give two dollars to any villager who could bring in sick animals. In ten months, only five sick animals were brought in—all were the same type that bit Dorado.<sup>12</sup> The mice were of the *Calomys* species normally found in the bush. The scientists euthanized the sick animals and dissected them. The mysterious virus was found in their blood, spleens, and brains. Since these animals were sick, the doctors were still uncertain as to what the host was because a host of a virus never becomes ill. They formed the hypothesis that the virus was carried by insects that inhabited the fur of the rodents or by mosquitos that fed on the sick rodents and then feasted on humans. Between the years of 1963 and 1964, the scientists laboriously captured one-thousand insects, mashed them, and turned them into extracts; the virus was never found. The local people began to tire of the researcher's unsuccessful efforts and they began to loot the laboratories, stealing vital supplies. The situation became so bad that the Bolivian government flew in fifty-five soldiers to San Joaquin and established Martial Law. During the duration of the soldiers' stay, thirty-seven of them became ill with the virus.<sup>13</sup>

Finally Dr. Johnson had a breakthrough—he had discovered the winning theory. He found that after the hamsters were injected with the virus, they began to shed the virus in their urine. He made the discovery after he injected baby hamsters with the virus. The babies died and the adult hamsters ate them and became infected. Then, live babies became infected. How could this be possible unless the adult hamsters with whom they shared their cage were somehow spreading the virus?

The virus vector was finally located after Dr. Johnson did an experiment with the town. First he divided the town in half and gave mouse traps to one-half of the town and let the other half remain as it was. He asked the people with mouse traps to bring in as many mice as they caught. One woman brought in twenty-two mice she had caught in three mouse traps in one night. Dr. Johnson was elated to discover that the half of the town to whom he gave mouse traps had no new infections while the other side of town continued to have the same rate of new infections.

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Drs. Johnson and MacKenzie's team was successful—they stopped a deadly, silent, stalker in the eighteen months that they had been there. Dr. Johnson said, "Within eighteen months we isolated the virus, discovered its mechanism of transmission, and stopped it cold."<sup>14</sup> Dr. Kuns told the *Saturday Evening Post*, "You might compare us to firemen. We have discovered the location of the blaze and we have put it out. But we do not know where or when it could start again."<sup>15</sup> Between the years of 1962–1964, forty-percent of the residents of the village were sick with the virus and twenty to thirty-percent of them died. Due to the research of Drs. Johnson and MacKenzie, another outbreak would be successfully halted in later years which occurred deeper in the Brazilian rain forests.<sup>16</sup>

What were the social causes of the virus? Most viruses do not pop out of the jungle without human intervention. It was suggested that Bolivia's social revolution of 1952 was the initial and indirect cause of the outbreak. A radical group called the *Movimiento Nacionalista Revolucionario* was brought to power, and the party stripped the Bolivian and Brazilian oligarchies of their land, giving it to the people of San Joaquin. The Brazilian family that originally owned the land was called the *Casa Suarez* family (the House of Suarez). The Suarez family was in control of an Amazon River fleet of refrigerated steamships that carried beef 1,400 miles upstream to where the Amazon met the sea. The beef was then shipped to North America and Europe. The people of San Joaquin were descendants of cowboys who tended the Suarez's cattle. The villagers lived off of the surplus beef and relied on the steamships to return with vegetables and supplies for the townspeople. When the Suarez family was stripped of their land, they refused to buy it back and closed their businesses. This was terribly detrimental to the people of San Joaquin. They did not know how to grow their own food because they had entirely relied on the beef and the charity delivered by the steamships.<sup>17</sup> The people were left isolated, impoverished, and facing malnutrition. They grew crops to supplement the beef.

In haste to grow crops, the people chopped down dense jungle areas wherever the land naturally formed a flat mesa above the flood-zone of the Machupo River. By doing this, they disturbed the natural habitat of the *Calomys* field mice and gave the rodents a superior new food source, corn. The rodent population escalated in the 1950s, and by the 1960s invaded towns and villages, looking for new territory and food. The rodents fed off of the townspeople's grain supplies and urinated on it. The virus could be eaten or inhaled and could also enter through cuts in the skin.<sup>18</sup> The leveling of the rain forest led to rampant death and illness—almost as if Nature was fighting back.

