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# Kuru: A Neurological Disorder

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## Abstract

Kuru is an incurable degenerative neurological disorder endemic to tribal regions of Papua New Guinea. It is a type of Transmissible Spongiform Encephalopathy's (TSE), caused by a prion found in human. It is now widely accepted that Kuru was transmitted among members of the Fore tribe of Papua New Guinea Kuru via cannibalism. The kuru is actually an infectious disease not caused by a virus, bacterium or parasite. Kuru was caused by what's called prions. Prions are misshapen proteins which would cause other proteins in the body to lose their shape. It was quite similar to other prion diseases such as Creutzfeldt-Jakob disease, BSE also known as Mad Cow Disease, and Scrapie. These are all well-known TSE's or Transmissible Spongiform Encephalopathy. To put it in easier terms, these diseases would essentially make the victim's brain spongy and full of holes. It is an extremely rare and fatal nervous system disease. The disease reached its peak during the 1950s and 1960s among the Fore people in the highlands of New Guinea. The Fore people contracted the disease by performing cannibalism during funeral rituals. It is characterized by difficulty walking, swallowing, and chewing. Symptoms also include loss of coordination and muscle twitching. Currently, there are no treatments available for Kuru. Although the disease is now virtually non-existent, Kuru provides a way for researchers to understand other prion caused diseases better.

**Keywords:** Kuru, Papua New Guinea, cannibalism, Prions.

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## 1. Introduction

Kuru is an incurable degenerative neurological disorder endemic to tribal regions of Papua New Guinea. It is a type of Transmissible Spongiform Encephalopathy (TSE)caused by a prion found in humans [1].The term "Kuru" derives from the Foreword "kuria/guria" ("to shake")[2] a reference to the body tremors that are a classic symptom of the disease; it is also known among the Fore as the *laughing sickness* due to the pathologic bursts of laughter people would display when afflicted with the disease. It is now widely accepted that Kuru was transmitted among members of the Fore tribe of Papua New Guinea via cannibalism[3]. The kuru is actually an infectious disease not caused by a virus, bacterium or parasite. Kuruwas caused by what's called prions. Prions are misshapen proteins which would

cause other proteins in the body to lose their shape. It was quite similar to other prion diseases such as Creutzfeldt-Jakob disease, Bovine Spongiform Encephalopathy also known as Mad Cow Disease, and Scrapie. These are all well-known TSE's or Transmissible Spongiform Encephalopathy. To put it in easier terms, these diseases would essentially make the victim's brain spongy and full of holes. It is an extremely rare and fatal nervous system disease. The disease reached its peak during the 1950s and 1960s among the Fore people in the highlands of New Guinea. The Fore people contracted the disease by performing cannibalism during funeral rituals. It is characterized by difficulty walking, swallowing, and chewing. Symptoms also include loss of coordination and muscle twitching. The name kuru translates to "shiver" or "trembling in fear." Kuru has no known cure and is generally fatal within one year [4].

**Kuru: Progressive Cerebellar Disease:**

The clinical features define kuru as a progressive cerebellar disease. It is much more than that with a wide variety of transient motor signs found in patients allowed carefully from onset to death. The progression of the cerebellar disease is clearly divided into three stages: ambulant, sedentary and recumbent, which often has a prolonged terminal state. The disease begins with pain (headache and joint pain); because this occurs for a variable period before the onset of cerebellar ataxia, it has been regarded, for clinical and epidemiological purposes, as a prodrome. Because such symptoms are common in the absence of kuru, particularly more recently with the increase in malaria in the highlands, and because kuru is the disease uppermost in people's minds in the region, false reports of kuru are common and require careful attention in epidemiological surveillance (they are recorded within the 'redherring' file of the database as recovery, rejected, reassigned or relinquish. No true recovery has ever been documented in a patient showing established signs of cerebellar ataxia; however, some patients have a long period of fluctuating illness at the beginning of their clinical course before settling into progressive, ultimately fatal, cerebellar disease [1]**.**

**Kuru: The First Prion Disease:**

Kuru disease is linked with the name of D. Carleton Gajdusek and he was the first to show that this human neurodegenerative disease can be transmitted to chimpanzees and subsequently classified as a transmissible spongiform encephalopathy (TSE), or slow unconventional virus disease. It was first reported to Western world in 1957 by Gajdusek and Vincent Zigas and in 1975 a complete bibliography of kuru was published by Alpers et al "Kuru" in the Fore language in Papua New Guinea means to shiver from fever and cold. The disease has been found to spread through ritualistic cannibalism and is an invariably fatal cerebellar ataxia accompanied by tremor, choreiform and athetoid movements. Neuropathologically, kuru is characterized by the presence of amyloid "kuru" plaques [5].

