Clinical management of hantavirus infection, including Andes virus disease

Interim regional guidance for suspected or confirmed cases

PAHO
Pan American Health Organization
World Health Organization
Americas Region

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Disclaimer

This publication provides interim guidance to support clinical management and public health response to hantavirus infection, including Andes virus disease. It reflects the best available evidence at the time of publication and may be revised as new information emerges.

This guidance does not replace clinical management protocols at national level. The application of this guidance should be adapted to local context and resources.

Abbreviations and acronyms

ANDV	Andes virus
ECMO	extracorporeal membrane oxygenation
ICU	intensive care unit
MEURI	Monitored Emergency Use of Unregistered and Investigational Interventions
PAHO	Pan American Health Organization
PPE	personal protective equipment
WHO	World Health Organization

Introduction

Hantaviruses are enveloped viruses belonging to the family *Hantaviridae*, genus *Orthohantavirus*, which currently comprises approximately 60 species. These are spherical, enveloped viruses measuring approximately 120–160 nm in diameter, with a genome consisting of three segments of single-stranded, negative-sense RNA, designated as small (S), medium (M), and long (L) *(1)*. They are broadly classified into Old World hantaviruses, distributed in Africa, Asia, and Europe, and New World hantaviruses in the Americas, which are associated with distinct clinical syndromes: hemorrhagic fever with renal syndrome and hantavirus cardiopulmonary syndrome, respectively *(1, 2)*.

These viruses are maintained in nature through chronic, asymptomatic infection of specific mammalian reservoirs – primarily rodents of the families *Muridae* and *Cricetidae* – with each hantavirus species typically linked to a single reservoir host that sheds virus in urine, feces and saliva *(2, 3)*. Human infection occurs predominantly through inhalation of aerosolized particles contaminated with infected rodent excreta, particularly in enclosed or poorly ventilated environments, although transmission may also occur via direct contact with contaminated materials or, rarely, rodent bites.

However, in the Americas, person-to-person transmission has been described, primarily associated with *Orthohantavirus andesense* or Andes virus (ANDV), endemic in the Southern Cone. These events have occurred in contexts of close and prolonged exposure, generally in household settings or during the prodromal phase of the index case *(4-11)*. ANDV is primarily maintained in rodents of the genus *Oligoryzomys*, notably *Oligoryzomys longicaudatus (12)*.

The incubation period for hantavirus infection generally ranges from 1 to 6 weeks, with variability depending on the viral species. Specifically, the incubation period for ANDV infection ranges approximately from 7 to 39 days *(8, 13)*. Hantavirus cardiopulmonary syndrome is characterized by rapid progression from a nonspecific febrile illness to severe cardiopulmonary compromise, with case-fatality rates frequently exceeding 30%, whereas hemorrhagic fever with renal syndrome typically manifests with renal involvement and variable severity *(2, 14, 15)*. These epidemiological and clinical characteristics underscore the importance of early recognition and prompt clinical management.

This interim guidance provides practical recommendations for the early recognition, clinical management, and referral of patients with suspected or confirmed hantavirus infection, with particular attention to ANDV disease and hantavirus cardiopulmonary syndrome. Suspected hantavirus infection should be managed as a clinical emergency. Patients may initially present with a nonspecific febrile illness but can deteriorate abruptly, progressing to acute respiratory failure, shock, and cardiopulmonary collapse. When clinical and epidemiological criteria are suggestive, clinical management, referral, and infection prevention and control measures should be implemented immediately and should not be delayed while awaiting laboratory confirmation.

For ANDV, person-to-person transmission has been documented and is epidemiologically relevant, although uncommon. Transmission in healthcare settings has been reported but appears to be limited, reinforcing the importance of early implementation of infection prevention and control measures. Therefore, clinical management should be implemented in parallel with infection prevention and control measures, including isolation, and standard and transmission-based precautions (contact and airborne), together with prompt notification to public health authorities, identification and monitoring of contacts, and safe handling of clinical specimens and potentially contaminated materials.

Key message

- Suspected hantavirus infection is a clinical emergency because deterioration may occur rapidly, with progression to respiratory failure and shock within hours *(16, 17)*.
- Do not delay the initiation of clinical management while awaiting laboratory confirmation when clinical and epidemiological criteria are suggestive.
- Early referral to a hospital with intensive care capacity, restrictive fluid management during the cardiopulmonary phase, and early activation of advanced cardiopulmonary support networks are central to care.
- For suspected or confirmed ANDV cases, standard and transmission-based precautions (contact and airborne) should be implemented.

1. Objective

The objective of this guidance is to reduce morbidity, mortality, and secondary transmission associated with hantavirus infection by supporting early clinical suspicion, timely diagnostic confirmation, immediate public health notification, appropriate infection prevention and control measures, early referral to a critical care setting, and specialized hemodynamic and respiratory management.

This guidance emphasizes the need to recognize hantavirus infection early, before progression to severe cardiopulmonary disease, and to integrate clinical care with infection prevention and control actions, particularly when ANDV infection is suspected.

2. Scope and intended users

This guidance applies to adult and pediatric patients with suspected or confirmed hantavirus infection evaluated in primary care, emergency departments, hospital wards, intermediate care units, and intensive care units (ICUs).

It is intended for general practitioners, infection prevention and control teams, emergency physicians, internists, pediatricians, intensivists, infectious disease specialists, nurses, transfer teams, clinical laboratories, epidemiology units, occupational health teams, and public health authorities.

Additional clinical considerations for specific populations, including pediatric patients, pregnant individuals, and patients with comorbidities, are provided in **Annex 3.**

3. Methods

A scoping review was conducted to support the development of interim regional public health guidance for suspected or confirmed hantavirus infection, with particular emphasis on ANDV disease and hantavirus cardiopulmonary syndrome. The review was structured around the priority topics addressed in the guidance: etiologic agent, reservoir, and transmission; clinical suspicion; early clinical risk assessment, warning signs and criteria for severe disease; initial diagnostic evaluation; clinical course and case classification; differential diagnosis; initial management and referral; infection prevention and

control in healthcare settings; contact identification, monitoring and quarantine; management of deceased persons; notification and epidemiological investigation; and clinical considerations for special populations. The search and selection process focused on technical documents, operational guidance, clinical guidelines, epidemiological alerts, public health recommendations, and other sources providing regional or directly applicable evidence to answer these questions. The guidance is intended for general practitioners, infection prevention and control teams, emergency physicians, internists, pediatricians, intensivists, infectious disease specialists, nurses, transfer teams, clinical laboratories, epidemiology units, occupational health teams, and public health authorities. The evidence was synthesized narratively into practical statements, supported where appropriate by technical supplementary material, flow charts, tables and annexes. The objective was to provide rapid, general, and specific guidance to support clinical care, infection prevention and control, public health notification, referral, and contact management while more comprehensive evidence-informed documents are being developed.

4. Etiologic agent, reservoir, and transmission

In Argentina and Chile, the most clinically relevant presentation is hantavirus cardiopulmonary syndrome, mainly associated with New World hantaviruses. In Chile, the main reservoir is the long-tailed pygmy rice rat, *Oligoryzomys longicaudatus*, distributed from the southern Atacama Desert to Magallanes.

The main route of transmission is inhalation of aerosols contaminated with urine, feces, or saliva from infected wild rodents. Transmission from rodent reservoirs is related to environmental exposure and does not involve a defined period of transmissibility. It may also occur through mucosal contact, contaminated food, or rodent bites, although these routes are less frequent. The incubation period for hantavirus infection generally ranges from 1 to 6 weeks, with variability depending on the viral species. Specifically, the incubation period for ANDV infection ranges approximately from 7 to 39 days *(8, 13)*.

For ANDV, person-to-person transmission has been documented, initially in Argentina and subsequently in family or cluster investigations in Chile. This route is considered uncommon, but it is epidemiologically relevant and occurs primarily in the context of close and prolonged contact, particularly during the early phases of illness *(2, 4-11)*, including exposure in close proximity and in enclosed and/or poorly ventilated environments.

The period of transmissibility is not precisely defined; however, available evidence from outbreak and cluster investigations suggests that ANDV transmission occurs primarily during the incubation and prodromal phases of infection *(2)*. This justifies strict contact tracing and reinforced infection prevention precautions when indicated.

5. Clinical suspicion of hantavirus infection

Suspect hantavirus infection in any patient with compatible symptoms plus an epidemiological risk factor within the previous six weeks, with or without suggestive laboratory or imaging findings. In any patient with suspected hantavirus infection, notification should be performed in accordance with national surveillance procedures, and the case should be managed in coordination with public health authorities.

Every suspected case must be notified immediately to the corresponding public health authority, and sample shipment must be coordinated with the national reference laboratory or another authorized laboratory.

Clinical suspicion criteria

- Compatible symptoms: fever, myalgia, headache, chills, abdominal pain, nausea, vomiting, diarrhea, malaise, dizziness, cough, or dyspnea.
- Epidemiological exposure within 6 weeks: residence, work, travel, or recreational activity in rural or wildland areas; cleaning closed houses or storage areas; exposure to rodents or rodent excreta; handling firewood; brush or yard clearing; agricultural or forestry work; camping; hiking; collecting wild fruit; or close contact with a confirmed or suspected case.
- Suggestive laboratory or imaging findings: thrombocytopenia, hemoconcentration, leukocytosis, immunoblasts or atypical lymphocytes, elevated lactate, blood gas abnormalities, chest radiograph with interstitial infiltrates, or pulmonary edema.

