

Hantavirus - A Clinical Report, And Role of AI In Earlier Detection of The Virus

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Abstract- Hantavirus is a type of virus, spread mostly by rodents and can cause different malady disorders in individuals around the world. It belongs to Arboviral. Arbovirus is a casual name used to allude to any infections that are transmitted by arthropod vectors. Hantavirus is found mostly in tropical zones than temperate zones. It is one of the 500 viruses listed by the International catalog of Arbovirus. Out of 500, 100 can infect humans, including Hantavirus. Hence identifying at the early stage is necessary. This is done by using Artificial Intelligence. Using AI Framework, people can be screened easily.

Keywords- Hantavirus, HFRS & HPS, Symptoms, Prevention, AI

I. INTRODUCTION

When the world is attempting to discover a solution for the feared coronavirus pandemic, a report in Global Times said that a man from China's Yunnan region kicked the bucket from Hantavirus while on a transport to the Shandong region.

This occurred during the period of COVID 19 pandemic.

1.1 CHARACTERISTICS

The physical character of the virus is **Labile**, i.e., easily altered. The virus is readily inactivated at the room temperature. It is destroyed by the bile salts. The infectivity of the virus retained even at 70°C.

1.2 STRUCTURE

The structure of the virus is SSRNA virus (negative sense SSRNA in tri-segments). The segments can be of small, medium and large.

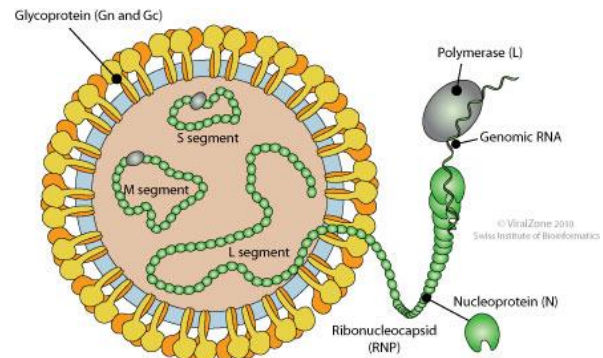


Figure 1: Structure of Hantavirus [2]

In figure 1, the structure of the Hantavirus is shown. The shape of the virus is Spherical. The diameter is ranged from 80 to 120 nm.

1.2.1 GENOME

A positive-sense single-stranded RNA (SSRNA) virus is a virus that uses positive sense single stranded RNA as its genetic material. Like different individuals from the Bunyavirus family, Hantaviruses are wrapped infections that comprises of three single-stranded genomes [4][5]. The S RNA encodes the nucleocapsid (N) protein. The M RNA encodes a polyprotein that is cotranslationally divided to yield the envelope glycoproteins G1 and G2. The L RNA encodes the L protein, which works as the viral transcriptase/replicase [3].

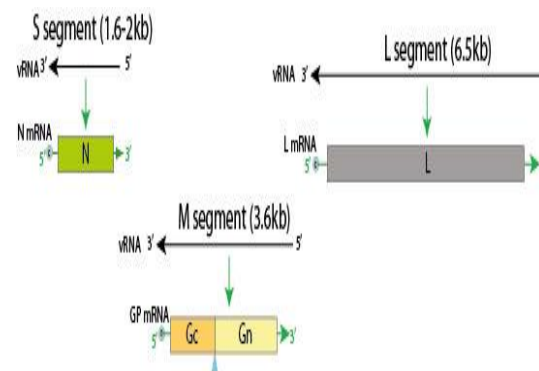


Figure 2: Hantavirus Genome [2]

In figure 2, the genome of Hantavirus is explained. The small segment of the virus consists of 1 to 3 kb, the medium segment is of 3.2 to 4.5 kb and the large segment is 6.9 to 12 kb. Here KB refers to Kilo Base [2].

Kilo base is the unit of measurement in Molecular Biology equal to 100 base pairs of DNA or RNA.

1.3 TAXONOMY

The Hantavirus belongs to the order of **Bunyaviridae** [4][5]. There are 5 genera inside the family: Bunyavirus, Phlebovirus, Nairovirus, Tosopovirus, and Hantavirus. Each is comprised of negative-detected, single-stranded RNA infections. [3] Every one of these genera incorporates arthropod-borne infections, except for Hantavirus, which is rodent borne.