**Background:**

Kuru is among the fatal neurodegenerative prion protein (PrP) diseases in humans. Others include Creutzfeldt–Jacobs disease (CJD), Gerstmann–Straüssler–Scheinker (GSS) disease, fatal familial insomnia (FFI), and variant CJD (vCJD). PrP diseases in nonhuman animals include bovine spongiform encephalopathy (BSE) also known as, mad cow disease, chronic wasting disease (CWD), Scrapie, transmissible mink encephalopathy, feline spongiform encephalopathy, and ungulate spongiform encephalopathy. Although cross-species transmission of prion diseases seems to be limited by an apparent species barrier, the epidemic of BSE in the United Kingdom, which began in 1986, and its transmission to humans indicated that animal prion diseases could pose a significant public health risk.
The kuru riddle, which was initially considered a slow conventional viral disease, opened a novel field of biomedical sciences and initiated more than a quarter century of research. This research has resulted in two Nobel prizes (D. Carleton Gajdusek in 1976 and Stanley (B. Prusiner in 1997) and is linked to a third prize (Kurt Wuthrich), who determined the structure of the PrP. Kuru research has affected the concepts of nucleation-polymerization protein cancers and conformational disorders.

Kuru affected the Fore linguistic group of the Eastern Highlands of Papua New Guinea and, to a lesser extent, neighbouring groups with whom the Fore intermarried. The word kuru is derived from a term in the Fore language that means "to shake from fear" and stems from trembling as a conspicuous symptom of the disease Local verbal history, recorded when the disease was first studied by Western medicine in the 1950s, dated the onset of the first case of kuru to the 1920s. During the epidemic, this disease predominantly affected women and children of both sexes, but only rarely affected men. It was spread by the endocannibalistic funeral practices of the Fore. Family members were ritualistically cooked and eaten following their death, with the female relatives usually consuming the brain, which was the most infectious organ. The brain of the deceased was usually removed by one of the older women from the community whose hand would be wrapped in ferns. The prohibition of endocannibalism in the 1950s led to the decline in the epidemic; however, the disease has persisted into the present century because of an incubation period that may exceed 50 years. Only two kuru-related deaths were reported from 2003-2008, indicating that the epidemic is approaching its end [6].

**History:**

Kuru was first noted in the Fore tribes of Eastern Highlands and lowlands Provinces of Papua New Guinea as Australian administrators explored the area in 1953–1959. Kuru (Keru) was reported by W. T. Brown in Kainantu Patrol Report No 8 of 1953/54 (13 January 1954 - 20 February 1954.).The first sign of impending death is a general debility which is followed by general weakness and inability to stand. The victim retires to her house. She is able to take a little nourishment but suffers from violent shivering. The next stage is that the victim lies down in the house and cannot take nourishment and death eventually ensues." The same reports described the cannibalism practiced by the Fore people. It was in the late 1950s that the full extent of the disease was realized, after it had reached large infection rates in the South Forkof the Okapa Sub district, though the agent was unknown. Kuru was first noted in 1952-1953 by anthropologists Ronald Berndt and Catherine Berndt among the Fore, Yate, and Usanufa people. Charles O. Pfarr, Lutheran Medical Services was brought to the area by tribal persons and reported the disease to Australian authorities. Dr. Vincent Zigas, District Medical Officer began observation. Blood specimens and brain tissue were sent to Melbourne. In 1957, Dr. Daniel Carleton Gajdusek of the National Institute of Health joined Dr. Zigas at the research centre. Sister Eva Hasselbusch of Germany joined the hospital in 1959 to take care of the patients. Sister Maria Horn of Germany was the first trained sister to work with the doctors to study the disease. By 1968 the hospital ceased to function as a Kuru hospital and was closed (1886-1986, The Lutheran Church in Papua New Guinea by Herwig Wagner and Hermann Reiner).

The disease was researched by Daniel Carleton Gajdusek as part of an international collaboration with Australian doctor Michael Alpers. In the mid-1960s Alpers collected post-mortem brain tissue samples from an 11-year-old Fore girl, Kigea, who had died of kuru. He took these samples to Gajdusek in the USA, who then injected two chimpanzees with the infected material. Within two years, one of the chimps, Daisy, had developed kuru, demonstrating that the unknown disease factor was transmitted through infected biomaterial and that it was capable of crossing the species barrier to other primates. As kuru is the only epidemic of human prion disease in known human history, it has provided important insights into Creutzfeldt–Jacobs Disease (CJD) in humans and Bovine Spongiform Encephalopathy (BSE) in cattle [7].

