

Epidemiological Approach to the Hantavirus Outbreak and the Role of the Social Dimension of Health Care

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Abstract: In late 2018, in the town of Epuyén, Argentine Patagonia, the outbreak of Andes hantavirus begins. Evidence led to the interhuman transmission hypothesis. The comparative analysis carried out by the National Administration of Laboratories and Health Institutes (ANLIS, *Administración Nacional de Laboratorios e Institutos de Salud*) Malbrán of Argentina showed that the viral genotype was Andes Sur. The percentage of genetic identity reached 99.9% and confirmed, univocally, that the transmission mechanism was from person to person. This finding indicates a unique and extraordinary event that required a multidimensional approach, incorporating the collective health approach to transform biomedical therapeutics through an intersectoral, interinstitutional and intercultural work based on the dynamics of social determination and its impact on the health/disease/attention/care process. The chain of contagion had 4 clusters with 34 confirmed cases and 11 deaths. Overall mortality was 32.4%, women doubling the number of deaths compared to men. This article presents not only the hard data of the outbreak, but also the observation of the socio-cultural context in which it took place and the value of social determination in the health care process, criteria without which selective respiratory isolation (ARS, *aislamiento respiratorio selectivo*), the main tool for containing the outbreak, would not have been possible in the multiethnic and multicultural context of the Patagonian region. Incidentally, 8.7% of the population of Chubut province recognizes itself as indigenous and more than half of the 100 communities are distributed in the area where the outbreak occurred. The concept of indigenous health is linked to a holistic view of balance between the individual and the universe, confronting the hegemony of the bio-model. This confrontation challenged the health team to look more deeply into the social collective and to find there the agreements and synergies that allowed the successful continuation of the intervention until the resolution and conclusion of the outbreak.

Keywords: Epuyén, Andes Sur Virus, Person-to-person Transmission, Social Determination, Interculturality

1. Introduction

Andes virus, one of the five hantaviruses known to cause the Hantavirus Cardiopulmonary Syndrome (HCPS), emerged in 1995 in southwestern Argentina. Phylogenetic analysis would reveal that all viruses analyzed from the Andean-Patagonian region belong to the Andes lineage. On the other hand, although human infection occurs mainly by inhalation of aerosolized particles contaminated with droppings of infected rodents, the results with Andes virus would show the first direct genetic evidence of interhuman transmission of a hantavirus [1, 2]. *Oligoryzomys longicaudatus* (OL), whose habitat is the Andean-Patagonian mountain range, was identified as the reservoir rodent.

There are four affected areas in Argentina. The northwestern region, including mainly the provinces of Salta and Jujuy; the northeastern region, including the province of Misiones; the central region, including the provinces of Buenos Aires, Santa Fe and Entre Ríos; and finally, the southern or Patagonian region, including the provinces of Neuquén, Río Negro and Chubut [3].

Two decades after the discovery of the Andean virus [4], in late 2018, a new outbreak begins in the town of Epuyén-Chubut, in central Patagonia, Argentina.

The region presents human activities -work and tourist/recreational ones-, which favor exposure to rodents. Consequently, judging by the contagion scene [5], nothing would raise suspicion of interhuman transmission at the

beginning of the outbreak. However, once again, as in 1996, evidence would lead to the hypothesis of interhuman transmission, attributable to the pattern of transmissibility and clustering of cases, to low capture of rodents in the areas of residence of the cases and to socio-environmental assessment around the sites of probable transmission.