6. Early clinical risk assessment, warning signs, and criteria for severe disease

All suspected or confirmed cases should be actively assessed for early prognostic factors, clinical warning signs of progression, and criteria for severe disease.

Hantavirus infection may progress from a nonspecific febrile prodrome to a cardiopulmonary phase, often within hours, with the development of hypoxemia, pulmonary edema, and shock. Clinical warning signs reflect this early deterioration and should be actively monitored to allow timely recognition and escalation of care *(17)*.

Prognostic factors, clinical warning signs, and criteria for very severe disease serve distinct roles in clinical assessment. Prognostic factors identify patients at higher risk of adverse outcome and may justify closer monitoring or earlier referral. Clinical warning signs indicate established or worsening disease severity and should prompt urgent escalation of care. Criteria for very severe disease, including extracorporeal membrane oxygenation (ECMO) indicators, identify patients with very severe cardiopulmonary failure requiring immediate consultation with an ECMO-capable center.

6.1 Early prognostic factors for mortality

The following factors were identified in a systematic review and meta-analysis of prognostic factors for mortality in patients with New World hantavirus infection. They are useful for early risk stratification, especially when present during initial evaluation or early hospitalization. Their presence should lower the threshold for hospital observation, referral to a center with intensive care capacity, and repeated clinical and laboratory reassessment.

Early prognostic factors supported by **moderate or high certainty evidence** include:

- **Demographic factors:**
  - Female sex.
- **Clinical findings:**
  - Clinical signs of bleeding, including skin, mucosal, gastrointestinal, or other overt bleeding.
- **Imaging findings:**
  - Pulmonary infiltrates on chest imaging.

- **Laboratory findings:**
  - Elevated hematocrit, reflecting hemoconcentration and capillary leakage;
  - Increased plasma creatinine, reflecting early organ dysfunction;
  - Platelet count below 50 000/mm³ or a decrease greater than 20% in less than 24 hours.

Additional routinely available findings may also support risk stratification, although the **certainty of evidence is lower:**

- **Laboratory findings:**
  - Leukocytosis.
- **Demographic and clinical context:**
  - Presence of comorbid conditions (e.g., cardiovascular or chronic respiratory disease), which may influence clinical course in critically ill patients.

These early prognostic factors should not be used in isolation to define severe disease or to make definitive individual-level decisions. Rather, they should be integrated with clinical course, vital signs, oxygenation, perfusion, laboratory trends, imaging findings, and local access to intensive care and transfer systems. Some variables may function both as early prognostic factors and as indicators of clinical progression depending on the timing of assessment and should be interpreted in the broader clinical context. Demographic variables, such as female sex, should be interpreted as risk stratification variables and not as clinical severity criteria.

6.2 Clinical warning signs and severity criteria

The presence of any of the following findings should be considered a warning sign of possible progression and should prompt urgent referral to a hospital with intensive care capacity or escalation within the hospital:

- Tachycardia;
- Tachypnea or dyspnea;
- Hypoxemia or progressive oxygen requirement;
- Progressive respiratory deterioration or increased breathing work;
- Hypotension or signs of shock;
- Altered mental status;
- Oliguria or other signs of hypoperfusion;
- Progressive pulmonary infiltrates or pulmonary edema;
- Hemoconcentration, particularly hematocrit above 45% or rising hematocrit;
- Leukocytosis, particularly white blood cell counts above 20 000/mm³;
- Elevated immunoblasts or atypical lymphocytes;
- Metabolic acidosis, particularly pH below 7.25;
- Elevated lactate, particularly lactate above 2 mmol/L;
- Rising creatinine or other evidence of evolving organ dysfunction.

Patients with warning signs should be monitored continuously whenever possible. Reassessment should include vital signs, oxygen saturation, respiratory work, perfusion, urine output, fluid balance, serial complete blood count, renal function, acid-base status, lactate, and chest imaging when clinically indicated.

6.3 Criteria for very severe disease and ECMO referral

Patients with severe hypoxemia, refractory shock, cardiopulmonary failure, or rapidly accelerating deterioration despite conventional support require immediate consultation with an ECMO-capable center. In hantavirus cardiopulmonary syndrome, veno-arterial ECMO is the preferred modality when severe circulatory failure or cardiogenic shock predominates.

Immediate referral to an ECMO-capable center or activation of the ECMO network should be considered when any of the following are present:

- Refractory shock despite appropriate vasoactive support;
- Plasma lactate above 4.0 mmol/L;
- Cardiac index below 2.2 L/min/m², when available;
- PaO_2/FiO_2 below 60;
- Severe cardiopulmonary failure with rapidly increasing vasopressor or ventilatory requirements;
- Cardiac arrest or peri-arrest condition.

ECMO consultation should occur early, ideally within the first hours of the cardiopulmonary phase. Referral should not be delayed until cardiac arrest, as outcomes after arrest are substantially worse. When ECMO is not available locally, early communication with the referral network is essential to determine transfer feasibility, stabilization priorities, and cannulation strategy.

7. Initial diagnostic evaluation

7.1 Tests recommended at first evaluation

- Complete blood count with platelet count;
- Biochemistry panel, creatinine, electrolytes, and liver function tests;
- Arterial or venous blood gases according to availability;
- Lactate;
- C-reactive protein or other inflammatory markers according to the differential diagnosis;
- Chest radiograph;
- Electrocardiogram and troponin if hemodynamic compromise or myocardial involvement is suspected;
- Hantavirus IgM/IgG serology;
- Hantavirus polymerase chain reaction when available or according to the reference laboratory network;
- Samples for confirmation in a national or authorized reference laboratory.

7.2 Diagnostic interpretation

A negative rapid test, ELISA, or serologic test does not exclude hantavirus infection when the patient is in an early phase, because IgM antibodies may appear late in the prodromal phase or at the beginning of the cardiopulmonary phase. If clinical suspicion is high, maintain clinical observation and repeat or confirm testing according to the reference laboratory network.

Serologic or rapid testing is not recommended for exposed but asymptomatic persons unless specifically indicated by the public health authority or an epidemiological investigation.

8. Clinical course and classification

8.1 Mild hantavirus disease

Mild disease may occur in previously healthy individuals presenting with a febrile syndrome characterized by nonspecific symptoms such as headache, myalgia, chills, and gastrointestinal symptoms, who have a compatible exposure history but do not develop pulmonary complications, do not require oxygen, and have a normal chest radiograph.

8.2 Hantavirus cardiopulmonary syndrome

Hantavirus cardiopulmonary syndrome is an acute infectious syndrome with high lethality. It usually evolves through three phases: prodromal, cardiopulmonary, and convalescent (Table 1).

Table 1. Clinical phases of hantavirus cardiopulmonary syndrome

Phase	Typical features	Operational implication
Prodromal phase	Usually 1–6 days. Fever, myalgia, headache, nausea, vomiting, abdominal pain, diarrhea, arthralgia. Complete blood count (CBC) may show thrombocytopenia, leukocytosis, immunoblasts, and normal or slightly elevated erythrocyte sedimentation rate (ESR). Chest radiograph may be normal or show interstitial infiltrates.	Suspect early; obtain CBC and chest imaging; assess exposure history; observe closely.
Cardiopulmonary phase	Abrupt cough, dyspnea, hypoxemia, pulmonary edema, hypotension, and hemodynamic instability due to increased capillary permeability and myocardial involvement. Severe cases may progress to acute respiratory distress syndrome (ARDS) and cardiogenic shock.	Emergency transfer/escalation to intensive care unit (ICU); restrictive fluids; early vasopressors; prepare for invasive ventilation and extracorporeal membrane oxygenation (ECMO) referral if needed.
Convalescent phase	Survivors gradually recover pulmonary and hemodynamic function. Recovery may be prolonged and may require follow-up for several months.	Plan clinical follow-up and assessment for respiratory, cardiovascular, renal, neurologic, auditory, ocular, and mental health sequelae.

Multiple clinical and laboratory variables have been associated with increased severity and mortality in hantavirus cardiopulmonary syndrome, particularly during the cardiopulmonary phase (Table 2) *(18)*.

Table 2. Clinical severity and mortality indicators in hantavirus cardiopulmonary syndrome

Indicator	Threshold / Description
Delayed hospitalization	≥7 days from symptom onset
Hypotension at admission	Not responsive to inotropic or vasoactive support
Leukocytosis	>20,000/mm³
Platelet count	<50,000/mm³
Hematocrit	>45%
Immunoblasts	>45% of lymphocytes
PaO_2/FiO_2 ratio	<150 prior to mechanical ventilation, or <70 during mechanical ventilation with positive end-expiratory pressure (PEEP)
Arterial pH	<7.20 during mechanical ventilation

Source: Adapted from Tapia G MS, Mansilla A C, Vera M TMJL. Síndrome pulmonar por hantavirus: Experiencia clínica en diagnóstico y tratamiento. Hospital Coyhaique-Chile. Rev chil infectol. 2000;17(3). Available from: http://dx.doi.org/10.4067/S0716-10182000000300010. .