Dr. Johnson also saw some social patterns that contributed to the outbreak. Every morning before breakfast the women in the village would sweep the dirt floors of their huts. Johnson said, "Each time they sweep that broom, they are sending particles of mouse-infected dust and crumbs drifting

all about in the air.”<sup>19</sup> Johnson also noticed a dearth of cats in the village. He asked the townspeople where they had gone and they said that all of the cats died. Did they die due to the virus or was there another human social factor that may be involved? The death of the cats did coincide with the rise in the population of the field mice, but Johnson suspected that there was another factor that probably killed them first.

In the 1960s there was a massive DDT spraying campaign started by a malaria epidemic during construction on the Panama canal. Bolivia was spraying in such great quantities that the homes of the villager’s had a constant white film of insecticide covering all their furniture. Dr. MacKenzie did an experiment to determine if the cats were killed by Machupo or by DDT. He force-fed DDT to some cats and injected others with Machupo. The ones fed DDT died and the ones injected with the virus were fine. Drs. Kuns and Johnson went on the radio and held a campaign for people to donate cats to the town of San Joaquin. Shiploads of cats soon arrived and they were successful in keeping down the population of field mice. Maybe the research team was successful in discovering what the virus was which infected the townspeople, but it was the responsibility of the cats to keep the town safe. The cats have continued to be successful and Drs. Johnson and MacKenzie have gone on to combat other hemorrhagic fever viruses.

The Machupo Hemorrhagic Fever Virus is called an arenavirus. The arenaviruses known to medical science are Lassa Fever, Machupo, and Junin hemorrhagic fever viruses. They are all “Biosafety Level Four” pathogens and can be worked with only in a laboratory under Maximum Containment conditions.<sup>20</sup> The media and medical journal attention that has been given to hemorrhagic fever viruses in the 20th century may suggest that these are new viruses, but they are only new to the human race—they are not new to the planet. Dr. Gajdusek said in 1962 in the *Journal of Pediatrics*, “Viral hemorrhagic fever is itself an emergent concept: a product of events of the 20th century, albeit some of the diseases we recognize as such today were clearly known to man many centuries ago.”<sup>21</sup> Dr. Johnson said in his article titled, “Emerging Viruses in Context: An Overview of Viral Hemorrhagic Fever,” from the book *Emerging Viruses*, “They [the viruses] were all zoonotic infections and this fact, together with the violent on-going ecological change that has occurred on this planet since the end of World War Two and the emergence of modern virological science, has led to a perception that these are ‘emerging’ diseases. The viruses almost surely antedate our species.”<sup>22</sup>

If these viruses are not new and have emerged from the jungles due to human intervention, then why can we not combat these “old” viruses with our modern medical technology? Johnson says that the reason is that these viruses are RNA viruses (ribonucleic acid). The RNA viruses are able to replicate themselves in the circulating monocyte and macrophage which are the cells that the lymph nodes send out whenever the body detects an infection. It is for this reason that doctors find the lymphatic nodes in the bodies of victims of hemorrhagic viruses to be completely empty after an



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autopsy is conducted. All of the white cells were sent into the blood stream to fight the infection but they, in turn, served as replicating devices for the virus. This is why doctors have difficulties developing antidotes for the RNA viruses.<sup>23</sup>

Hemorrhagic fever viruses are not new; they have recently emerged from their hiding places deep in the rain forests due to the progress of humans and ever-increasing intrusion into the forests. Dr. Johnson says, "we know they (the viruses) are in Africa; we do not know where. I am personally not happy to report that there is hardly anybody trying to find out." Johnson attributes this apathy to lack of government funding and to the few Maximum Containment Facilities in the world. It is only due to humans tampering with the environment that these viruses have emerged, and because of this, the communities on the edges of the forests are the ones who suffer the consequences. Johnson concludes his essay by saying, "Most of the "new" hemorrhagic fevers emerged only because of large and often still accelerating ecological changes made by a burgeoning *Homo Sapiens*."<sup>24</sup>

Drs. Johnson and MacKenzie knew that the outbreak of 1962 was not the last time they would see the Machupo virus. In July of 1994, Señor Bismar Monasterio did not know about the technical history of the Machupo virus or of the CDC doctors from 1962, but he was about to become one of the sufferers of the illness and, more happily, part of a small fraternity of people who survived the virus.