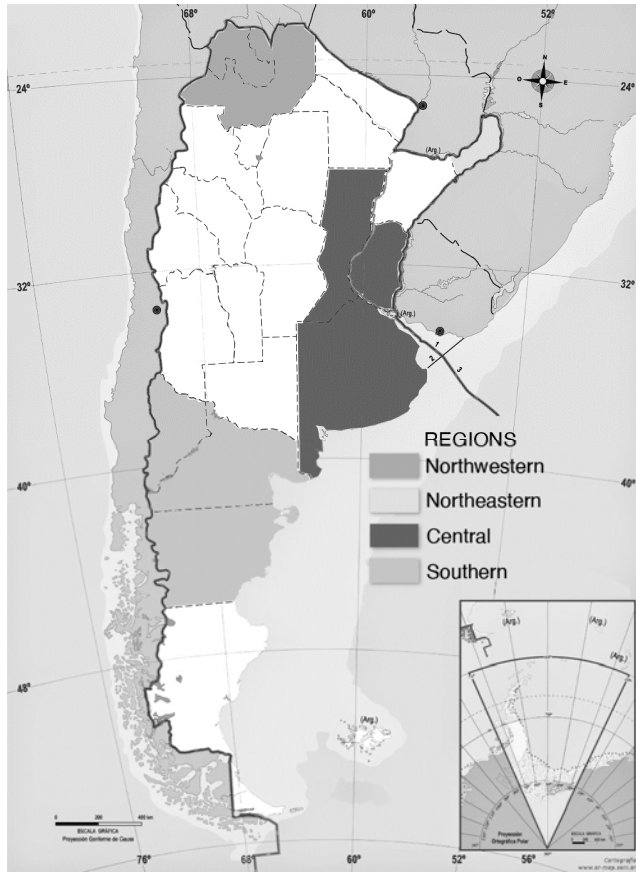


Figure 1. Regional Distribution by Genotypes

Source: Made by ourselves on the basis of data from the Ministry of Health of the Province of Chubut and from the National Ministry of Health

Finally, the National Reference Laboratory for Hantavirus (*Laboratorio Nacional de Referencia para Hantavirus*) of the National Institute of Infectious Diseases (INEI, *Instituto Nacional de Enfermedades Infecciosas*), dependent on the ANLIS Dr. Carlos G. Malbrán, started a study to confirm the transmission mechanism by complete sequencing of the 3 segments of the viral genome (S, M and L), using technology of Next Generation Sequencing (NGS) [6]. The comparative analysis has shown that the viral genotype causing the outbreak was indeed Andes Sur, with a percentage of genetic identity of 99.9% among all the analyzed sequences of the outbreak. This finding univocally confirmed that the transmission mechanism was from person to person. On the other hand, exclusive changes were identified in the viral genome of the strain involved in this outbreak, which could confer on it a greater spread potential, quality empirically observed by the local team involved.

In short, this article shows a manner of intervention

designed on the basis of the transmission mechanism identified (person-to-person) and of the socio-cultural context of the outbreak. Furthermore, unlike what happened in 1996 in El Bolsón, Epuén's outbreak was not self-limited, but it required the application of novel strategies like ARS. For this purpose, the analysis of the social determination of the health/disease/attention/care process (h/d/a/c) from a rights perspective was included, especially in an exceptional multicultural and ethnic context like the one described here.

2. Ethnic-Cultural Setting of the Region and Its World View of Health

Incidentally, 8.7% of the population of Chubut province identify themselves as indigenous [7], which amount to a population of 43,279 out of a total of 509,108 inhabitants. This percentage is more than three times the national average of 2.4%. Of these 43,279 inhabitants, 73.4% identify themselves as part of the Mapuche community, 18.3% as members of the Tehuelche community, 1.6% as part of the Toba community, and also 1.6 as members of the Quechua community [8]. Additionally, more than half of the 95 registered indigenous communities reside in the western part of Chubut province, the area where the outbreak occurred.

For these communities, the concept of health is linked to a holistic view of the universe in which the person reaches a state of balance or harmony (*xemolen*) [9] with the surrounding environment, planet earth (*wajutun mapu*) and the universe containing it (*waj mapu*). Reaching *xemolen* implies absence of disease (*kuxan*) [10, 11].

The context challenged the intervening team to work from a social-intercultural approach and to think about a comprehensive approach to the community from the perspective of social determinants, knowing that health services are not the main inequality-generating factor, but they do have an impact on them, especially when access to services and quality are not equitable for the entire population [12, 13]. This is the reason for the team's observation of the opportunity to apply the health criterion to all policies [14], whose intersectoral and interdisciplinary approach to public policies would seek collective agreements and synergies to reduce health inequity, even more so knowing that the development of epidemiological knowledge has shown that the social determination of the frequency and distribution of pathological events is at a hierarchical level higher than their biological and psychological determination.

In other words, the community's chances of finding itself at a disadvantage in the face of the outbreak would not be linked to its ethnic group/race but to the position it acquires in the social context, the degree of recognition and acceptance of its culture, and the health approach strategies that the bio-model proposes based on the socio-cultural model, even though, statistically, indigenous people are five times less likely to develop severe hantavirus pulmonary syndrome, probably because of their millennial exposure to Andes virus [15]. Incidentally, the hegemonic biomedical model, per se,

subalternates the world view of rural communities that identify themselves as indigenous, [16] which, if not taken into account, leads to an invisible but powerful barrier to access to the system, increasing inequity and exclusion in health [17], especially in the context of an outbreak.