**Discovery of Kuru:**

The first to study Kuru scientifically was Dr. Vincent Zigas who arrived in New Guinea in 1955 and was alerted to Kuru's existence by Patrol Officer MacArthur. In 1957 Zigas interested Dr. D C Gajdusek who had come to research child development and disease patterns. In March a Research Centre, constructed initially of native materials, was set up west of Okapa. Primitive at first, the research facilities improved during the next 10 years after which the place was closed down. The first researchers into Kuru noticed it seemed to run in families. They therefore postulated a genetic disorder – a mutation passed to off-spring. This explanation lost credibility because Kuru was common yet always fatal. A lethal genetic disorder should decrease in incidence as victims die and the proportion of genes responsible for it decreases in the gene pool[8].

**Figure 1: A kuru patient in Okapa region**

**The Mystery of Kuru:**

In 1957, a virologist who had studied several infectious diseases among remote peoples, came to New Guinea to study kuru. Carleton Gajdusek wanted to uncover the cause of this unique and always fatal disease. He searched for sources of toxins in the Fore's diet and environment. He conducted epidemiological studies and sent samples of brain tissue to the United States to be studied by a neuropathologist. Because there was no sign of inflammation in the bodies or brains of the kuru victims, and because kuru tended to appear within certain families, Gajdusek at first believed kuru was an inherited genetic disorder.

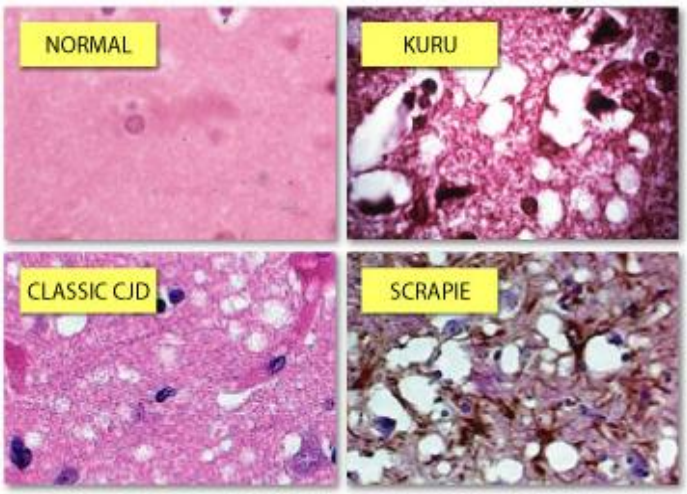


**Figure 2: Thin slices of kuru, classic CJD and Scrapie brain tissue under the microscope, it is easy to see that they are full of holes. The holes form after misfolded prion proteins kill neurons in the brain.**

In 1959 Gajdusek's work came to the attention of William Harlow, a research veterinarian who was studying a remarkably similar disease, called Scrapie, in sheep. Like kuru, Scrapie was a fatal disease that gradually destroyed the brains of sheep, leaving the brain full of holes and producing no immune response. And very importantly, scientists knew that Scrapie was infectious. The similarities between kuru and Scrapie led to begin experiments to show that kuru could be transmitted to chimpanzees. He then went on to show that classic Creutzfeldt-Jakob disease (CJD), another spongiform disease in people, was also transmissible. Ultimately, the rapid spread of kuru was linked to the Fore's funeral rituals: the Fore cooked and ate their dead relatives. This practice was only carried out by the fore women and children, who lived apart from the men. This explains why men were rarely infected, and why cases appeared within families. The Fore quickly stopped eating their dead, and the spread of the disease stopped. Unfortunately, because of Kuru's long incubation time, there are still a few kuru cases among the Fore each year. The people who come down with kuru today are in their 50s and 60s, which means that they have been harbouring the disease ever since they ate infected tissue as young children [10].

**Causes:**

1. Many believe that Kuru is a cannibal diseasespread due to the Fore tribes' cannibalistic funeral rites. Once a member of their tribe had died, they would be ritualistically dismembered by the female relatives. They would remove the arms, feet and brain. As well as ripping the muscle from their bones and would cut open the chest cavity and remove their internal organs. After the corpse was completely butchered they would cook and eat all the meat they'd accumulated, this included the brain. According to medical science, the brain is the most infectious organ of all.
2. The meat they had collected from the bodies was well treasured by the Fore. In fact the fat layers from the dead folk actually resembled pork and the men of the tribe were fed the best cuts. While the remains and brains were left for the women and children to feed on. Seeing how those parts were more likely to carry infection, this would explain why kuru disease was more prevalent in women and children.
3. Then not only were the women more apt to contract the disease because of the cuts of meat they were eating. But they were also responsible for dismembering the bodies. If any infection was present, they were more likely to catch something, by open sores or cuts and abrasions coming into direct contact with the infected flesh.
4. The effects from kuru disease were quite dramatic and an epidemic quickly followed.
5. The main risk factor for kuru is eating human brain tissue, which can contain the infectious particles [10].