1.3.1 IMPORTANT SPECIES

Hantavirus is the genus of Hantavirus, since it was found in Far East, China, Russia and Russia. This was named after the Hantan River in South Korea. The host species was *Apodemusagrarius* (striped field mouse). The disease caused in humans was Hemorrhagic fever with renal syndrome. The mortality rate of Hantan is 5-15 %.

Seoul virusis another virus, which is the genus of the Hantavirus. The geographic distribution of the Seoul virus was worldwide. The disease caused in humans was Hemorrhagic fever with renal syndrome. The host species was found to be *Rattusnorvegicus* (Norway rat). The mortality rate of Seoul virus is 1%.

Puumala virus belongs to the genus Hantavirus. The geographic distribution of the Puumala virus was Scandinavia, Europe, and Russia. The host species was found to be *Clethrionomysglareolus* (bank vole). The disease caused in humans was Hemorrhagic fever with renal syndrome. The mortality rate of Puumala virus is 1%.

Sin Nombre virus was found to be present in America. The host species was *Peromyscusmaniculatus* (deer mouse) and other reservoir rodent species. The disease in humans due to this virus was found to be Hantavirus pulmonary syndrome. The mortality rate of Sin Nombre is 50%.

1.4 PATHOGENESIS

The source of the infection is found to be Rodents. This is the definitive host of the virus. Sometimes humans may be the accidental host. The definitive host can be of Field

mice (*ApodemusAgarius*). The range of this species is from Eastern Europe to eastern Asia [4] [5]. The domestic rats in urban areas will also act as the host.

1.5 MODE OF TRANSMISSION

The virus is transferred mainly by inhaling the aerosols of rodent excreta such as urine, saliva and faeces (feces). Infection occurs when the person breathes in the virus particles [4]. Courses of transmission: ingestion, contact of irresistible materials with mucous layers, broken skin and by means of animal nibbles (rat to human through chomps has been recorded); rat to rat transmission by means of nibbles; the individual-to-individual transmission of Hantavirus has not happened in the USA, anyway individual to transmission has happened in Argentina, the individual-to-individual transmission is extremely rare.

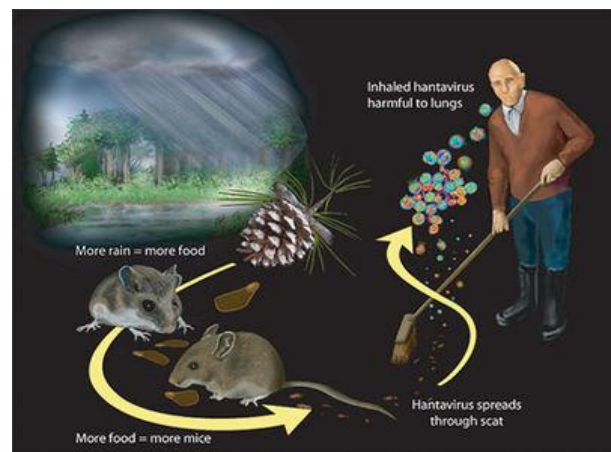


Figure 3: Transmission of Hantavirus [21]

In figure 3, the way of transmission of the Hantavirus is shown. The main host is the rodent. From the rodent wastes, the virus is spread to humans by means of air, or by rodent excreta. In most of the cases, this virus doesn't spread from humans to humans.

1.6 SYMPTOMS

The symptoms of the Hantavirus includes

- Fever
- Myalgia
- Headache
- Dizziness
- Non-productive Cough
- Vomiting

1.7 CONTRIBUTION

Paper discusses on Hantavirus to create awareness about it. We have contributed the Evolution and structure of the virus. How the virus is created, how it spreads, and what are the precaution needed to be taken and also prevention measures for one who is working and treating the admits in the healthcare unit. We have explained about, how the virus does enters the human body and how it affects. The main intention of the paper is to make everyone get to know about, how the virus spreads and how to prevent it from spreading.

1.8 ORGANIZATION OF THE PAPER

Section 1, of the paper provides an overview of Hantavirus, followed by Etiological agent, classification and structure of the Hantavirus. The family of the Hantavirus is also discussed. This includes Genome, Taxonomy and Pathogenesis. The section 1 ends with the Mode of transmission and Symptoms. Section 2 attempts to provide an overview of the related works with a neat comparison. Section 3 of the paper covers the Discussion part where the Origin, HFRS, HPS, NE, Treatment and Prevention are discussed. Section 4 covers the role of Artificial Intelligence in the prediction and treatment of previously occurred diseases. Section 5 includes the proposed solutions using Artificial Intelligence. Section 6 concludes the paper, followed by References.