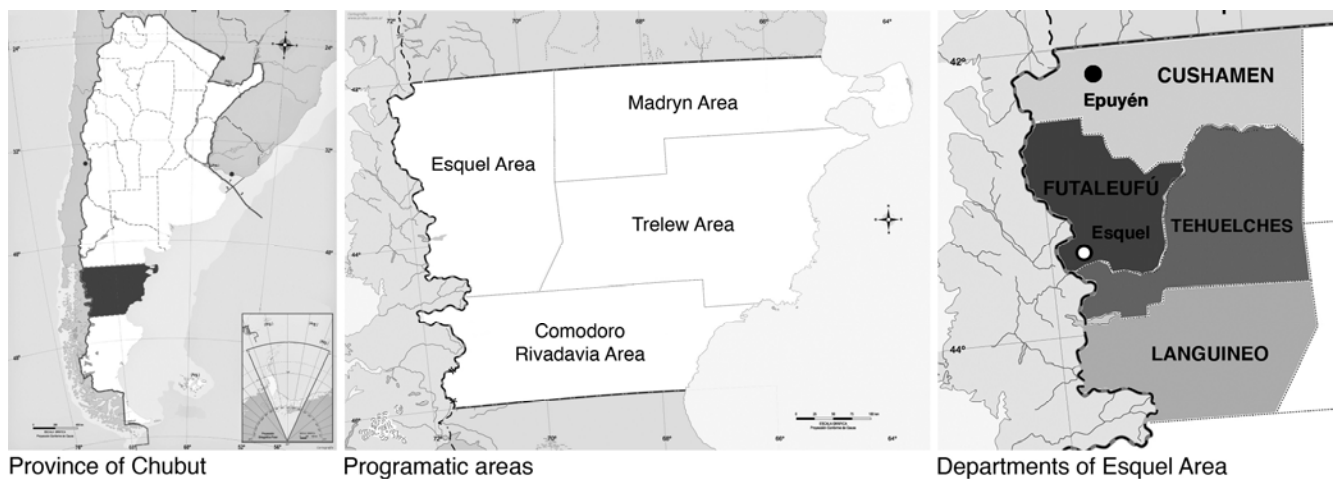
The outbreak of Andes Hantavirus, which began in the town of Epuyén in late 2018, claimed 11 lives out of 34 confirmed cases and taught several lessons about community-based strategies, under the microscope of the social determinants of the process (h/d/a/c), in a multi-ethnic and multicultural context such as the one described above, which has been coexisting for centuries although this has been without equitable interrelationships [18].

3. Health Context Description

The province of Chubut, with a surface of 224,686 km², is

located in the Patagonian region between the 42nd and 46th parallels; the projected population for 2020 is 618,994 inhabitants, which places the province in the 18th place in the national context and in the 3rd place with respect to the largest surface, after the provinces of Buenos Aires and Santa Cruz. It also has one of the lowest population densities in the country (2.2 inhabitants/km²) [7].

Chubut is divided into 4 areas whose operational areas (programmatic areas) are in the most important cities of each region: Madryn, Trelew, Comodoro Rivadavia and Esquel. This last region, in the west of the Province of Chubut, was the scene of 2018 Hantavirus outbreak. The area is divided into four departments: Cushamen (24,538 inhabitants), Futaleufú (48,976 inhabitants), Languineo (3,127 inhabitants) and Tehuelches (5,516 inhabitants). The projected population for 2020 for the area is 82,157 inhabitants.



Source: Made by ourselves with Google Resources.

Figure 2. Geographical Location of the Outbreak Epicenter.

The 47 public health providers of the Provincial Directorate of Esquel Programmatic Area (DPAPE, *Dirección Provincial de Área Programática Esquel*) are organized according to complexity. Esquel is the most important city and it has the most complex hospital (primary level). Further north, in the Cushamen department, there is El Maitén Sub-Zonal Hospital (secondary level), which is a reference for nearby rural hospitals, including Epuyén rural hospital, the epicenter of the outbreak. This town of 2,300 inhabitants and 500 houses is organized around a municipal government, which -together with other institutions, such as primary and high schools, police post, fire department, churches, etc.- played a leading role in networking for the social control of selective social respiratory isolation (ASRS, *aislamiento social respiratorio selectivo*) which would finally control the outbreak.