9. Differential diagnosis

- Influenza, COVID-19, and other respiratory viruses;
- Severe bacterial pneumonia;
- Leptospirosis (Table 2);
- Dengue or other arboviral infections;
- Sepsis of respiratory, abdominal, or unknown origin;
- Meningococcemia;
- Typhoid fever or other systemic infections;
- Myocarditis;
- Cardiogenic pulmonary edema;
- Acute respiratory distress syndrome from another cause;
- Other regional infections, including Junin virus or malaria when epidemiologically relevant.

Table 3. Key discriminating features: hantavirus cardiopulmonary syndrome vs. severe leptospirosis vs. severe dengue

Feature	Hantavirus cardiopulmonary syndrome (Andes/SNV)	Severe leptospirosis	Severe dengue
Epidemiological exposure	Rural/wildland; rodent excreta inhalation; Andes: person-to-person	Water/soil contact; occupational; flooding	Urban/peri-urban; *Aedes* mosquito bite
Key distinguishing features	Hemoconcentration, immunoblasts, thrombocytopenia, abrupt cardiopulmonary collapse; no rash	Jaundice (Weil's disease), prominent acute kidney injury (AKI), conjunctival suffusion; responds to penicillin/doxycycline	Rash, positive tourniquet test, plasma leakage (pleural effusion/ascites) without pulmonary edema predominance
Laboratory hallmarks	Thrombocytopenia + hemoconcentration + leukocytosis with immunoblasts; positive hantavirus IgM/RT-PCR	AKI, elevated bilirubin and creatine kinase (CK); positive leptospira MAT/ELISA	Thrombocytopenia + leukopenia; positive NS1/dengue IgM; no hemoconcentration early

Feature	Hantavirus cardiopulmonary syndrome (Andes/SNV)	Severe leptospirosis	Severe dengue
Pulmonary involvement	Dominant – noncardiogenic pulmonary edema, rapid acute respiratory distress syndrome (ARDS)	Variable – less prominent than renal involvement	Pleural effusion possible; overt pulmonary edema less common

Note: Coinfection is possible in endemic areas and does not exclude hantavirus cardiopulmonary syndrome. When clinical suspicion is high, manage empirically for hantavirus cardiopulmonary syndrome and evaluate in parallel for alternative diagnoses.

10. Initial management and referral

10.1 General principles

Initial management should begin at the point of first clinical suspicion and should prioritize early monitoring, cautious fluid administration, and timely escalation of respiratory and hemodynamic support. Detailed management of fluids, vasoactive support, and respiratory care are described in the following sections.

At the time of first clinical contact, an initial structured assessment should be performed to identify immediate priorities for stabilization and referral. The use of a standardized checklist may support early decision-making and ensure that critical steps are not delayed (see Annex 4).

Every patient with a well-founded suspicion of hantavirus infection should be managed as potentially severe, even if initially stable. The window for effective intervention is early.

Because transport may be delayed in rural or remote settings, early referral at initial suspicion is recommended to ensure timely access to advanced care.

Do not delay referral while waiting for confirmatory results. Do not delay transfer solely to complete stabilization if this exposes the patient to preventable deterioration or fluid overload. Early transfer to a higher level of care should be considered at the stage of initial suspicion, particularly in settings where clinical deterioration may limit the feasibility or safety of later transfer *(2, 17)*.

The level of care and escalation should be determined according to clinical severity and risk of progression:

- Suspected case without warning signs or severity criteria: Hospital observation, serial examinations, epidemiology notification, and referral coordination according to evolution;
- Suspected case with warning signs: Immediate transfer to a hospital with intermediate or intensive care capability;
- Patients with respiratory failure, shock, elevated lactate, progressive hypoxemia, or need for ventilatory support: Management in a high-complexity ICU, ideally with access to ECMO or a defined ECMO referral network.

In all cases, infection prevention and control measures should be implemented at the point of care, including standard precautions and transmission-based precautions. Patients with suspected hantavirus infection should be managed in healthcare facilities with intensive care capacity.

11. Hemodynamic management: central recommendation on fluids

Core fluid recommendation

- In suspected or confirmed hantavirus infection with respiratory failure, pulmonary edema, hypoxemia, or cardiopulmonary phase, use a restrictive fluid strategy.
- Guide fluids by perfusion, blood pressure, lactate, urine output, bedside echocardiography, lung ultrasound (including dynamic assessment), and dynamic response when available.
- Do not manage these patients as undifferentiated sepsis with automatic large-volume fluid loading.

The pathophysiological basis is marked pulmonary and endothelial vascular permeability. Liberal crystalloids may rapidly worsen pulmonary edema, hypoxemia, respiratory failure, and need for mechanical ventilation.

11.1 Practical approach in hypotension or hypoperfusion

1. Assess whether true hypovolemia is present.
2. Avoid repeated empirical boluses.
3. If fluid is administered, use small boluses, for example 250 mL of balanced crystalloid, followed by immediate reassessment.
4. Stop fluids if breathing work increases, oxygenation worsens, crackles appear, pulmonary edema increases, or there is no hemodynamic response.
5. Do not delay initiation of vasopressors; prioritize early use when shock is present and fluid tolerance is poor.
6. Monitor fluid balance, urine output, lactate, peripheral perfusion, and lung/cardiac ultrasound when available.

11.2 Vasopressors and inotropes

In persistent hypotension or shock, initiate vasopressors early, preferably norepinephrine. Epinephrine may be considered according to local protocols and hemodynamic profile. If myocardial dysfunction or cardiogenic shock is suspected, obtain urgent echocardiography and provide individualized vasoactive/inotropic support. Activate the ECMO network early in refractory deterioration.

12. Respiratory management

The objective is to prevent progression to severe hypoxemia, respiratory muscle fatigue, and cardiopulmonary collapse.

12.1 Oxygen therapy

- Start supplemental oxygen early if SpO_2 is below 94%, if dyspnea is present, or if work of breathing increases.
- Use continuous monitoring.
- Escalate rapidly if respiratory status deteriorates.

12.2 Noninvasive ventilation or high-flow nasal oxygen

These may be considered in selected patients under close monitoring, provided they do not delay intubation, transfer, or ICU admission. In hantavirus infection, deterioration may be abrupt, so the threshold for escalation should be low.

12.3 Invasive mechanical ventilation

Indications include progressive hypoxemia, respiratory fatigue, altered mental status, shock, or severe acidosis. Use a lung-protective strategy and avoid excessive pressures or tidal volumes. Early prone positioning with invasive mechanical ventilation should be used in patients with PaO_2/FiO_2 <150 or oxygenation index >13.

12.4 Extracorporeal membrane oxygenation

ECMO should be considered early in patients with hantavirus cardiopulmonary syndrome who develop severe hypoxemia, refractory shock, cardiopulmonary failure, or rapidly accelerating deterioration despite optimized conventional support. Because severe hantavirus cardiopulmonary syndrome is frequently characterized by combined respiratory failure and circulatory collapse, veno-arterial ECMO is the preferred modality when cardiogenic shock or severe hemodynamic instability predominates. Veno-venous ECMO alone is generally insufficient in patients with significant myocardial dysfunction or refractory shock.

In patients requiring VA-ECMO, peripheral femoro-femoral cannulation with placement of a distal perfusion cannula in the superficial femoral artery should be considered to minimize the risk of lower limb ischemia. In cases where severe pulmonary dysfunction persists and cardiac function begins to recover, differential hypoxemia (Harlequin syndrome) may develop and may require optimization of native cardiovascular output; in selected cases, conversion to hybrid configurations such as V-AV ECMO may be necessary.

Management of ECMO configuration and associated complications should be guided by experienced ECMO teams in specialized centers.

The ECMO referral center should be contacted as soon as very severe disease is suspected, ideally within the first hours of the cardiopulmonary phase. Referral or cannulation decisions should not be delayed until cardiac arrest, since outcomes after postarrest ECMO are substantially worse.

Immediate consultation with an ECMO-capable center, and consideration of ECMO cannulation, is warranted when any of the following are present:

- Refractory shock despite appropriate fluid restriction and escalating vasoactive support;
- Plasma lactate >4.0 mmol/L;
- PaO_2:FiO_2 <60 despite optimized ventilatory support;
- Rapidly declining cardiac index, particularly <2.2–2.5 L/min/m² when available;
- Severe cardiopulmonary failure with rapidly increasing vasopressor or ventilatory requirements;
- Severe arrythmias;
- Cardiac arrest or peri-arrest condition.

The decision to initiate ECMO should consider the trajectory of deterioration, timing since onset of the cardiopulmonary phase, availability of an experienced ECMO team, transport feasibility, contraindications, and local protocols. When ECMO is not available on site, early communication with the

referral network is essential to determine whether the patient should be transferred, stabilized for transport, or cannulated locally by a mobile ECMO team if available.