II. RELATED WORKS

Joel M Montgomery *et al.*, proposed a paper on Hantavirus Pulmonary Syndrome, The sound of a mouse roaring [6]. The paper discusses about HPS (Hantavirus Pulmonary Syndrome) in detail. The origin and the cause of the virus are explained clearly. The paper fails to explain the symptoms, treatment and precautions.

- 1 Fanglin Zhang *et al.*, have proposed antiviral therapeutic against Hantavirus in his paper, An Improved Enzyme-Linked Focus Formation Assay Revealed Baloxavir Acid as a Potential Antiviral Therapeutic against Hantavirus Infection [7]. HPS and HFRS are clearly explained. A newly developed FFA-based approach to precisely titer HTNV is reported. The method to evaluate the anti-hantavirus effects of two existing antiviral drugs is provided.
- 2 Carlyn Harris *et al.*, have proposed a paper on Sociocultural determinants of adoption of preventive practices for hantavirus: A knowledge, attitudes, and practices survey in Tonosí, Panama [8]. In this the author has mentioned about the prevention measures which should be followed to avoid Hantavirus. The preventive practice is based on using health belief model (HBM).

Several daily preventive practices like wearing gloves and masks while cleaning, keeping trash in rodent-resistant containers are explained. The paper fails to provide the treatment for the virus.

- 3 Harinirina Aina Rabemananjara *et al.*, have proposed a paper on Human Exposure to Hantaviruses Associated with Rodents of the Murinae Subfamily, Madagascar [9]. The author suggested that their results mentions, population of Madagascar is exposed to Hantaviruses associated with the Murinae subfamily of rodents. The paper fails to say the origin, treatment and precaution measures of the Hantavirus.
- 4 Walter Muranyi *et al.*, have proposed a detailed report on their paper titled, Hantavirus Infection [10]. The Biology and epidemiology, host range, old world and new world Hantavirus are stated clearly. The clinical courses for NE, HFRS, HPS and the pathology of those were given. The replication cycle of the Hantavirus, laboratory diagnosis and the therapy for the Hantavirus is explained. The paper hoped that a better understanding of viral biology and pathophysiology will lead to more effective and specific therapeutic modalities in the future.
- 5 Zhenqiang Biet *et al.*, have proposed a paper on Hantavirus Infection: a review and global update [11]. Both Hemorrhagic Fever with Renal Syndrome (HFRS) and Hantavirus Pulmonary Syndrome (HPS) are explained clearly. The overall report on Hantavirus affected continents and countries are mentioned. Clinical courses and symptoms for both HPS and HFRS are shown with a neat comparison. The epidemiological features of the virus and Clinical features and management for both the viruses are shown and explained.

N. D. B. Ehelepolet *et al.*, have proposed a paper on Two Atypical Cases of Hantavirus Infections from Sri Lanka [12]. The paper provides an X-ray report of the Hantavirus affected person. But the paper fails to explain the prevention, symptoms, and clinical treatments and so on.

T. Avšič-Župancet *et al.*, proposed a paper on Hantavirus Infections in Clinical Microbiology and Infections [25]. The paper explains about the brief history and provides a clear explanation on the spreads, precautions and treatment of the disease. The author proposed that the Hantavirus is a group of infectious zoonotic disease. The symptoms and clinical diagnosis of the virus is explained. The paper states that, in the animals and humans, Hantavirus contaminations fundamentally happen in pneumonic or renal endothelial cells and macrophages, but the viral antigen is available additionally in a wide range of organs [25].

C. A. Hart *et al.*, have proposed a paper on Hantaviruses [26]. The paper mainly discusses about HPS (Hantavirus Pulmonary Syndrome). The author states that the Hantavirus is responsible for a variety of human illness. Each genotype of the Hantavirus appears from different rodent host. HPS occurred only in America, whereas HFRS occurred throughout the world. The paper discusses about the growth in cell culture, distribution and disease associations. The author proposed the distribution of Hantavirus in Great Britain and Northern Island.

Table 1: This table represents the related works published on the topic **Hantavirus**.