Tourism is one of the region's main economic activities along with agriculture and stockbreeding, which began with the arrival of the first migratory flows of Welsh, Basque-French and, on a smaller scale, Spanish, Italian and Syrian-Lebanese people, who imposed a new pattern that

would not only start the first urbanized centers as we know them today, but also the segmentation and division of the territory.

This fact, quite significant from the indigenous world view, marks the beginning of the deterioration of good living or *küme monge* (The concept of “*KÜME MOGÑEN*” is broken down into *KÜME*=good and *MOGÑEN*=live. It is associated with the western notion of health, but understood by the Mapuche communities in a much more holistic way, establishing a necessary relationship between the individual, the community and the ecosystem environment) by breaking the harmonic balance between the person and the link to the territory. Consequently, the indigenous communities were pressured to adapt to a new social order, their culture being gradually subordinated to the western view. However, a large part of the community of Epuyén and its surroundings keep the basis of their ancestral social organization and treasure elements of the indigenous world view that, when considering the strategies of community approach in the context of an outbreak, have to be taken into account to achieve the objectives.

4. Results

The alert of possible outbreak began between epidemiological week (SE, *semana epidemiológica*) 52 and 53 with the cluster of 5 suspicious cases (CS, *casos sospechosos*) in a short period of time. In this context, a 14-year-old girl died on 12/03/2018; her relatives and affected people warned the local health team that all of them had participated in a social gathering (100 people) on 11/03/2018. In addition, there are records of the first case registered in 2018, which corresponded to an older adult from the same town, tested positive for hantavirus (HV) on 11/14/2018. He survived and was discharged from the clinic. In an interview in his home, it was confirmed that he had been at the social event mentioned by the first cluster and that he attended with prodromes of the disease (febrile syndrome and myalgias). Consequently, he consulted at Epuyén Hospital on 11/5/2018, being referred to Esquel Hospital without a clear diagnosis. The evolution of the case and the biochemical laboratory led to the presumptive diagnosis of HV, which was confirmed a week later.

Retrospective analysis was initiated to recreate the spatial distribution of the first cluster of cases concurrent with the party room. Dozens of people who had attended the event were interviewed, resulting in a sketch with the exact location of the suspicious cases. A pattern emerged clearly that pointed to the possibility of person-to-person transmission.

By December 5, the first cluster was confirmed positive for HV. It was officially declared that this was an outbreak and the contingency committee formed by the provincial and national level was enlarged. With the available evidence, on 12/13/2018, referents from the ANLIS C. Malbrán Institute were summoned to an interdisciplinary debate.

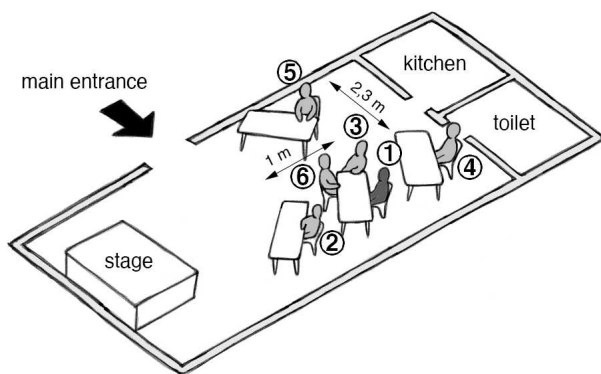


Figure 3. Sketch of the Party Room and Spatial Distribution of the First Cluster Hantavirus Outbreak, Epuyén, (2018-2019).

Source: Made by ourselves on the basis of the field work of the Epidemiology Team DPAPE, Ministry of Health, Province of Chubut

The updated situation of the outbreak was presented and the time line of cases was analyzed. On that date, there were six confirmed cases (1st cluster), two suspected ones and two discarded ones. One of the suspected cases presented an epidemiological link to the first cluster.

The possibility of possible contagion was extended in

relation to the information about the party (common background for all confirmed cases) and other situations of possible risk referred by those affected. It was concluded that the only common factor was attendance at the social event. However, there are contradictory elements since two people, from the first cluster, presented an epidemiological link with the environment.

A round of discussion was initiated and a working hypothesis was formulated, considering the following questions: Is the transmission due to a common source within the party? Or is it person-to-person transmission? Or did the cases contract the virus outside the party and randomly congregated that night?