While lying in his bed in the hospital in Magdalena, blood was oozing from every orifice in Monasterio's body; his body was filling with blood and he was drowning in his own body fluids. He was not alone in his small hospital room; his wife and children visited him frequently. The windows were open and the hot temperatures made his illness even more unbearable. A small, steel frame held his thin mattress and a single, bare light bulb lit the tiny room. However, he only had light from six in the evening to midnight. The hospital is not air conditioned and there are no meals served; everything that we expect as minimal requirements for comfort in an American hospital are not standard in Magdalena. His wife went to the hospital every evening to bring him his daily meals. After a while, he could no longer eat when his esophagus became swollen and tender. He was put on an IV and fed electrolytes intravenously to compensate for his loss of fluids.<sup>25</sup> Drs. Ali and Arce suspected that they had another case of the "Black Typhus" in the town of Magdalena. They gave Bismar supportive treatment hoping that their patient would out-last the hemorrhaging. They gave him an antibacterial drug, Chlorophenocol (which is also used for salmonella treatment), vitamin B, glucose, Gentomicin (an antibiotic), and Dioxodol for the fever. His white blood cell counts were decreasing. The doctors knew that the Machupo virus was turning his white blood cells into virus-replicating mechanisms.

After a while, his wife stopped coming to the hospital with the meals—she now occupied the bed next to her husband's. Maria Ester Acosta Riborola, a thirty-three year old housewife, was admitted into the hospital on August

8, 1994, with gastroenteritis. The rest of the Monasterio family continued their visits. Maria's mother took care of the children in their parents' absence. In addition, she brought meals to Maria and Bismar.

On August 9, 1994, Maria Riborola Monasterio, the ten-year old child of the two hospitalized patients, was admitted with flu-like symptoms. She soon began hemorrhaging. The doctors immediately began her support treatment of glucose, Dioxodol, and Ampicillin. Her temperatures were very erratic. Jorge Riborola Monasterio soon joined his parents and sister. Jorge was only three-years old. He entered the hospital on August 18, 1994. He had the same symptoms as the other members in his family, but as soon as his gums began to bleed profusely, the doctors in Magdalena were overwhelmed with their limited medical equipment and drugs. Soon after her older brother, Jorge, was brought in, Yovana Riborola Monasterio, ten month old baby, was admitted. The doctors in Magdalena decided to transfer the patients to a larger hospital in Trinidad, Bolivia. On the other hand, how were they going to get the patients there? This presented a problem because they certainly could not put the four ill patients on the commercial airplane, Aero Boliviano.

Bismar was beginning to improve. His temperature was going down and the hemorrhaging was decreasing. Pilot Eduardo Morales,<sup>26</sup> a missionary who often flew his plane to remote missions in the jungle, offered to take the family to Trinidad. On August 14, 1994, the mother and her children were loaded into the small, two seat plane with their IVs running. For thirty minutes, the patients drifted in and out of delirium on their way to Trinidad. In Trinidad, the ambulances were waiting and took them straight to the Hospital for Infants and Women. In the hospital's small isolation room, the patients were given blood and Valium.

Back in Magdalena, the outbreak continued. Soon after Morales' plane left for Trinidad on August 14, 1997, the mother of Maria Riborola and her eighteen-year old cousin were admitted. The doctors suspected that the women had become infected when they cared for the children. The cousin of Bismar, Madela Montero Riborola, also assisted with the care of the children while their parents were in the hospital in Magdalena. Bismar Monasterio said that he suspects that his cousin contracted the illness when she drank contaminated water in his house, but the initial mode of transmission was never fully established. Bismar's mother-in-law died on August 16, 1997, and Madela died a day later. In Trinidad, Maria and her children had similar fates. The youngest child, Yovana, was the first to die. Her small body could not withstand the pulmonary edema and she died of cardiac arrest on August 15, 1997—just a day after they arrived in Trinidad. The ten-year old female, Maria, died on August, 15, 1997. Jorge died on the same day as his mother, Maria, on August 17, 1997. Jorge died at ten in the morning—his mother could not hang-on any longer and she died at 2:10 in the afternoon.