JOURNAL	DATE OF PUBLICATION	TITLE	OBSERVATION
PLOS Negl Trop Dis	Feb 27 2020	Sociocultural determinants of adoption of preventive practices for hantavirus: A knowledge, attitudes, and practices survey in Tonosi, Panama[8]	Using Health Belief Model preventive practices are shown
EID Emerging Infectious Diseases	Mar 3 2020	Human Exposure to Hantaviruses Associated with Rodents of the Murinae Subfamily, Madagascar[9]	Population of Madagascar is exposed to Hantavirus
Front Pharmacol	Oct 16 2019	An Improved Enzyme-Linked Focus Formation Assay Revealed Baloxavir Acid as a Potential Antiviral Therapeutic against Hantavirus Infection[7]	Antiviral against Hantavirus
JIDC The journal of infection in Developing Countries	Feb 2008	Hantavirus Infection: a review and global update[11]	HFRS and HPS reports are provided with Continent wise affected list.
JASN Journal of American Society of Nephrology	Dec 16 2005	Hantavirus Infection[10]	Precautions, Treatment, Laboratory diagnosis and therapy is observed and provided.

III. DISCUSSION

In 1978, a causative specialist Korean Hemerologic fever was confined from little contaminated field rat close Hantaan stream in South Korea. The virus was named as Hantaan virus, after the name of the waterway Hantaan [13]. Hantaviruses in America are known as "New World" Hantaviruses and may cause Hantavirus Pneumonic Syndrome (HPS). Different Hantaviruses, known as "Old World" Hantaviruses, are found for the most part in Europe and Asia and may cause Hemorrhagic Fever with Renal Syndrome (HFRS).

3.1 HFRS

HFRS stands for **Hemorrhagic Fever with Renal Syndrome**. It leads to symptoms like characterized fever + acute renal failure + petechial rashes.

3.1.1 ORIGIN

A baffling malady was first announced from Korea when it had been seen during pre-summer 1951 in UN Forces

working in the focal region near the 38th equal. The sickness indicated particular highlights which included high fever, low circulatory strain, hemorrhagic inclination, and intense renal disappointment. After Lee Ho-Wang prevailing with regards to showing the Hantaan infection which caused Hemorrhagic Fever with Renal Syndrome (HFRS), numerous examinations have uncovered different organic and epidemiological parts of the illness.

3.1.2 INCUBATION PERIOD

The hatching or the incubation time of HFRS is 7 to 36 days. Just 10 to 15% of cases have a serious course, with lethality rates between 6 to 15%. HFRS is described by the fundamental contribution of capillaries and venules. It initiates different hemorrhagic signs and flow issues i.e.) circulation disorder [14] [15].

3.1.3 STAGES

The clinical course is divided into five stages. They are Febrile, Hypotensive, Oliguric, Diuretic, and convalescent.

- **Febrile** stage lasts for 3-4 days with high fever, backache, abdominal pain, myalgia, etc.
- **Hypotensive** stage lasts for 2 days. Shock or hypotension might occur.
- **Oliguric** stage starts at day 8 and lasts for 3-10 days and hemorrhagic indications become increasingly noticeable.
- **Diuretic** stage starts from day 11. This results to hypertension.
- **Convalescent** stage lasts for about a month. This includes chronic renal failure and cause hypertension.

Also, thyroid, liver, and pancreas might be influenced. Lung inclusion yet to a lesser degree than in HPS is likewise seen during HFRS [15-17]

3.2 HPS

HPS stands for **Hantavirus Pulmonary Syndrome**. Symptoms for HPS include fever, malaise, myalgia, etc.

3.2.1 ORIGIN

In May 1993, an episode of an unexplained pulmonary illness happened in the southwestern US, in a region shared by Arizona, New Mexico, Colorado and Utah known as "The Four Corners" [18]. In November 1993, the particular Hantavirus that caused the Four Corners episode was segregated. The new virus was called Muerto Canyon

infection. It was later changed to Sin Nombre Virus (SNV) and the new illness brought about by the virus was named HPS (Hantavirus Pulmonary Disorder) [18].

3.2.2 STAGES

- For 3-4 days, the patient has **prodromal symptoms** like fever, headache.
- After 3-4 days, **cardiopulmonary symptoms** are seen. Those symptoms include Tachycardia, tachypnea and mild hypotension.
- Later, patient develops **pulmonary edema**, which results to respiratory failure, hypoxemia resulting to death.