Observational evidence supports the use of early VA-ECMO in selected patients with severe hantavirus cardiopulmonary syndrome and refractory cardiopulmonary failure. In Chile, recent national experience has reported frequent use of VA-ECMO among confirmed hantavirus cardiopulmonary syndrome cases requiring advanced support, with survival in ECMO-treated cohorts. These data reinforce the importance of early recognition, timely referral, and activation of ECMO networks before irreversible shock or cardiac arrest occurs.

13. Specific pharmacologic treatment

Management of hantavirus cardiopulmonary syndrome remains primarily supportive, with a focus on careful hemodynamic management and respiratory support. Early recognition and support treatment, timely referral, and access to advanced cardiopulmonary support are critical for improving outcomes. The available evidence for specific pharmacologic treatments is limited and of low certainty, and no intervention has demonstrated consistent clinical benefit. A rapid evidence synthesis using GRADE methodology was conducted to inform these recommendations (Table 3).

Key aspects:

- There is currently no proven specific antiviral or immunomodulatory treatment for hantavirus cardiopulmonary syndrome. Management remains primarily supportive and should focus on early recognition, careful hemodynamic management, respiratory support, timely referral, and access to advanced cardiopulmonary support when needed.
- Pharmacologic treatments directed at the virus or the host inflammatory response should be considered investigational. These interventions should not be used as routine clinical care and should only be administered within ethically approved clinical studies, formal research protocols, or appropriately authorized monitored emergency-use frameworks, according to national regulations.
- In symptomatic patients with confirmed mild hantavirus pulmonary syndrome/cardiopulmonary syndrome, ribavirin[1] should not be used routinely. Early ribavirin may be used only in the context of clinical research, or under a Monitored Emergency Use of Unregistered and Investigational Interventions (MEURI) or analogous monitored emergency-use framework for unproven interventions, particularly when administered before advanced cardiopulmonary compromise is established and after individual assessment of potential benefits, harms, and feasibility of timely administration *(17)*.
- In patients with severe hantavirus cardiopulmonary syndrome, early high-dose corticosteroids may be used only in the context of clinical research, or under a MEURI or analogous monitored emergency-use framework for unproven interventions (research-context recommendation; low certainty of evidence). Direct evidence in severe hantavirus cardiopulmonary syndrome is limited and of low certainty, but suggests a possible reduction in mortality, refractory shock, and need for mechanical ventilation, with imprecise estimates. Use should include institutional oversight,

[1] Direct clinical evidence for ribavirin in HPS/HCPS is limited and uncertain, and available evidence does not establish a mortality benefit once cardiopulmonary involvement is established. Indirect evidence from other hantavirus syndromes, particularly hemorrhagic fever with renal syndrome, suggests that any potential benefit is more biologically plausible when ribavirin is administered early, before severe disease progression. Use should include institutional oversight, availability informed consent when feasible, standardized documentation of timing from symptom onset, disease severity, dosing, adverse events, and clinical outcomes.

informed consent when feasible, and standardized documentation of clinical outcomes and adverse events.

- Other investigational strategies, including immunomodulatory therapies, monoclonal antibodies, convalescent plasma, or other targeted treatments, should only be used in the context of approved research protocols or formally monitored emergency-use programs (MEURI).
- Antibiotics do not treat hantavirus infection. However, empiric antibiotics may be started when bacterial sepsis, severe community-acquired pneumonia, leptospirosis, meningococcemia, or another treatable infection remains in the differential diagnosis. Antibiotic therapy should be reassessed early according to microbiological results, imaging, epidemiological context, and clinical course.
- For fever and pain, acetaminophen/paracetamol is preferred. Nonsteroidal anti-inflammatory drugs should be avoided when thrombocytopenia, renal dysfunction, bleeding, hypovolemia, or hemodynamic instability is present.

Table 4. Rapid synthesis of evidence on potential therapeutic interventions in people at risk of or with hantavirus pulmonary/cardiopulmonary syndrome. Summary of findings from human studies, by clinical scenario

Clinical scenario / population	Intervention / comparison	Outcome	Best evidence included in summary of findings	Summary relative effect	Anticipated absolute effect	Certainty of evidence	Narrative summary of findings statement
Symptomatic contacts / prodromal phase or early disease	Ribavirin	Mortality – observational studies	2 observational studies: Rusnak et al. and Lavarra et al., summarized by Strella et al.	Rusnak et al. reported 1/34 deaths in early treated hemorrhagic fever with renal syndrome (HFRS). Lavarra et al. reported 0/7 deaths in prodromal hantavirus pulmonary syndrome (HPS) / hantavirus cardiopulmonary syndrome (HCPS) treated with oral ribavirin, without a concurrent control group.	Not comparatively estimable because of absence of a concurrent control group. Observed risk with ribavirin: 1/34 and 0/7 deaths.	Very low ⊕◯◯◯	The evidence is very uncertain about the effect of ribavirin on mortality in observational studies of early disease or prodromal phase.
		Mortality – randomized trial	1 RCT: Huggins et al. in HFRS with ≤6 days of fever	RR 0.28 [0.08 to 1.00]. Mortality: 3/125 with ribavirin vs. 10/117 with placebo.	Without ribavirin: 8.5%. With ribavirin: 2.4% [0.7 to 8.5]. Difference: 6.2% fewer [7.9 fewer to 0.0 fewer].	Low ⊕⊕◯◯	The evidence suggests that ribavirin may reduce mortality in patients treated early, although the evidence comes from HFRS and is indirect for HPS/HCPS.
		Adverse events	1 RCT: Malinin and Platonov in HFRS caused by Puumala virus	Low hemoglobin 35/37 vs. 13/36; unconjugated hyperbilirubinemia 30/37 vs. 3/36; sinus bradycardia 16/37 vs. 5/36; rash 7/37 vs. 0/36; 1 patient discontinued ribavirin because of grade 3 bradycardia and required temporary pacing.		Moderate ⊕⊕⊕◯	Ribavirin probably increases adverse events, especially anemia/decrease in hemoglobin, unconjugated hyperbilirubinemia, and bradycardia.
Moderate or severe HPS/HCPS	Ribavirin	Mortality	2 clinical studies in HPS/HCPS: Chapman et al. and Mertz et al.	RR 0.99 [0.60 to 1.61]. Approximate risk: 40.4% without ribavirin vs. 40.0% with ribavirin. In Chapman: 14/30 deaths vs. 17/34. In Mertz: 2/10 deaths vs. 2/13.	Without ribavirin: 40.4%. With ribavirin: 40.0% [24.2 to 65.0]. Difference: 0.4% fewer [16.2 fewer to 24.7 more].	Moderate ⊕⊕⊕◯	Ribavirin probably does not reduce mortality in patients with moderate or severe HPS/HCPS or established cardiopulmonary involvement.
		Adverse events	1 compassionate-use clinical study: Chapman et al.	Among 140 patients exposed to ribavirin, 99/140 developed anemia and 26/140 required transfusion.		Very low ⊕◯◯◯	The evidence is very uncertain about the effect of ribavirin on hematologic adverse events in patients with moderate or severe HPS/HCPS.
Severe HPS/HCPS	Systemic corticosteroids / methylprednisolone vs. placebo	Death	1 RCT: Vial et al. 2013	OR 0.55 [0.18 to 1.62]. Death: 8/30 with methylprednisolone vs. 12/30 with placebo.	Study population baseline risk: 40.0%. With corticosteroids: 22.0% [7.2 to 64.8]. Difference: 18.0%	Low ⊕⊕◯◯	Corticosteroids may reduce mortality in patients with severe HPS/HCPS, but the evidence is uncertain.