There is a possible eighth patient with the Machupo virus. Mr. Bismar Monasterio told me about a man named Luis Suarez. He says that Señor Suarez is a meat salesman. I was told that he worked in the Campo (jungle

region), but did not live where he worked. (Presumably, he lived in the town of Magdalena.) Señor Monasterio suspects that Señor Suarez became ill after he ate a piece of spoiled fruit that he picked up from the ground in the Campo. He returned to Magdalena, sick. He had two children and a wife, but they never became ill with the virus. There is no formal medical history for Suarez, but there is a short medical history in essay-form which I found in Magdalena's hospital.

After my research was complete in Magdalena, I returned to Trinidad for a few days before beginning my journey home. During that time, I met with other doctors in La Paz who had worked on the Bolivian hemorrhagic fever virus. At the USAID office, I talked with Dr. Coco Velasco who had researched Machupo while he was a student at Harvard's School of Public Health. He gave me an international report that was co-authored by one of the physicians I had met in Trinidad, Dr. Maria A. Costales. This report mentions a patient of Machupo who is thirty-four years old and from Magdalena. He developed the symptoms for Machupo on August 28, 1994, just a couple of weeks after the Monasterio family died. He was transferred to a hospital in Cochabamba on September 3, 1994. During his third day in the hospital in Cochabamba, he began convulsing. He died later that day after severe gastrointestinal bleeding. I suspect that this patient was the same man that Bismar told me about.

Also mentioned in this report is the medical history of a fifty-two year old agricultural worker from San Ramon who was admitted into Magdalena's hospital on September 2, 1994. In contrast, this patient was lucky enough to be transferred to the hospital in Trinidad while a team from the Center for Disease Control was visiting. They administered an anti-viral drug called Ribavirin (ICN Pharmaceutical, Costa Mesa, CA). The patient recovered on September 23, 1997, but he still had signs of neurological damage.

Another patient with Machupo was lucky enough to receive Ribavirin. On October 10, 1997, a fifty-seven year old agricultural worker from San Ramon was hospitalized in Trinidad—Ribavirin treatment was initiated on that same day. By the tenth day of drug treatment, he had no fever, had a heart rate of 75, and a blood pressure of 90/70 mm Hg. He was walking around the hospital after the ten day drug regime. The authors of this paper remark that, while these results are positive, they cannot definitely conclude that the patient's recoveries resulted solely from the administration of Ribavirin.<sup>27</sup>

While this information about the administration of Ribavirin is good news for Machupo patients, it may never be reality for the majority of patients in Bolivia. According to Dr. Jimenez in Magdalena, this drug treatment is too expensive for the hospital. In addition, many of Machupo's victims are poor cattle herders or agricultural workers who contract the virus out in the jungle regions of the Campo—they certainly cannot afford Ribavirin. If the Bolivian government cannot subsidize the treatment, then it is not a realistic one. Dr. Velasco of USAID is in agreement. He said, "If I had a choice of providing kidney dialysis machines throughout the country, or Ribavirin, I would

choose the dialysis machines—many more people suffer from this illness than are struck by Machupo. Sometime you must consider which programs would help the most people.”<sup>28</sup>

If I had talked to Dr. Velasco before my research trip to Trinidad and Magdalena, I would have vehemently disagreed. Being a recipient of private American health insurance, I would have replied that every person should get equal health care—especially in the case of emergencies. However, after I visited the hospitals in Bolivia’s tropical interior, I realized that good health care is a challenge—even for the wealthy. The hospitals simply do not have the equipment or the supplies to adequately treat the large indigenous populations and the town’s people. Dr. Jimenez and his wife, Dr. Costales, explained to me that they do as much as they can, but there are public health issues that they do not have the resources to improve.