**Symptoms of Kuru:**

1. The first noticeable symptoms of kuru were headaches, joint pain, physical tremors and a gradual loss of motor skills. It was not uncommon for some victims to burst out into pathological fits of laughter as another side effect.
2. In the later stages, signs of psychiatric disturbances develop, including loss of emotion control, depression, euphoria, agitation, and confusion. Dementia can also occur in individuals with kuru, but it is a relatively more common feature of CJD.
3. Neurological signs of kuru include hyperreflexia, loss of grasp reflex, strabismus, and nystagmus. Involuntary muscle jerking and twitching is observed, along with other cerebellar signs such as tremor on finger-to-nose testing, difficulty with heel-to-toe walking, and dysdiadochokinesis. Plantar responses include flexor, and hypertonia is often present in advanced cases.
4. Ptosis and occulomotor imbalance are observed in a small number of cases

5. Eventually, individuals with kuru become bedridden and may even be unable to sit, raise their head, or roll over. In advanced stages, patients lose the ability to chew, swallow, or control excretory processes and become progressively wasted [10].

Death results from starvation, complicating pneumonia, or infected decubitus ulcers. The preclinical or asymptomatic phase, also called the incubation period, lasts between possibly 5 to 20 years following initial exposure. The clinical stage lasts an average of 12 months.

The symptoms of Kuru are broken down into three specific stages.

**1. Ambulant Stage**:

It exhibits unsteady stance and gait, decreased muscle control, tremors, deterioration of speech and dysarthria (slurred speech).

**2. Sedentry Stage**:

In these stage patient is incapable of walking without support, suffers ataxia (loss of muscle coordination) and severe tremors. Furthermore, the victim is emotionally unstable, depressed, yet having uncontrolled sporadic laughter. Interestingly, the tendon reflexes are still normal at this point.

**3. Terminal Stage:**

In these stage, the patient is incapable of sitting without support, suffers severe ataxia (no muscle coordination), is unable to speak, is incontinent (unable to restrain natural discharges/evacuations of urine or faeces), has dysphagia (difficulty swallowing), is unresponsive to their surroundings, and acquires ulcerations (sores with pus and necrosis). An infected person usually dies within 3 months to 2 years after the first, often because of pneumonia or pressure sores infection [11].

**Pathophysiology:**

The prion is a naturally occurring protein found in the CNS and elsewhere. Prion diseases are associated with an accumulation of a disease-related isoform of host-encoded PrP through a posttranslational process involving conformational change and aggregation. According to the protein-only hypothesis, an abnormal PrP isoform is the principal, and possibly sole, constituent of the transmissible agent or prion.A common coding polymorphism at codon 129 of the PrP gene (*PRNP*), where either methionine (M) or valine (V) may be encoded, is a strong susceptibility factor for human prion diseases. Codon 129 heterozygosity protects against the development of iatrogenic and sporadic CJD and kuru. Protease-resistant glycoprotein, designated PrP, was isolated as a result of work done by Prusiner and co-workers in 1982 by progressive enrichment of brain homogenates for infectivity. The central feature of this protein was a posttranslational conversion of the host-encoded cellular prion protein (PrPC) to an abnormal isoform, termed PrPSc, that consists of ‘‘small proteinaceous infectious particles that resist inactivation by procedures which modify nucleic acids,” i.e., radiation, heat, or enzymatic degradation [6].

**Transmission:**

In 1961 historical research suggested that the epidemic may have originated around 1900 from a single individual who lived on the edge of Fore territory, who is thought to have spontaneously developed some form of (CJD)[12]. Alpers and LindenBaum's research conclusively demonstrated that kuru spread easily and rapidly in the Fore people due to their funeral practices, in which relatives consumed the bodies of the deceased to return the "life force" of the deceased to the hamlet, a Fore societal subunit [13]. The evident in the infection rates kuru was 8 to 9 times more prevalent in women and children than in men at its peak is because while the men of the village took the choice cuts, the women and children would eat the rest of the body including the brain, where the prionparticles were particularly concentrated. There is also the strong possibility that it was passed on to women and children more easily because they took on the task of cleaning relatives after death and may have had open sores and cuts on their hands [2]. Although ingestion itself of the prion particles can lead to the disease, there was a high degree of transmission if the prion particles could reach the subcutaneous tissue [14]. With elimination of cannibalism because of Australian colonial law enforcement and the local Christian missionaries' efforts, Alpers' research showed that Kuru was already declining among the Fore by the mid-1960s, although cases continued to appear for several more decades, and the last sufferer died in 2005. However, the mean incubation period of the disease is 14 years and cases were reported with latencies of 40 years or more for those who were most genetically resilient [15].