As we know, the index case attended the event presenting prodromes (fever, myalgia), and the cases from the first cluster emerged around the third week after exposure at the party. It is known that the incubation period for interhuman transmission is approximately 20 days according to records from El Bolsón in 1996 with a behavior similar to the present outbreak; the characteristics described in the available bibliography were reviewed.

On the other hand, from the rodent traps placed in the party premises, the school and the house of the first deceased, there were no captures, and only one specimen was found in the index case's home. The capture rate of 5% was lower than the average expected for the area and season of the year (8-10%).

It should be noted that, in the region, according to the representative of Los Alerces National Park, no rodents had been seen on the rangers' rounds yet. Usually, around September, the rodent population is lower, only adults being observed. In fact, at the end of the winter, the levels are lower. At the beginning of spring, several instances of reproduction start. At the beginning, the first litter of new mice of the year are born, and during the course of the following summer, that first litter reproduces again. Therefore, in autumn, there is maximum abundance due to the accumulation of mice born in spring and summer. In relation to human activity, in autumn, mushroom collection activities are observed and in spring-summer, weeding tasks are carried out as well as recreational activities in contact with nature that would favor exposure and an increase in the possibility of the epidemiological link with the environment.

From ANLIS Malbrán Institute, it was stated that it is not easy to verify interhuman transmission in endemic areas. However, in light of the evidence, the current situation was analyzed due to the similarity with the outbreak in El Bolsón in 1996.

The interdisciplinary team stated that there are sufficient elements to suspect interhuman transmission. The available evidence shows that the party with the presence of a symptomatic individual (index case) is the only point in common with the other cases to date. This is also associated with the incubation periods analyzed, and the negative result of the work of rodents in situ. It was concluded that, in the current epidemiological context, there are sufficient

elements to include the interhuman transmission hypothesis.

As the outbreak progressed, the second cluster of cases emerged, reaching other towns in the region and even the neighboring country of Chile. This period was the one of greatest uncertainty because of the ambiguity of the conceptual definitions known up to that point of close contact. Thus, the definition was adjusted and derived in the operative concept of ARS that, as its name indicates, implied the selectivity of close contacts to initiate isolation at home for a period of 45 days. During this stage, the biomedical, scientific viewpoint, opposed to the community's perception and demands, was strongly put forth. In fact, several people abandoned their isolation, which led to a precautionary measure of social protection issued by the Public Prosecutor's Office of the city of Esquel, which urged suspicious cases and close contacts to stay in their homes. Thus, the following 20 cases (3rd and 4th cluster) arose from individuals who were isolated and supervised at home. The last confirmed case was reported on February 8, and 45 days later, in the absence of new cases, the outbreak was considered to be over.

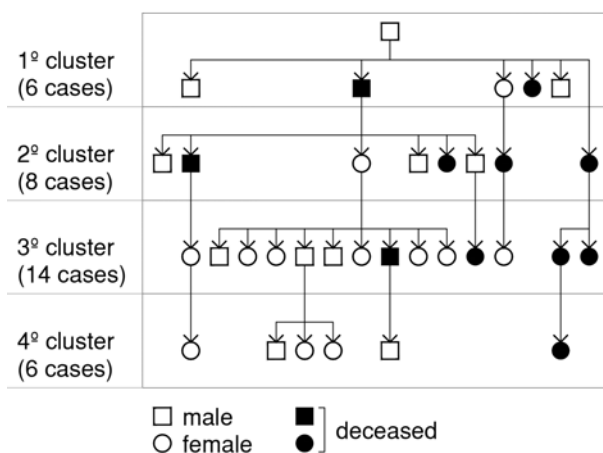


Figure 4. Reconstruction of the epidemiological links that show the most probable person-to-person transmission routes. Hantavirus Outbreak Epuén, (2018-2019), N= 34

Source: Made by ourselves on the basis of data from the Provincial Direction of Prevalent Pathologies and Epidemiology, Ministry of Health of the Province of Chubut.

However, as we mentioned, at the moment of greatest uncertainty, the definitions and key concepts that made it possible to limit the expansion of the outbreak were constructed. Thus, the already known definition of close contact lacked the concepts of space, distance to the source of infection and time of interaction. Thus, a new definition of close contact was made as a result of available evidence, meaning any person who was in contact with a confirmed case for a minimum of 30 minutes at a maximum distance of 1 meter. Moreover, the exposure period of close contact with the source (i.e., with the positive case) would be during a period of 48 hours prior to 48 hours after the appearance of symptoms.