My expectations to improve health care in Bolivia have become more practical. I learned that a public health official must assess the necessity, and cost, of expensive drugs and medical equipment. Some things that I might consider to be a necessity in America (such as a respirator) may be a luxury in Bolivia. To be successful, public health officials must work within the existing system.

On the other hand, this is not to say that I do not have ambitions to improve the existing systems; perhaps those changes should start at the basic levels such as education of the indigenous populations and of poor people living in unsanitary conditions. Small behavioral changes, as previously mentioned in this report, would make significant differences. As a doctor, I would like to spend my future career doing this for indigenous populations.

In addition, the ecological changes causing the outbreaks of “new” viruses must also be addressed. The interest to preserve the rain forest is often viewed from the perspectives of biologists concerned about the potential for loss of bio-diversity when logging corporations buy large tracts of the rain forest and rapidly harvest their assets. In Bolivia the logging industry is booming because the benefits of delaying harvesting are minimal.<sup>29</sup> Apparently, viruses like Machupo are also “booming.” Human contact with undiscovered viruses remains an unwritten chapter in the history of mankind. We are now making choices which may adversely affect us in the future. The historian and biologist, Hans Zinsser, believes that humans are at mercy to the plagues and diseases which emerge from the environment. He says, “... typhus, with its brothers and sisters,—plague, cholera, typhoid, dysentery,—has decided more [military] campaigns than Caesar, Hannibal, Napoleon, and all the inspector generals in history. The epidemics get the blame for defeat, the generals the credit for victory ... only force against which political genius and military valor were utterly helpless—epidemic disease.”<sup>30</sup> Hence, perhaps humans have not yet fought our most ferocious enemies—the small viruses and bacteria that inhabit a realm within our world which we cannot yet master.



## Endnotes

1. Laurie Garrett, *The Coming Plague*, (New York: Farrar, Straus and Giroux, 1994), p. 18.
2. *ibid*, p. 18.
3. *ibid.*, p. 18.
4. *ibid*, p. 20.
5. *ibid*, p. 20.
6. *ibid*, p. 20.
7. *ibid*, p. 20.
8. *ibid*, p. 21.
9. *ibid*, p. 21.
10. *ibid*, p. 22.
11. *ibid*, p. 23.
12. *ibid*, p. 25.
13. *ibid.*, p. 25.
14. *ibid*, p. 26.
15. "The Search for the Invisible Killer," *Saturday Evening Post*, December 3, 1966, pp. 92-96.
16. R.B. MacKenzie, P.A. Web, and K.M. Johnson, "Detection of Complement—Fixing Antibody After Bolivian Hemorrhagic Fever, Employing Machupo, Junin, and Tarcaribe Virus Antigen," *American Journal of Tropical Medicine and Hygiene*, Vol 14, 1965: 1079-1084.
17. Garrett, *loc cit*, p. 15.
18. *ibid*, p. 27.
19. *ibid*, p. 27.
20. Fields, *Virology*, 2nd ed., p. 24.
21. D.C. Gajdusek, "Virus Hemorrhagic Fevers," *The Journal of Pediatrics*, 1962, Vol. 60: 841-857.
22. S.S. Morese, ed., *Emerging Viruses*, (Oxford: Oxford University Press, 1993), p. 46.
23. *ibid*, p. 48.
24. *ibid*, p. 55.
25. I was given xerox copies of all the patient's medical histories at the hospital in Magdalena. Bismar Monasterio was very helpful with the collection of the charts.
26. Name changed to preserve anonymity.
27. Kilmore, Ksiazek, Rollin, Mills, Villagra, Montenegro, Costales, Paredes, and Peters, "Treatment of Bolivian Hemorrhagic Fever with Intravenous Ribavirin," *Clinical Infectious Diseases*, 1997, 24:718-22.
28. Interview with Dr. Velasco on August 11, 1997.
29. Richard Rice, Raymond E. Gullison, and John W. Reid, "Can Sustainable Management Save Tropical Forests?" *Scientific American*, April 1997, pp.44-49.
30. Hans Zinsser, *Rats, Lice, and History*, (New York: Black Dog & Leventhal, 1996), pp. 133, 153.