Clinical scenario / population	Intervention / comparison	Outcome	Best evidence included in summary of findings	Summary relative effect	Anticipated absolute effect	Certainty of evidence	Narrative summary of findings statement
					fewer [32.8 fewer to 24.8 more]. High baseline risk: 70.0%. With corticosteroids: 38.5% [12.6 to 113.4]. Difference: 31.5% fewer [57.4 fewer to 43.4 more].		
		Refractory shock	1 RCT: Vial et al. 2013	OR 0.35 [0.08 to 1.58]. Shock: 4/21 with methylprednisolone vs. 6/15 with placebo.	Study population baseline risk: 40.0%. With corticosteroids: 14.0% [3.2 to 63.2]. Difference: 26.0% fewer [36.8 fewer to 23.2 more]. High baseline risk: 70.0%. With corticosteroids: 24.5% [5.6 to 110.6]. Difference: 45.5% fewer [64.4 fewer to 40.6 more].	Low ⊕⊕◯◯	The evidence suggests that corticosteroids may reduce refractory shock, but the estimate is imprecise.
		Need for mechanical ventilation	1 RCT: Vial et al. 2013	OR 0.30 [0.08 to 1.06]. Mechanical ventilation: 6/26 with methylprednisolone vs. 10/20 with placebo.	Study population baseline risk: 50.0%. With corticosteroids: 15.0% [4.0 to 53.0]. Difference: 35.0% fewer [46.0 fewer to 3.0 more]. High baseline risk: 70.0%. With corticosteroids: 21.0% [5.6 to 74.2]. Difference: 49.0% fewer [64.4 fewer to 4.2 more].	Low ⊕⊕◯◯	The evidence suggests that corticosteroids may reduce the need for mechanical ventilation, but the estimate is imprecise.
	Human immune plasma vs. methylprednisolone arm of Vial 2013	Overall mortality	1 observational study with contextual/historical comparison	OR 0.44 [0.12 to 1.66]. Death: 4/29 with plasma vs. 8/30 with methylprednisolone in Vial 2013.	Crude risk: methylprednisolone 26.7%; plasma 13.8%. Crude difference: 12.9% fewer with plasma.	Very low ⊕◯◯◯	The evidence is very uncertain about the effect of human immune plasma compared with the methylprednisolone arm of Vial 2013.
	Human immune plasma	Overall mortality	1 observational study: Vial et al. 2015	OR 0.32 [0.10 to 1.05]. Death: 4/29 with plasma vs. 20/60 in the full Vial 2013 trial.	Without plasma: 33.3%. With plasma: 10.7% [3.3 to 35.0]. Difference: 22.7% fewer [30.0 fewer to 1.7 more].	Very low ⊕◯◯◯	The evidence is very uncertain about the effect of human immune plasma on overall mortality in HPS/HCPS.
		Mortality, SOFA ≤8 subgroup	1 observational study: Vial et al. 2015	OR 0.19 [0.02 to 1.62]. Death: 1/21 with plasma vs. 9/43 in the full Vial 2013 trial.	Without plasma: 20.9%. With plasma: 4.0% [0.4 to 33.9]. Difference: 17.0% fewer [20.5 fewer to 13.0 more].	Very low ⊕◯◯◯	The evidence is very uncertain about the effect of human immune plasma on mortality in patients with HPS/HCPS and SOFA ≤8.

Clinical scenario / population	Intervention / comparison	Outcome	Best evidence included in summary of findings	Summary relative effect	Anticipated absolute effect	Certainty of evidence	Narrative summary of findings statement
		Mortality, SOFA >8 subgroup	1 observational study: Vial et al. 2015	OR 0.33 [0.06 to 1.88]. Death: 3/8 with plasma vs. 11/17 in the full Vial 2013 trial.	Without plasma: 64.7%. With plasma: 21.4% [3.9 to 121.6]. Difference: 43.4% fewer [60.8 fewer to 56.9 more].	Very low ⊕◯◯◯	The evidence is very uncertain about the effect of human immune plasma on mortality in patients with HPS/HCPS and SOFA >8.
		Adverse events	1 observational study: Vial et al. 2015	Eleven serious adverse events were reported in 29 patients, including the 4 deaths; none was directly attributed to the infusion. No bloodborne pathogen transmission was detected up to 180 days.		Very low ⊕◯◯◯	The evidence is very uncertain about the effect of human immune plasma on adverse events; in the available series, no events were identified as directly attributable to the infusion.
	Tocilizumab plus standard supportive care	Mortality	1 observational study: Monitored Emergency Use of Unregistered and Investigational Interventions (MEURI) case series with contextual comparison	OR 0.03 [0.001 to 0.94]. Death: 1/5 with tocilizumab vs. 5/5 with standard supportive care.	Study population baseline risk: 80.0%. With tocilizumab: 2.4% [0.1 to 75.2]. Difference: 77.6% fewer [79.9 fewer to 4.8 fewer].	Very low ⊕◯◯◯	The evidence is very uncertain about the effect of tocilizumab on mortality in patients with severe HPS/HCPS.
Severe / refractory HCPS meeting criteria for predicted 100% mortality	VA-ECMO vs. historical/predicted mortality without ECMO	All-cause mortality / survival	2 main case series plus smaller reports: Dietl et al. and Wernly et al.; 89 patients in the two largest series	Dietl et al.: survival 60.5% (23/38). Wernly et al.: survival 66.6% (34/51). Wernly et al. also reported temporal improvement: 56% survival in 1994–2000 vs. 80% survival in 2003–2010 (P=0.048).	Approximately 600–800 survivors per 1000 patients who would otherwise be predicted to die without ECMO.	Low ⊕⊕◯◯	VA-ECMO may substantially reduce mortality in selected patients with severe or refractory HCPS meeting criteria for predicted 100% mortality. All evidence is observational and based on case series and historical or predicted comparisons.
	VA-ECMO	Full recovery among survivors	2 main case series: Dietl et al. and Wernly et al.; 57 survivors across the two largest series	Not applicable as a comparative relative effect. Dietl et al. reported that all survivors fully recovered; Wernly et al. reported survival in 34/51 patients.	Complete recovery was reported among survivors in the two major ECMO series.	Low ⊕⊕◯◯	Among patients with severe HCPS who survive after VA-ECMO, complete recovery has been reported in the main case series, consistent with the potentially reversible nature of HCPS-associated cardiopulmonary dysfunction.
	VA-ECMO	ECMO-related complications	2 main case series: Dietl et al. and Wernly et al.; 89 patients across the two largest series	Dietl et al. reported cannulation-related complications: percutaneous 26.6%; open femoral 34.8%,	Approximately 220–360 complications per 1000 patients treated with ECMO, depending on cannulation approach and series.	Low ⊕⊕◯◯	ECMO-related complications are clinically important. The evidence suggests meaningful survival despite procedural risks, but the data come from observational case series.

Clinical scenario / population	Intervention / comparison	Outcome	Best evidence included in summary of findings	Summary relative effect	Anticipated absolute effect	Certainty of evidence	Narrative summary of findings statement
				including one leg amputation.			

Source: Developed by the authors based on a rapid synthesis of evidence from the following studies:

Chapman LE, Mertz GJ, Peters CJ, et al. Intravenous ribavirin for hantavirus pulmonary syndrome: safety and tolerance during 1 year of open-label experience. Antivir Ther. 1999;4(4):211–219. Available from: https://doi.org/10.1177/135965359900400404.

Chung DH, Västermark Å, Camp JV, et al. The murine model for Hantaan virus-induced lethal disease shows two distinct paths in viral evolutionary trajectory with and without ribavirin treatment. J Virol. 2013;87(20):10997–11007. Available from: https://doi.org/10.1128/JVI.01394-13.

Huggins JW, Hsiang CM, Cosgriff TM, et al. Prospective, double-blind, concurrent, placebo-controlled clinical trial of intravenous ribavirin therapy of hemorrhagic fever with renal syndrome. J Infect Dis. 1991;164(6):1119–1127. Available from: https://doi.org/10.1093/infdis/164.6.1119.

Medina RA, Mirowsky-Garcia K, Hutt J, Hjelle B. Ribavirin, human convalescent plasma and anti-beta3 integrin antibody inhibit infection by Sin Nombre virus in the deer mouse model. J Gen Virol. 2007;88(Pt 2):493–505. Available from: https://doi.org/10.1099/vir.0.82459-0.

Mertz GJ, Miedzinski L, Goade D, et al. Placebo-controlled, double-blind trial of intravenous ribavirin for the treatment of hantavirus cardiopulmonary syndrome in North America. Clin Infect Dis. 2004;39(9):1307–1313. Available from: https://doi.org/10.1086/425007.

Moreli ML, Marques-Silva AC, Pimentel VA, da Costa VG. Effectiveness of the ribavirin in treatment of hantavirus infections in the Americas and Eurasia: a meta-analysis. Virusdisease. 2014;25(3):385–389. Available from: https://doi.org/10.1007/s13337-014-0219-7.

Ramírez-Olivencia G, Estébanez M, Membrillo FJ, Ybarra MDC. Use of ribavirin in viruses other than hepatitis C: a review of the evidence. Enferm Infecc Microbiol Clin (Engl Ed). 2019;37(9):602–608. Available from: https://doi.org/10.1016/j.eimce.2018.05.018.

Rusnak JM, Byrne WR, Chung KN, et al. Experience with intravenous ribavirin in the treatment of hemorrhagic fever with renal syndrome in Korea. Antiviral Res. 2009;81(1):68–76. Available from: https://doi.org/10.1016/j.antiviral.2008.09.007.

Safronetz D, Haddock E, Feldmann F, Ebihara H, Feldmann H. In vitro and in vivo activity of ribavirin against Andes virus infection. PLoS One. 2011;6(8):e23560. Available from: https://doi.org/10.1371/journal.pone.0023560.

Saúl PA, Sánchez-Cunto M, Gregori-Sabelli RA, Chacón NR, Chediack V, Cunto ER. Controversias sobre el uso de corticoides en el síndrome cardiopulmonar por hantavirus. Medicina (B Aires). 2021;81(4):617–623. Available from: https://www.scielo.org.ar/scielo.php?pid=S0025-76802021000400617&script=sci_arttext.

Strella T, Echazarreta SE, Couto EM, et al. Controversias en Hantavirus. Medicina (B Aires). 2025;85(2):11. Available from: https://www.medicinabuenosaires.com/PMID/40198172.pdf.

Sun Y, Chung DH, Chu YK, Jonsson CB, Parker WB. Activity of ribavirin against Hantaan virus correlates with production of ribavirin-5'-triphosphate, not with inhibition of IMP dehydrogenase. Antimicrob Agents Chemother. 2007;51(1):84–88. Available from: https://doi.org/10.1128/AAC.00790-06.