4.1. Distribution of Cases and Contacts in the Region

The outbreak of hantavirus started on 11/14/2018 with the confirmation of the first case (index case) and the last confirmed case on 02/08/2019, on the other hand, 34 out of 86 suspected cases were confirmed and 11 of them died, mortality being of 32.4% as shown in the figure below:

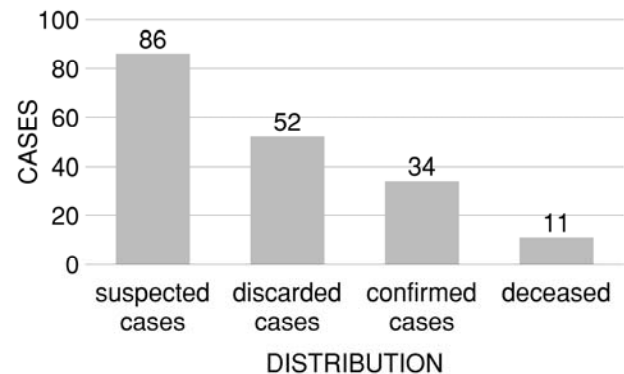


Figure 5. Distribution of Suspected, Confirmed and Deceased Cases Hantavirus Outbreak, Epuén, (2018-2019).

Source: Provincial Direction of Prevalent Pathologies and Epidemiology Ministry of Health of the Province of Chubut

The distribution of these cases in the chain of infection was grouped into 4 clusters. The third cluster, in SE 1 of 2019, marked the peak of the curve. ARS started on 12/28/2018 (SE 52) and from this moment, 20 cases were confirmed from people in isolation as shown in the figure below:

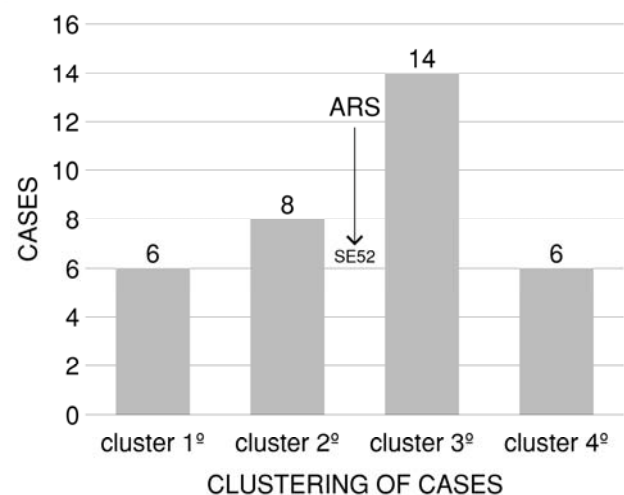


Figure 6. Clustering of Cases by Link of Infection - Hantavirus Outbreak Epuén, (2018-2019), N= 34.

Source: Provincial Direction of Prevalent Pathologies and Epidemiology Ministry of Health of the Province of Chubut with respect to gender, mortality was twice as high in women (40%) as in men (21%).

Finally, the symptoms most frequently reported were fever, myalgias, headaches, abdominal pain, and asthenia. Fever was the most frequent onset symptom.

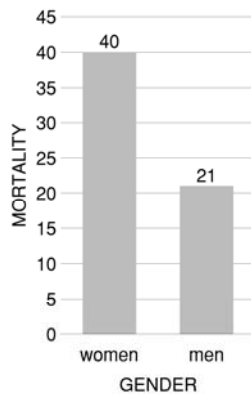


Figure 7. Distribution of Mortality by Gender Hantavirus Outbreak, Epuén, (2018-2019), $N = 34$.

Source: Provincial Direction of Prevalent Pathologies and Epidemiology Ministry of Health of the Province of Chubut.

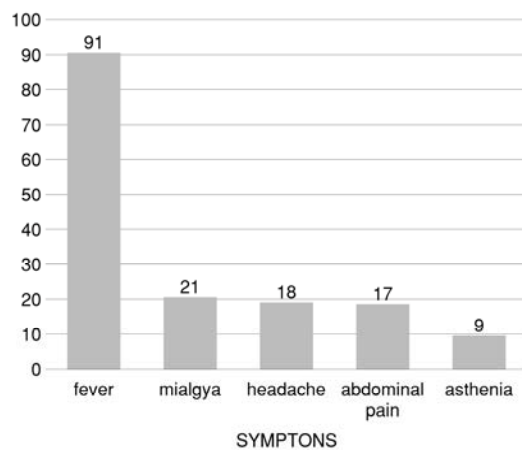


Figure 8. Distribution of Symptoms Percentage - Hantavirus Outbreak Epuén, (2018-2019), $N = 34$.