**Immune System Response:**

Due to the late onset of the disease, believed to be between 2 years to 50, scientists first thought of Kuru to be caused by a slow virus. However, there is no evidence of Kuru eliciting immune system response, or antibody reactions in those infected, most likely because host cells have a hard time identifying disease causing prions apart from normal Prps the host normally has [16].

**Epidemiology:**

**1. International:**

Kuru is restricted to the Fore, a people found in the New Guinea highlands, although there is a single report of a case of transmissible sub-acute spongiform encephalopathy occurring in a visitor to the eastern highlands of New Guinea. Kuru was acquired during endocannibalistic funeral rituals .When first investigated in 1957; kuru was found to be

present in epidemic proportion, with approximately 1000 associated deaths in the first 5 years of observation, 1957-1961.The total number of kuru cases from 1957-2004 exceeded 2700, with more than 200 dying of the disease every year in the late 1950s.

This number fell to about 6 per year in the early 1990s and between one and two cases per year in late 1990s, with only 11 cases identified from July 1996 through June 2004.More recently, kuru-related deaths declined to only two from 2003-2008. The prohibition of the practice of endocannibalism in the 1950s has clearly led to the decline in the epidemic, with a few cases still occurring because of kuru's long potential incubation period, which can exceed 50 years. Only 9 cases of kuru have been reported among Fore people who were born after 1956, and no cases have been reported among those born after 1959. However, zoonotic, not human, prion disease that is BSE continues to be sporadically seen. The BSE epizootic in the United Kingdom peaked in January 1993. There exists strong epidemiologic and laboratory evidence for a causal association between a new human prion disease called variant CJD that was first reported from the United Kingdom in 1996 and the BSE outbreak in cattle [6].

**2. Mortality/Morbidity:**

There is no effective treatment for kuru. It is uniformly fatal within 4-24 months of symptom onset. The incubation period may be as short as 5 years or as long as 50 years.

**3. Race**:

Kuru has affected only the people of the Fore linguistic group of the Eastern Highlands of Papua New Guinea and their neighbours with whom they intermarried.

The practice of endocannibalism was important to the Fore people as a way of respecting their dead relatives. It was rigorously forbidden, however, by the Australian government following the establishment of the Okapa patrol post in 1954 as one of the first administrative controls following contact with the people. Public consumption of dead relatives ceased almost immediately, and compliance was censured by local police responsible for the sub-district. By 1956, endocannibalism was effectively eliminated. Surreptitious eating of dead relatives was reported in remote communities for some years afterward, but, by the end of the 1950s, the practice had effectively ended. Epidemiological surveillance for kuru began in 1957 and has continued since.

**4. Sex:**

During the New Guinea epidemic, kuru was found to predominantly affect women and children of both sexes. Only 2% of overall cases were found in men from 1957-1958.

**5. Age:**

The latest year of birth recorded for any patient withkuru was 1959; only 9 individuals with kuru are recorded as having been born since 1956.During the peak of the epidemic, it was estimated that most of the affected individuals were young women, but a small number of children and postmenopausal women were found to be infected, as well as post-pubertal males in rare cases. The findings can be explained by women cooking and handling a dead relative's organs and women most commonly consuming the cooked brains. After age 6–8 years, boys were taken from their mothers and raised in the houses of men. From this point on, their exposure risk was the same as that for men, who typically had little participation in these feasts and did not eat cooked brains, by far the most infectious organ responsible for kuru. These cultural practices most likely explain why so few men developed with kuru [6].

**The Social Impact of Kuru:**

In addition to investigating the history and transmission of kuru, examined the Fore experience and response to the epidemic, and how they explained it to themselves. Between 1957 and 1977, some 2500 people died of kuru, most of them adult Forewomen. The pronounced sexual bias in kuru mortality was one of its most deranging aspects. In 1962, a sample of 125 Wanitabe males over the age of 21 showed that 63 had no living wives and 10 had never married. Women often died of kuru shortly after giving birth to a child. The motherless nuclear family was a common domestic unit.

Many men were thus forced to perform the roles of both mother and father. Some assistance was provided by sisters and brothers' wives, and small daughters often worked long hours in the gardens, but men took on many domestic activities once considered as the woman's sphere. In addition to clearing and fencing garden sites, well-recognized male labours, men now began to dig the ground, plant crops, weed and harvest, becoming progressively involved in women's tasks as their wives' capacities began to wane. Sometimes they cooked food and fed the children. Bride price was now withheld until the bride had survived long enough to produce a child Marriage speeches during the distribution of bride price often included directions for the distribution of the bride's death payment.