Lavarra E, Strella T, Garrido A, et al. Uso de ribavirina como tratamiento contra infecciones por hantavirus Andes Sur en Chubut, Argentina. International Meeting on Emerging Diseases; 2021. Conference abstract.

Malinin OV, Platonov AE. Insufficient efficacy and safety of intravenous ribavirin in treatment of haemorrhagic fever with renal syndrome caused by Puumala virus. Infect Dis (Lond). 2017;49(7):514–520. Available from: https://doi.org/10.1080/23744235.2017.1293841.

Riquelme R, Rioseco ML, Bastidas L, et al. Hantavirus pulmonary syndrome, Southern Chile, 1995–2012. Emerg Infect Dis. 2015;21(4):562–568. Available from: https://doi.org/10.3201/eid2104.141437.

Sayer WJ, Entwhisle G, Uyeno B, Bignall RC. Cortisone therapy of early epidemic hemorrhagic fever: a preliminary report. Ann Intern Med. 1955;42(4):839–851. Available from: https://doi.org/10.7326/0003-4819-42-4-839.

Tapia G MS, Mansilla A C, Vera M TMJL. Síndrome pulmonar por hantavirus: experiencia clínica en diagnóstico y tratamiento. Hospital Coyhaique-Chile. Rev Chil Infectol. 2000;17(3):258–269. Available from: https://doi.org/10.4067/S0716-10182000000300010.

Vial PA, Valdivieso F, Ferres M, et al. High-dose intravenous methylprednisolone for hantavirus cardiopulmonary syndrome in Chile: a double-blind, randomized controlled clinical trial. Clin Infect Dis. 2013;57(7):943–951. Available from: https://doi.org/10.1093/cid/cit394.

Vial PA, Valdivieso F, Calvo M, et al. A non-randomized multicentre trial of human immune plasma for treatment of hantavirus cardiopulmonary syndrome caused by Andes virus. Antivir Ther. 2015;20(4):377–386. Available from: https://doi.org/10.3851/IMP2875.

Tortosa F, Santamaría G, Bustamante R, Ragusa MA, Iglesias A, Espasandin Y, et al. Use of tocilizumab for severe hantavirus pulmonary syndrome: a MEURI case series with contextual comparisons. Lancet Infect Dis. [forthcoming 2026].

Moore SA, Dietl CA, Coleman DM. Extracorporeal life support during pregnancy. J Thorac Cardiovasc Surg. 2016;151(4):1154–1160. Available from: https://doi.org/10.1016/j.jtcvs.2015.12.027.

14. Summary recommendation on fluid therapy

In patients with suspected or confirmed hantavirus cardiopulmonary syndrome who present with respiratory failure, pulmonary infiltrates, hypoxemia, or signs of cardiopulmonary phase, a restrictive fluid strategy is recommended. These patients should not be managed as undifferentiated sepsis with systematic large-volume fluid loading, because the predominant pathophysiology is pulmonary and endothelial vascular permeability, with a high risk of respiratory deterioration associated with overhydration. Resuscitation should be individualized, with small boluses only when there is evidence of hypovolemia, immediate reassessment, and early use of vasopressors when appropriate.

15. Infection prevention and control in healthcare settings

Detailed infection prevention and control measures for hantavirus infection, including ANDV disease, are addressed in the Pan American Health Organization (PAHO) regional infection prevention and control guideline *(19)*. The present publication does not aim to duplicate the guidance, but to highlight key principles relevant to integration with clinical management.

15.1 General principles

Infection prevention and control measures should be implemented as soon as hantavirus infection is suspected. For suspected or confirmed ANDV infection, **standard and transmission-based precautions** (contact and airborne) should be applied in healthcare settings. These precautions should not be limited to confirmed clusters only, because delays in recognition may increase the risk of exposure among healthcare workers, patients, visitors, and household contacts.

ANDV transmission is usually associated with close contact with a symptomatic person, including direct physical contact, prolonged time in close or enclosed spaces, or exposure to body fluids or respiratory secretions. Therefore, clinical care should be integrated with early isolation in single room, adherence to hand hygiene, appropriate use of personal protective equipment (gowns, gloves, eye protection, and fit-tested N95 or equivalent respirator), safe handling of specimens and contaminated materials, environmental cleaning, and rapid identification and monitoring of close contacts.

Detailed operational guidance on infection prevention and control, including the elements outlined in this section, is provided in the PAHO regional infection prevention and control guideline *(19)* and should be followed in accordance with national and local protocols.

16. Discharge

In hospitalized patients with hantavirus infection for whom discharge is being planned, sustained clinical stability should be confirmed before hospital discharge. This includes recovery of respiratory and hemodynamic function, no ongoing requirement for advanced organ support, favorable clinical and laboratory evolution, and an established outpatient follow-up plan.

16.1 Implementation considerations

Respiratory stability should include absence of clinically relevant hypoxemia, stable oxygen saturation without increasing supplemental oxygen requirements, and no signs of progressive respiratory distress. Hemodynamic stability should include absence of shock, persistent hypotension, or need for vasopressor

or inotropic support. Discharge should not be based on a single isolated parameter, but on an integrated assessment of clinical evolution, laboratory trends, improvement or resolution of cardiopulmonary involvement, absence of recent deterioration, and the feasibility of timely follow-up, warning signs education, and prompt reevaluation if symptoms worsen.

17. Follow-up after discharge

Patients who developed hantavirus cardiopulmonary syndrome should receive clinical follow-up for at least 6 months, with assessment for respiratory, cardiovascular, renal, neurologic, auditory, ocular, and mental health sequelae. Occupational attribution and return-to-work decisions should follow local legislation and occupational health procedures.

Evidence indicates that approximately 62% of hantavirus cardiopulmonary syndrome survivors report incomplete recovery at 3–6 months postdischarge *(20)*. All patients who required ICU admission, mechanical ventilation, or ECMO support should receive structured multidisciplinary rehabilitation referral at discharge.

References

1. Avšič-Županc T, Saksida A, Korva M. Hantavirus infections. Clinical microbiology and infection. 2019;21:e6-e16 10.1111/1469-0691.12291. Available from: https://www.clinicalmicrobiologyandinfection.org/article/S1198-743X(15)00536-4/fulltext.
2. Vial PA, Harkins M. Pathogenesis, epidemiology, and diagnosis of hantavirus infections [Internet]. UpToDate Inc. (Wolters Kluwer); 2026. [cited 2026/05/13]. Available from: https://www.uptodate.com/contents/pathogenesis-epidemiology-and-diagnosis-of-hantavirus-infections.
3. Enria DAM, Levis SC. Zoonosis virales emergentes: Las infecciones por hantavirus. Revue scientifique et technique (International Office of Epizootics). 2004;23(2):595-611 10.20506/rst.23.2.1501. Available from: https://doc.woah.org/dyn/portal/index.xhtml?page=alo&aloId=30360&nobl=1.
4. Wells RM, Sosa Estani S, Yadon ZE, Enria D, Padula P, Pini N et al. An unusual hantavirus outbreak in southern Argentina: person-to-person transmission? Hantavirus Pulmonary Syndrome Study Group for Patagonia. Emerging infectious diseases. 1997;3(2):171-4 10.3201/eid0302.970210. Available from: https://wwwnc.cdc.gov/eid/article/3/2/97-0210_article.
5. Martinez-Valdebenito C, Calvo M, Vial C, Mansilla R, Marco C, Palma RE et al. Person-to-Person Household and Nosocomial Transmission of Andes Hantavirus, Southern Chile, 2011. Emerging infectious diseases. 2014;20(10):1629-36 10.3201/eid2010.140353. Available from: https://wwwnc.cdc.gov/eid/article/20/10/14-0353_article.
6. Padula PJ, Edelstein A, Miguel SDL, López NM, Rossi CM, Rabinovich RD. Hantavirus Pulmonary Syndrome Outbreak in Argentina: Molecular Evidence for Person-to-Person Transmission of Andes Virus. Virology (New York, NY). 1998;241(2):323-30 10.1006/viro.1997.8976. Available from: https://doi-org.eux.idm.oclc.org/10.1006/viro.1997.8976.
7. Martinez VP, Bellomo C, San Juan J, Pinna D, Forlenza R, Elder M et al. Person-to-Person Transmission of Andes Virus. Emerging infectious diseases. 2005;11(12):1848-53 10.3201/eid1112.050501. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC3367635/.
8. Martínez VP, Di Paola N, Alonso DO, Pérez-Sautu U, Bellomo CM, Iglesias AA et al. "Super-Spreaders" and Person-to-Person Transmission of Andes Virus in Argentina. The New England journal of medicine. 2020;383(23):2230-41 10.1056/NEJMoa2009040. Available from: https://www.nejm.org/doi/full/10.1056/NEJMoa2009040.
9. Toro J, Vega JD, Khan AS, Mills JN, Padula P, Terry W et al. An Outbreak of Hantavirus Pulmonary Syndrome, Chile, 1997. Emerging infectious diseases. 1998;4(4):687-94 10.3201/eid0404.980425. Available from: https://wwwnc.cdc.gov/eid/article/4/4/98-0425_article.
10. Ferrés M, Vial P, Marco C, Yañez L, Godoy P, Castillo C et al. Prospective Evaluation of Household Contacts of Persons with Hantavirus Cardiopulmonary Syndrome in Chile. The Journal of infectious diseases. 2007;195(11):1563-71 10.1086/516786. Available from: https://doi.org/10.1086/516786.
11. Ferrés M, Martínez-Valdebenito C, Angulo J, Henríquez C, Vera-Otárola J, Vergara MJ et al. Mother-to-Child Transmission of Andes Virus through Breast Milk, Chile1. Emerging infectious diseases. 2020;26(8):1885-8 10.3201/eid2608.200204. Available from: https://wwwnc.cdc.gov/eid/article/26/8/20-0204_article.
12. Medina RA, Torres-Perez F, Galeno H, Navarrete M, Vial PA, Palma RE et al. Ecology, Genetic Diversity, and Phylogeographic Structure of Andes Virus in Humans and Rodents in Chile. Journal of Virology. 2009;83(6):2446-59 10.1128/JVI.01057-08. Available from: https://doi.org/10.1128/jvi.01057-08.
13. Vial PA, Valdivieso F, Mertz G, Castillo C, Belmar E, Delgado I et al. Incubation Period of Hantavirus Cardiopulmonary Syndrome. Emerging infectious diseases. 2006;12(8):1271-3 10.3201/eid1208.051127. Available from: https://wwwnc.cdc.gov/eid/article/12/8/05-1127_article.
14. Jonsson CB, Figueiredo LTM, Vapalahti O. A Global Perspective on Hantavirus Ecology, Epidemiology, and Disease. Clinical Microbiology Reviews. 2010;23(2):412-41 10.1128/CMR.00062-09. Available from: https://doi.org/10.1128/cmr.00062-09.