Patients who endure the intense period of the illness recuperate ordinarily inside 5 to 7 days with no sequelae. Intense renal disappointment is auxiliary because of stunned and respiratory disappointment. [14]

3.3 NE

In Europe, the Hantavirus serotype Puumala causes NE, a milder variation of HFRS (Hemorrhagic Fever with Renal Syndrome). NE is described by an abrupt beginning with high fever, migraine, spinal pain, and stomach torment. The event of conjunctival hemorrhages, palatine petechiae, and a truncal petechial rash after 3 or 4 days is conceivable. Inside 3 days, the rash vanishes and the patients create polyuria. Serious courses of NE with intense renal disappointment and deadly result extend somewhere in the range of 0.1 and 1%

3.4 WORLDWIDE STUDY

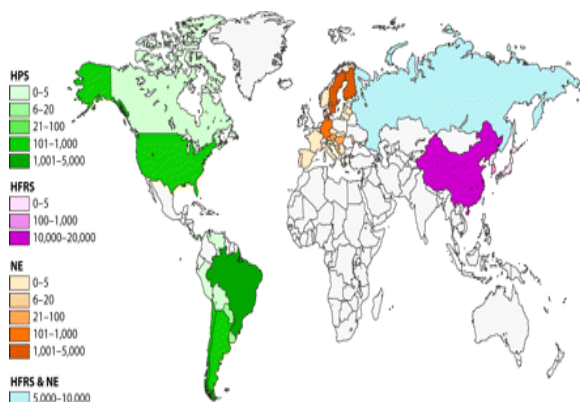


Figure 4: HPS, HFRS, NE, (HFRS & NE)

The figure 4 represents the spread of HPS, HFRS, NE, and (HFRS & NE). The number of countries affected in those areas are mentioned in four colors. Each color represents a virus.

3.5 REPLICATION

- Infection appends to host receptors however Gn-Gc glycoprotein dimer, and is endocytosed into vesicles in the host cell. [2]
- Combination of infection film with the vesicle layer; ribo-nucleocapsid portions are discharged in the cytoplasm.
- Translation, viral mRNAs are topped in the cytoplasm.
- Replication apparently begins when enough nucleoprotein is available to encapsidate neo-synthesized antigenomes and genomes.
- The ribo-nucleocapsids buds at Golgi device, discharging the virion by exocytosis. [2]

3.6 COMPARISON

A small comparison on the Target organ, evolution, first and second phase and the mortality rate is made between HFRS and HPS.

Feature	HFRS	HPS
Major target organ	Kidney	Lung
First phase	Febrile	Febrile "prodrome"
Second phase	Shock	Shock, pulmonary edema
Evolution	Oliguria, diureses, convalescence	Diureses, convalescence
Mortality	1-15%	50%

Figure 5: HFRS & HPS [19]

In figure 5, comparison between HPS and HFRS is shown.

3.7 TREATMENT

There is no particular treatment for Hantavirus disease. Nonetheless if the infection is gotten early and the patient gets clinical consideration in an emergency unit, they will probably improve.

Once in a while antiviral medications, for example, **Ribavirin**, are utilized to treat different strains of Hantavirus and related diseases.

3.8 PREVENTION

- Seal up openings or breaks through which rodents may pick up passage to your home or workplace.

Keep in mind, they can traverse openings that are a lot littler than you may suspect.

- Distinguish potential settling destinations and cautiously tidy up flotsam and jetsam, clear shrubs and trap rodents to expel them. When tidying up, wear defensive rigging and be incredibly mindful so as not to work up the infection by clearing waste and trash.
- Wear a respirator when cleaning buildings or home with overwhelming rat pervasions.
- Gloved hands ought to be washed with cleanser and water or an appropriate disinfectant. Hands ought to be altogether washed with cleanser and water following expelling gloves [20].

3.9 PRECAUTIONS FOR HEALTHCARE WORKERS

- Gloves and outfits and goggles/face shield ought to be worn when dealing with patients, conceivably irresistible examples, societies or tissues
- Extra essential regulation and work force insurances might be demonstrated for exercises with a high danger of vaporized or bead creation [20].

IV. AI IN HEALTHCARE

Artificial Intelligence is now leading the world in all fields. Especially, the use of Artificial Intelligence in Healthcare is used to predict, analyze and treat several new diseases.