**Figure 3. Bride price presentation, 1962. Men pray that the bride will survive and produce children.**

Faced with a demographic emergency, the dimensions of which they grasped clearly, the South Fore had recourse to a series of desperate remedies During 1961 and 1962 the Fore expended much time, material wealth and emotional energy in an attempt to locate the sorcerers they believed to be responsible for the calamity. They also consulted a variety of curers in distant locations, taking ambulant victims of the disease on healing pilgrimages, the most spectacular of which took place among the neighbouring Gimi people. Between April and August 1961, more than 70 patients consulted a Gimi curer whose therapy consisted of bloodletting, the ingestion of medicinal barks and leaves, and the identification of the location where the guilty sorcerer might be found. Back at home, the sick women sometimes revealed the identity of their aggressor, said to have come to them in a dream. With the women present, men also conducted divination tests to reveal the sorcerers' identities, which often led to new tensions when the tests suggested that the sorcerers might be close neighbours and relatives. To the often expressed fear of extinction from the loss of women's reproductive power was now added a fear of internal disruption so great that their future was in danger.

The threat of banishment derived its force from the colonial regime's access to armed police, and the ability to jail those who disobeyed the new laws. Government patrols, though infrequent, caused a ripple of anxiety as the official party, including the police, camped for several days in selected communities, where they carried out a census, identified people with leprosy to be sent for treatment at a distant government hospital and adjudicated disputes that local groups had been unable to resolve.

**Figure 4: Brain eating phenomenon in kuru**

By then kuru was becoming rare, the political and social order had changed (Papua New Guinea had been an independent nation for more than 15 years) and discussions began to absorb new information, new experiences and to present additional views about the cause of kuru and its demise. As the great debates of the 1960s and the more informal discussions in the 1990s show, the Fore quest for truth is at the heart of sorcery beliefs, which seek to assign cause for severe illness, misfortune and death by identifying the persons responsible. This socio-medical analysis of the epidemic does not rest on germ theory. Nevertheless, it should not be viewed as a mere metaphor or fiction [17].

**Kuru & Cannibalism:**

The thoughts about the relationship between kuru and cannibalism rested heavily on data had collected concerning Fore rules about the consumption of human flesh, which seemed to fit the epidemiological evidence available to us at that time. Although it was no longer present in the 1960s, having been suppressed under pressure from the

government and missions, the Fore spoke openly about the recent customary practices of consuming the dead. The first government patrols in the late 1940s had also reported cannibalism to be customary throughout the region. Beyond the Fore, however, it was customary to consume enemies (exocannibalism), not deceased kin (endocannibalism), a pattern of behaviour with consequences for the transmission and geographical boundaries of kuru. All body parts were eaten, except the gall bladder that was considered too bitter. Not all bodies were eaten. The Fore did not eat those who died of dysentery, leprosy and possibly yaws, but kuru victims were viewed favourably.

Most significantly, not all Fore were cannibals. Cannibalism among adult men in the North Fore occurred more frequently than it did in the south; in the south, men rarely ate human flesh, and those who did said they avoided eating the bodies of women. Small children residing in houses with their mothers ate what their mothers gave them. Initiated youths who moved to the communal men's house approximately at age 10 left behind the world of immaturity, femininity and cannibalism. Consumption of human flesh was thus largely limited to adult women, children of the sexes and a few adult men, a pattern that matched the epidemiology of kuru in the early 1960[17].

**Figure 5. Foreinitiate1961. Accompanied by his father he visits relatives to exhibit his new status.**

**Treatment:**

1) Currently, there are no treatments available for Kuru. Although the disease is now virtually non- existent, Kuru provides a way for researchers to understand other prion caused diseases better.
2) Amongst the microbes known to man, infections by prions are believed to be the hardest to get rid of. This is because the traditional targets that normal drugs attack in bacteria's and viruses do not exist in prions. Prions have no nucleic acids, they are not cells, do not have cytoplasmic membranes or cell walls, no functional ribosomes, no metabolic functions and very little is understood about them.
3) In mice, anti- malarial drug, quinacrine and antipsychotic drug, chlorpromazine obstruct TS-formation. Clinical trials are in place for human testing.
4) Outside the host, the only possible way to deactivate prions are by incineration Autoclaving in 1N NaOH.
5) There is no known successful treatment for kuru. According to the University of Utah, boiling water, radiation, and acid cannot destroy the prions that cause kuru Brains contaminated with prions remain infectious even when preserved in formaldehyde for years
6) The patients can only be helped with certain supportive therapy. In the beginning the food can be given via feeding tubes and in later stages of the disease intravenous fluids and certain medications can only partially reduce the horrible symptoms [18-19].

**Diagnosis**:

**1. Neurological Exam:**

**Neurological examination** is the assessment of sensory neuron and motor responses, especially reflexes, to determine whether the nervous system is impaired. This typically includes a physical examination and a review of the patient's medical history but not deeper investigation such as neuro-imaging. It can be used both as a screening tool and as an investigative tool, the former of which when examining the patient when there is no expected neurological deficit and the latter of which when examining a patient where you do expect to find abnormalities. If a problem is found either in an investigative or screening process then further tests can be carried out to focus on a particular aspect of the nervous system (such as lumbar punctures and blood tests).