15. MacNeil A, Nichol ST, Spiropoulou CF. Hantavirus pulmonary syndrome. Virus research. 2011;162(1):138-47 10.1016/j.virusres.2011.09.017. Available from: https://doi.org/10.1016/j.virusres.2011.09.017.
16. Hallin GW, Simpson SQ, Crowell RE, James DS, Koster FT, Mertz GJ et al. Cardiopulmonary manifestations of hantavirus pulmonary syndrome. Critical care medicine. 1996;24(2):252-8 10.1097/00003246-199602000-00012. Available from: http://dx.doi.org/10.4067/S0716-10182000000300010.
17. Harkins M, Vial PA, Hirsch MS, File TM, Jr., White N. Hantavirus cardiopulmonary syndrome. UpToDate; 2026 (https://www.uptodate.com/contents/clinical-features-diagnosis-and-management-of-hantavirus-cardiopulmonary-syndrome.).
18. Tapia G MS, Mansilla A C, Vera M TMJL. Síndrome pulmonar por hantavirus: Experiencia clínica en diagnóstico y tratamiento. Hospital Coyhaique-Chile. Revista chilena de infectología. 2000;17(3) http://dx.doi.org/10.4067/S0716-10182000000300010). Available from: http://dx.doi.org/10.4067/S0716-10182000000300010.
19. Pan American Health Organization. Infection prevention and control of hantavirus infection, including Andes virus disease. Interim regional guidance for suspected or confirmed cases. [forthcoming 2026]. Washington, D.C.: Pan American Health Organization / World Health Organization; [forthcoming 2026]. Available from. [cited 15 May 2026]
20. Valenzuela G, Barahona K, Rojas C, Barrera A, Henríquez C, Martínez-Valdebenito C et al. Beyond ECMO Survival: Long-Term Symptom Burden and Quality-of-Life Impairment in Hantavirus Cardiopulmonary Syndrome Survivors. Viruses. 2025;17(9):1241 10.3390/v17091241. Available from: https://www.mdpi.com/1999-4915/17/9/1241.
21. Superintendencia de Riesgos del Trabajo. Hantavirosis o infección por hantavirus. 2024. Buenos Aires: Superintendencia de Riesgos del Trabajo; 2024. Available from: https://www.argentina.gob.ar/sites/default/files/hantavirosis_o_infeccion_por_hantavirus_2024.pdf. [cited

Selected source documents

Ambrosio A, Saavedra M, Mariani M, et al. Argentine hemorrhagic fever vaccines. Hum Vaccin. 2011 Jun;7(6):694–700. Available from: https://doi.org/10.4161/hv.7.6.15198.

Blond OPA. The Epuyén outbreak of hantavirus pulmonary syndrome, Argentina, 2018–2019. CABI One Health Cases. 2023;2023:1–11. Available from: https://doi.org/10.1079/onehealthcases.2023.0018.

Coelho R, Kehl S, Periolo N, Biondo E, Alonso D, Perez C, et al. Virological characterization of a new isolated strain of Andes virus involved in the recent person-to-person transmission outbreak reported in Argentina. PLoS Negl Trop Dis. 2025;19(6):e0013205. Available from: https://doi.org/10.1371/journal.pntd.0013205.

Dirección Nacional de Epidemiología y Análisis de la Situación de Salud. Hantavirus: Recomendaciones de Bioseguridad en el contexto del brote de Epuyén, provincia del Chubut. Argentina: Dirección Nacional de Epidemiología y Análisis de Situación de la Salud; INEI-ANLIS Dr. C. G. Malbrán; 2019. Available from: https://saludsantacruz.gob.ar/portal/wp-content/uploads/2019/01/0000001396cnt-2019-01-23-hantavirus-bioseguridad.pdf.

Dirección Nacional de Epidemiología y Análisis de la Situación de Salud. Vigilancia y control de Hantavirosis por virus Hanta Andes Sur: recomendaciones ante casos y manejo de contactos. Argentina: Dirección Nacional de Epidemiología y Análisis de la Situación de Salud; 2019. Available from: https://www.argentina.gob.ar/sites/default/files/vigilancia_control_hantavirosis_virus_hanta_andes_sur_recomendaciones.pdf.

Enría D, Padula P, Segura EL, Pini N, Edelstein A, Posse CR, et al. Hantavirus pulmonary syndrome in Argentina. Possibility of person to person transmission. Medicina (B Aires). 1996;56(6):709–711. Available from: https://medicinabuenosaires.com/revistas/vol56-96/6/709.pdf.

Ferrés M, Vial P, Marco C, Yañez L, Godoy P, Castillo C, et al. Prospective evaluation of household contacts of persons with hantavirus cardiopulmonary syndrome in Chile. J Infect Dis. 2007 Jun 1;195(11):1563–1571. Available from: https://doi.org/10.1086/516786.

Lázaro ME, Cantoni GE, Calanni LM, Resa AJ, Herrero ER, Iacono MA, et al. Clusters of hantavirus infection, southern Argentina. Emerg Infect Dis. 2007;13(1):104–110. Available from: https://wwwnc.cdc.gov/eid/article/13/1/06-0404_article.

Lozano ME, Posik DM, Albarino CG, et al. Characterization of arenaviruses using a family-specific primer set for RT-PCR amplification and RFLP analysis. Its potential use for detection of uncharacterized arenaviruses. Virus Res. 1997;49(1):79–89. Available from: https://doi.org/10.1016/S0168-1702(97)01458-5.

Martínez VP, Di Paola N, Alonso DO, Pérez-Sautu U, Bellomo CM, Iglesias AA, et al. Super-spreaders and person-to-person transmission of Andes virus in Argentina. N Engl J Med. 2020;383(23):2230–2241. Available from: https://www.nejm.org/doi/full/10.1056/NEJMoa2009040.

Martinez-Valdebenito C, Calvo M, Vial C, et al. Person-to-person household and nosocomial transmission of Andes hantavirus, southern Chile, 2011. Emerg Infect Dis. 2014;20(10). Available from: https://doi.org/10.3201/eid2010.140353.

Martinez VP, Bellomo CM, Cacace ML, Suarez P, Bogni L, Padula PJ. Hantavirus pulmonary syndrome in Argentina, 1995–2008. Emerg Infect Dis. 2010;16(12):1853–1860. Available from: https://doi.org/10.3201/eid1612.091170.

Martinez VP, Bellomo C, San Juan J, Pinna D, Forlenza R, Elder M, et al. Person-to-person transmission of Andes virus. Emerg Infect Dis. 2005;11(12):1848–1853. Available from: https://doi.org/10.3201/eid1112.050501.

Martínez VP, Di Paola N, Alonso DO, Pérez-Sautu U, Bellomo CM, Iglesias AA, et al. “Super-spreaders” and person-to-person transmission of Andes virus in Argentina. N Engl J Med. 2020;383(23):2230-2241. Available from: https://www.nejm.org/doi/full/10.1056/NEJMoa2009040.

Ministry of Health, Chile. Guía clínica para el diagnóstico, tratamiento, prevención y control del síndrome cardiopulmonar por hantavirus. Santiago: Ministerio de Salud; 2013. Available from: https://diprece.minsal.cl/wrdprss_minsal/wp-content/uploads/2015/02/Gu%C3%ADa-HANTA-completa.pdf.