Source: Provincial Direction of Prevalent Pathologies and Epidemiology Ministry of Health of the Province of Chubut

The average incubation period was 21 days with a range of 9 to 39 days.

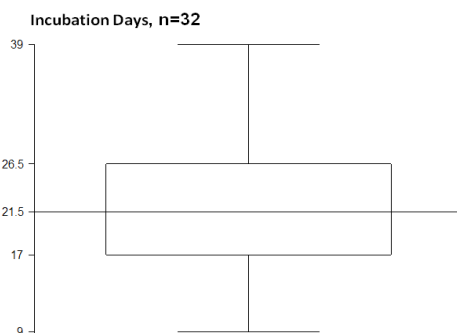


Figure 9. Distribution of Incubation Periods - Hantavirus Outbreak Epuén, (2018-2019), $n = 32$.

Source: Provincial Direction of Prevalent Pathologies and Epidemiology Ministry of Health of the Province of Chubut

4.2. Community Intervention Model During the Outbreak

The fundamental support axes during ARS were guaranteeing coverage of basic needs, considering loss of earnings, integral psycho-emotional assistance, and assistance to dependent relatives of hospitalized patients due to the loss of family support. Thus, the contenance and end of the outbreak was achieved through the application of ARS with an intercultural approach, which required subsuming the management model to an intersectoral perspective, and the care model to an integral approach, combining hard technologies with those of the social field. Thus, the intervention was addressed from three approaches:

First approach: It is based on the disease, adaptation of the care model (assistance) and coordination by levels of increasing complexity as well as on the available technologies (hard), fundamentally the management of the critical patient in the intensive care unit, on the applicability of the professional cut (soft-hard technologies). This allowed an adequate response and, consequently, a survival of 67.6%. Information was systematized through the so-called daily reports as a tool for social control of collective anxiety.

Second approach: It is based on promotion and prevention, subsumed to networking with the cooperation of multiple actors to optimize available resources and generate joint intervention strategies.

Third approach: It is based on the social production of health/disease/attention/care. This is a caring dimension of health supported by soft technologies or the social field, considering the intercultural approach. Thus, the community was integrally approached with the purpose of guaranteeing the coverage of their basic needs with a rights approach in order to reduce contingency-generated inequities.

5. Final Considerations

The Cardiopulmonary Syndrome due to Andes Hantavirus, its non-specific clinical presentation and rapid clinical deterioration posed a challenge for the health teams from the assistance perspective and in terms of technical operative competences regarding early management of the patient with biosecurity rules. However, in the context of an outbreak, such as the one that started in Epuén, the health system is faced with a social, complex and multidimensional phenomenon.

The organization of the civil group through community participation, such as inter-institutional articulation, unidirectional information management as well as the focus on social determinants of the h/d/a/c process and the perspective of the intercultural approach to reduce the system inequities led to collective health care and limitation in the transmission of the Andes virus.

Final control of the outbreak was not achieved through the technologized professional cut of bio-medicine but through participatory social control, without neglecting the fundamental role that bio-medicine would play in the cases, in early and timely management that ultimately allowed limitation of the impact on the health system, particularly on Intensive Care Units.

As we can see, the comprehensive approach to the outbreak was based on a tripartite model: 1) Epidemiological management from the biomedical perspective. 2) Epidemiological management from a networking approach. 3) Epidemiological management from the community approach (social-intercultural).

With this approach, mortality was reduced, reaching good survival indicators without serious comorbidities. 146 people were successfully contained under ARS for 45 consecutive days. Finally, in light of the socio-cultural model of the region and the intercultural community approach developed, the objective was to mitigate inequities of the socio-economic-cultural impact caused by the outbreak, which makes it pertinent to conduct a comparative study with outbreak management without this perspective.

Population strategies, in the context of an outbreak, have to consider inequalities in order to increase accessibility for the most vulnerable groups, a strategy aimed at the effective use of resources to reduce health inequities.

Conflict of Interests

The authors declare that they have no conflict of interest in this study.

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