**Table.1 Specific tests in a neurological examination include**

| Category | Tests | Example of writeup |
|---|---|---|
| Mental status examination | The assessment of consciousness, often using the Glasgow Coma Scale (EMV)<br>Mental status examination, often including the abbreviated mental test score (AMTS) or mini mental state examination (MMSE)<br>Global assessment of higher functions<br>Intracranial pressure is roughly estimated by fundoscopy; this also enables assessment for micro vascular disease. | "A&O x 3, short and long-term memory intact" |
| Cranial nerve examination | Cranial nerves (I-XII): sense of smell (I), visual fields and acuity (II), eye movements (III, IV, VI) and pupils (III, sympathetic and parasympathetic), sensory function of face (V), strength of facial (VII) and shoulder girdle muscles (XI), hearing (VII, VIII), taste (VII, IX, X), pharyngeal movement and reflex (IX), tongue movements (XII). These are tested by their individual purposes (e.g. the visual acuity can be tested by a Snelling chart). | "CNII-XII grossly intact" |
| Motor system | Muscle strength, often graded on the MRC scale 0 to 5 (i.e. 0 = Complete Paralysis to 5 = Normal Power).<br>Grades 4 -, 4 and 4+ maybe used to indicate movement against slight, moderate and strong resistance respectively.<br>Muscle tone and signs of rigidity.<br>Examination of posture<br>Decerebrate<br>Decorticate<br>Hemiparetic<br>Resting tremors<br>Abnormal movements<br>Seizure<br>Fasciculation<br>Tone<br>Spasticity<br>Pronator drift<br>Rigidity<br>Cogwheeling (abnormal tone suggestive of Parkinson's disease)<br>*Gegenhalten* - is resistance to passive change, where the strength of antagonist muscles increases with increasing examiner force. More common in dementia. | "strength 5/5 throughout, tone WNL" |
| Deep tendon reflexes | Reflexes: masseter, biceps and triceps tendon, knee tendon, ankle jerk and plantar (i.e. Babinski sign). Globally, brisk reflexes suggest an abnormality of the UMN or pyramidal tract, while decreased reflexes suggest abnormality in the anterior horn, LMN, nerve or motor end plate. | "2+ symmetric, down going plantar reflex" |
| Sensation | Sensory system testing involves provoking sensations of fine touch, pain and temperature. Fine touch can be evaluated with a *monofilament test*, touching various dermatomes with a nylon monofilament to detect any subjective absence of touch perception.<br>Sensory<br>Light touch<br>Pain<br>Temperature<br>Vibration<br>Position sense<br>Graphesthesia<br>Stereognosis, and<br>Two-point discrimination (for discriminative sense)<br>Extinction<br>Romberg test - 2 out of the following 3 must be intact to maintain balance: i. vision ii. Vestibule cochlear system iii. epicritic sensation | "intact to sharp and dull throughout" |

| | | |
|---|---|---|
| Cerebellum | Cerebellar testing<br>Dysmetria<br>Finger-to-nose test<br>Ankle-over-tibia test<br>Dysdiadochokinesis<br>Rapid pronation-supination<br>Ataxia<br>Assessment of gait<br>Nystagmus<br>Intention tremor<br>Staccato speech | "intact finger-to-nose, gait WNL" |

**Blood tests**:

**1) Liver function tests**

**Liver function tests** (**LFTs** or **LFs**), are groups of clinical biochemistry laboratory blood assays designed to give information about the state of a patient's liver. The parameters measured include Prothrombin time (PT/INR), aPTT, albumin, bilirubin (direct and indirect) and others.

**2) Thyroid function test:**

Thyroid function test (TFTs) is a collective term for blood tests used to check the function of the thyroid. TFTs may be requested if a patient is thought to suffer from hyperthyroidism or hypothyroidism (underactive thyroid), or to monitor the effectiveness of either thyroid-suppression or hormone replacement therapy. It is also requested routinely in conditions linked to thyroid disease, such as atrial fibrillation and anxiety disorder [5].

3) **Kidney-function test**.:

**Creatinine clearance test**:

This test evaluates how efficiently the kidneys clear a substance called creatinine from the blood. Creatinine, a waste product of muscle energy metabolism, is produced at a constant rate that is proportional to the individual's muscle mass. Because the body does not recycle it, all creatinine filtered by the kidneys in a given amount of time is excreted in the urine, making creatinine clearance a very specific measurement of kidney function. The test is performed on a timed urine specimen—a cumulative sample collected over a two to 24-hour period. Determination of the blood creatinine level is also required to calculate the urine clearance.