4.1 AI PREDICTION

A Canadian wellbeing observing AI stage called **BLUEDOT** gave a notice on December 31st, an entire week before the world got on a new virus. On January 6, the American CDC gave notice about influenza like episode in China; they were trailed by the WHO on January 9. From that point forward the infection became to known as the Coronavirus and the flare-up turned into a worldwide consideration [22].

4.2 NEW MOLECULAR IDENTIFICATION

In computational medication a startup situated in Maryland, USA revealed that it had utilized Artificial Intelligence to quickly distinguish particles that could frame the premise of a viable treatment against the coronavirus at the core of the present circumstance [22]. They reported that the

Artificial Intelligence they used, took just 4 days to identify thousands of new molecules, which can be an antiviral for the upcoming and present viruses.

4.3 EARLY DETECTION

Artificial Intelligence is as of now being utilized to distinguish ailments, for example, malignant growth, i.e.) Cancer, all the more precisely and in their beginning times [24]. As per the American Cancer Society, a high extent of mammograms yields bogus outcomes, prompting 1 of every 2 sound ladies to be told they have malignancy. The utilization of Artificial Intelligence is empowering audit and interpretation of mammograms multiple times quicker with 99% precision, lessening the requirement for pointless and unnecessary biopsies [23].

The expansion of consumer wearable's and other clinical gadgets joined with Artificial Intelligence is additionally being applied to administer beginning time, and early stages of coronary illness (heart disease), empowering specialists and different guardians to all the more likely screen and identify possibly dangerous scenes at prior, increasingly treatable stages.

4.4 TREATMENT BY AI BOTS

Robots have been utilized in the field of medicine for over 30 years. They extend from straightforward research center robots to profoundly complex surgical robots that can either help a human specialist or execute tasks without anyone else. Notwithstanding medical procedure, they're utilized in emergency clinics and labs for tedious errands, in restoration, active recuperation and on the side of those with long haul conditions. [24]

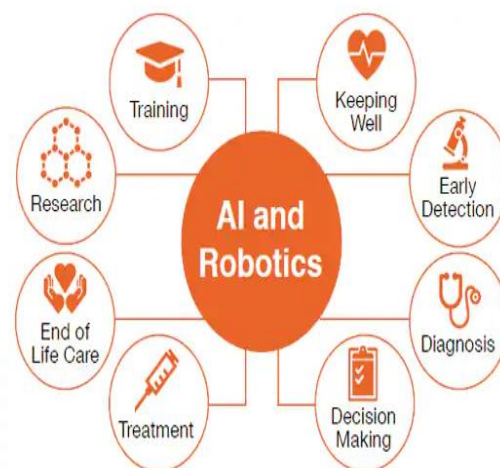


Figure 6: AI in healthcare [24]

In figure 6, the use of Artificial Intelligence in the healthcare sector is shown. Hence an AI system is able to predict, analyze, and also used in the treatment of several diseases.

V. PROPOSED SOLUTIONS

By providing the previous affected persons details (set of data's) to the AI system, the AI framework is capable of identifying whether a person is infected or not. By using Machine Learning technique, comparing the data does will be easy and produces productive results. This helps to avoid spending a lot of time for Doctors to analyze the report, rather the AI Framework analyze the whole report in just a fraction of seconds. This is done by training the AI with some set of data's and testing The AI with another set of data's. This will enhance the accuracy of the findings. Using AI, screening the patients will be an easy and time saving process.

We can use Artificial Intelligence to process the gigantic proportion of data adequately open online from general prosperity affiliations, population databases, tracking animal and plant disease networks and transport records. Automated affliction observation stages are presently engaging us to follow and see the spread of illness all around through a blend of Machine Learning and Natural Language Processing and had the alternative to report the spread of Hantavirus or any other virus, faster than the World Health Organization.

An Artificial Intelligence system can be made which uses cameras outfitted with PC vision and infrared sensors to anticipate people's temperatures in open zones. People with suspects can be monitored for further treatments. This enables the screening time faster rather than screening every individuals personally.

VI. CONCLUSION

This paper covers an overview of Hantavirus, structure, characteristics, replication, transmission modes, prevention measures and treatments. The explanation behind this paper is to provide clear and important guidance to safe assignments through the expectation, early disclosure, and control of Hantavirus. This also includes the Artificial Intelligent system used in Healthcare units and the earlier detection of the virus in the body by using AI Frameworks and Machine Learning algorithms.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors have no conflict of interest.

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