**Urea clearance test**: Urea is a waste product that is created by protein metabolism and excreted in the urine. The urea clearance test requires a blood sample to measure the amount of urea in the bloodstream and two urine specimens, collected one hour apart, to determine the amount of urea that is filtered, or cleared, by the kidneys into the urine.

**Urine osmolality test**:

Urine osmolality is a measurement of the number of dissolved particles in urine. It is a more precise measurement than specific gravity for evaluating the ability of the kidneys to concentrate or dilute the urine. Kidneys that are functioning normally will excrete more water into the urine as fluid intake is increased, diluting the urine. If fluid intake is decreased, the kidneys excrete less water and the urine becomes more concentrated. The test may be done on a urine sample collected first thing in the morning, on multiple timed samples, or on a cumulative sample collected over a 24-hour period. The patient will typically be prescribed a high-protein diet for several days before the test and be asked to drink no fluids the night before the test.

**Urine protein test:**

Healthy kidneys filter all proteins from the bloodstream and then reabsorb them, allowing no protein, or only slight amounts of protein, into the urine. The persistent presence of significant amounts of protein in the urine, then, is an important indicator of kidney disease. A positive screening test for protein (included in a routine urinalysis) on a random urine sample is usually followed up with a test on a 24-hour urine sample that more precisely measures the quantity protein [5,20].

**Electro-diagnostic test**:

The exam may also include electro-diagnostic tests. These tests include **electromyography** (EMG) or nerve conduction velocity (NCV). These tests examine the electrical activity in your brain. Brain scans such as an MRI may be necessary as well. Electro-diagno**sis** is a method of obtaining information about diseases by passively recording the electrical activity of body parts or by measuring their response to external electrical stimulus. The electrical activity recorded may be spontaneous or elicited by stimuli. The most widely used methods of recording spontaneous electrical activity are electrocardiography (ECG) and electroencephalography (EEG). The evoked potential studies record the electrical responses after the stimulation of central nervous system structure.

**Other Considerations:**

The **incubation period** (the time between initial infection and the appearance of symptoms) of kuru can be as long as 30 years. Therefore, cases have been reported long after the practice of cannibalism has ceased.

**Brain biopsy:**

Brain biopsy is the removal of a small piece of brain tissue for the diagnosis of abnormalities of the brain. It is used to diagnose Alzheimer's disease, tumours, infection, inflammation, and other brain disorders. By examining the tissue sample under a microscope, the biopsy sample provides doctors with the information necessary to guide diagnosis and treatment [5].

**Prognosis:**

Similar to other the TSEs, kuru had a long incubation period; it was years or even decades before an infected person showed symptoms. Because kuru mainly affected the cerebellum, which is responsible for coordination, the usual first symptoms were an unsteady gait, tremors, and slurred speech. (Kuru is the Fore word for shiver.) Unlike most of the other TSEs, dementia was either minimal or absent. Mood changes were often present. Eventually, individuals became unable to stand or eat, and they died in a comatose state from 6 to 12 months after the first appearance of symptoms. Death usually occurs within 1 year after the first sign of symptoms [4].

**The Changing Face of Kuru:**

The epidemic of kuru is now known to have been transmitted among the Fore by ritual consumption of infected organs from deceased relatives. As cannibalism was suppressed by government patrol officers during the 1950s, most transmission had ceased by 1957, when the kuru research programme first commenced. As predicted in the 1960s, the epidemic has waned, with progressive ageing of kuru-affected cohorts over the years to 2007. The few cases seen in the twenty-first century, with the longest incubation periods, were almost certainly exposed as children prior to 1960. Although the research programme had almost no role in bringing the kuru epidemic to an end, it did provide important knowledge that was to help the wider world in controlling the later epidemics of iatrogenic and variant Creutzfeldt–Jacobs disease and bovine spongiform encephalopathy. Kuru is exceptionally rare. It is only contracted by ingesting infected brain tissue or coming into contact with sores infected with prions. According to NINDS, the disease has almost completely vanished [21].

## 3. Conclusion

The kuru is a neurodegenerative disease occurring only in fore tribes of highlands of Papua Guinea It is caused by prions protein. Kuru was observed in 1957 in which total 1000 peoples were died. Thus in 1957-61 totally 2700 people died. In 2004 kuru declined .It was found to be rarely occurring then. Kuru is exceptionally rare. It is only contracted by ingesting infected brain tissue or coming into contact with sores infected with prior. According to NINDS, the disease has almost completely vanished.There is no known successful treatment for kuru. According to the University of Utah, boiling water, radiation, and acid cannot destroy the prions that cause kuru. Death usually occurs within 1 year after the first sign of symptom. It is generally fatal within a year.

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