Ministry of Health and Social Development, Argentina. Hantavirus: guía para el equipo de salud. Buenos Aires: Ministerio de Salud y Desarrollo Social; 2019. Available from: https://www.sadi.org.ar/novedades/48-boletines-y-reportes/50-ministerio-de-salud/702-hantavirus-guia-para-el-equipo-de-salud-del-ministerio-de-salud-de-la-nacion.

Olschewski S, Thielebein A, Hoffmann C, et al. Validation of inactivation methods for arenaviruses. Viruses. 2021;13(6):968. Available from: https://doi.org/10.3390/v13060968.

Padula PJ, Edelstein A, Miguel SD, López NM, Rossi CM, Rabinovich RD. Epidemic outbreak of hantavirus pulmonary syndrome in Argentina. Molecular evidence of person-to-person transmission of Andes virus. Medicina (B Aires). 1998;58 Suppl 1:27–36.

Padula PJ, Edelstein A, Miguel SDL, López NM, Rossi CM, Rabinovich RD. Hantavirus pulmonary syndrome outbreak in Argentina: molecular evidence for person-to-person transmission of Andes virus. Virology. 1998;241(2):323–330. Available from: https://doi.org/10.1006/viro.1997.8976.

Pan American Health Organization. Infection prevention and control. Washington, D.C.: PAHO; 2026 [cited 19 May 2026]. Available from: https://www.paho.org/en/topics/infection-prevention-and-control.

Pan American Health Organization. Infection prevention and control recommendation in health-care settings for hantavirus, Andes virus infections. Draft, 11 May 2026.

Pan American Health Organization. Hantavirus in the Americas: Guidelines for diagnosis, treatment, prevention, and control. Washington, D.C.: PAHO; 1999. Available from: https://iris.paho.org/server/api/core/bitstreams/ab4454a1-182e-4a98-a64e-db62e1f96394/content.

Pan American Health Organization. Epidemiological alert: Hantavirus pulmonary syndrome in the Americas Region; 19 December 2025. Washington, D.C.: PAHO; 2025. Available from: https://www.paho.org/en/documents/epidemiological-alert-hantavirus-pulmonary-syndrome-americas-region-19-december-2025.

Pan American Health Organization. Management of dead bodies after disasters: A field manual for first responders. Second (revised) edition. Washington, D.C.: PAHO; 2016. Available from: https://iris.paho.org/items/92bebc8d-8431-4e6b-951e-1be6f9850ac3.

Pfau CJ. Arenaviruses. In: Baron S, editor. Medical microbiology. 4th edition. Galveston: University of Texas Medical Branch at Galveston; 1996 [cited 19 May 2026]. Chapter 57. Available from: https://www.ncbi.nlm.nih.gov/books/NBK8193/.

Pinna DM, Martínez VP, Bellomo CM, López C, Padula P. Nueva evidencia epidemiológica y molecular a favor de la transmisión interhumana para el linaje Sout del hantavirus Andes. Medicina (B Aires). 2004;64(1):43–46. Available from: https://www.researchgate.net/publication/262670369_Nueva_evidencia_epidemiologica_y_molecular_a_favor_de_la_transmision_interhumana_para_el_linaje_Sout_del_hantavirus_Andes.

Pizarro E, Navarrete M, Mendez C, et al. Immunocytochemical and ultrastructural evidence supporting that Andes hantavirus (ANDV) is transmitted person-to-person through the respiratory and/or salivary pathways. Front Microbiol. 2020;10:2992. Available from: https://doi.org/10.3389/fmicb.2019.02992.

Radoshitzky SR, Buchmeier MJ, Charrel RN, et al. ICTV virus taxonomy profile: Arenaviridae 2023. J Gen Virol. 2023 Sep;104(9):001891. Available from: https://doi.org/10.1099/jgv.0.001891.

Tapia G, Mauricio S., Mansilla A, Carlos, & Vera M, TM Jose L. (2000). Síndrome pulmonar por hantavirus: Experiencia clínica en diagnóstico y tratamiento. Hospital Coyhaique-Chile. Rev chil infectol. 17(3), 258–269. Available from: https://dx.doi.org/10.4067/S0716-10182000000300010.

Tortosa F, Ragusa MA, Neumann I, et al. Prognostic factors for mortality in patients infected with New World hantaviruses: a systematic review and meta-analysis. BMJ Open. 2026;16:e096313. Available from: https://doi.org/10.1136/bmjopen-2024-096313.

Trombley AR, Wachter L, Garrison J, et al. Comprehensive panel of real-time TaqMan polymerase chain reaction assays for detection and absolute quantification of filoviruses, arenaviruses, and New World hantaviruses. Am J Trop Med Hyg. 2010;82(5):954–960. Available from: https://doi.org/10.4269/ajtmh.2010.09-0636.

Ulloa-Morrison, R., Pavez, N., Parra, E., Lopez, R., Mondaca, R., Fernandez, P., Kraunik, D., Sanhueza, C., Bravo, S., Cornu, M. G., & Kattan, E. Critical care management of hantavirus cardiopulmonary syndrome. A narrative review. Respiratory investigation. J Crit Care. 2024;62(3). Available from: https://doi.org/10.1016/j.jcrc.2024.154867.

United States Department of Health and Human Services. Biosafety in microbiological and biomedical laboratories 6th Edition. [place unknown]: U.S. Government Printing Office; 2026. Available from: https://www.cdc.gov/labs/bmbl/index.html.

UK Health Security Agency. Andes hantavirus: epidemiology, outbreaks and guidance. London: UKHSA; 2021. Available from: https://www.gov.uk/guidance/andes-hantavirus-epidemiology-outbreaks-and-guidance.

U.S. Centers for Disease Control and Prevention. Clinician brief: Hantavirus pulmonary syndrome (HPS). Atlanta: CDC; 2026 [cited 19 May 2026]. Available from: https://www.cdc.gov/hantavirus/hcp/clinical-overview/hps.html.

U.S. Centers for Disease Control and Prevention. Appendix A: Type and duration of precautions recommended for selected infections and conditions. Atlanta: CDC; 2025 [cited 19 May 2026]. Available from: https://www.cdc.gov/infection-control/hcp/isolation-precautions/appendix-a-type-duration.html.

U.S. Centers for Disease Control and Prevention. Hantavirus infection — Southwestern United States: Interim recommendations for risk reduction. Morb Mortal Wkly Rep. 1993;42(RR11):1–13. Available from: https://www.cdc.gov/mmwr/preview/mmwrhtml/00030643.htm.

Valenzuela G, Barahona K, Rojas C, et al. Beyond ECMO survival: Long-term symptom burden and quality-of-life impairment in hantavirus cardiopulmonary syndrome survivors. Viruses. 2025;17(9):1241. Available from: https://doi.org/10.3390/v17091241.

Vasconcelos PF, Travassos da Rosa AP, Rodrigues SG, et al. [Laboratory-acquired human infection with SP H 114202 virus (Arenavirus: Arenaviridae family): clinical and laboratory aspects]. Rev Inst Med Trop Sao Paulo. 1993;35(6):521–525. In Portuguese. Available from: https://doi.org/10.1590/s0036-46651993000600008.

Vial P, Valdivieso F, Ferrés M. Manejo del paciente crítico con síndrome cardiopulmonar por hantavirus. Chile: Programa Hantavirus Ecología y Enfermedad en Chile; 2004. 140 pp.

Wells RM, Sosa Estani S, Yadon ZE, Enria D, Padula P, Pini N, et al. An unusual hantavirus outbreak in southern Argentina: Person-to-person transmission? Emerg Infect Dis. 1997;3(2):171–174. Available from: https://wwwnc.cdc.gov/eid/article/3/2/97-0210_article.

Wernly JA, Dietl CA, Tabe CE, et al. Extracorporeal membrane oxygenation support improves survival of patients with severe hantavirus cardiopulmonary syndrome. J Thorac Cardiovasc Surg. 2008;135(3):579–584. Available from: https://doi.org/10.1016/j.jtcvs.2007.11.020.

World Health Organization. Hantavirus outbreak toolbox. Geneva: WHO; 2026 [cited 19 May 2026]. Available from: https://www.who.int/emergencies/outbreak-toolkit/disease-outbreak-toolboxes/hantavirus-outbreak-toolbox.

World Health Organization. Hantavirus disease – Argentina. Disease Outbreak News. Geneva: WHO; 2019 [cited 19 May 2026]. Available from: https://www.who.int/emergencies/disease-outbreak-news/item/23-January-2019-hantavirus-argentina-en.

World Health Organization. Infection prevention and control. Geneva: WHO; 2026 [cited 19 May 2026]. Available from: https://www.who.int/teams/integrated-health-services/infection-prevention-control.

World Health Organization. Laboratory biosafety manual. 4th ed. Geneva: WHO; 2020. Available from: https://www.who.int/publications/i/item/9789240011311.

World Health Organization. Guidance on regulations for the transport of infectious substances 2023–2024. Geneva: WHO; 2024. Available from: https://www.who.int/publications/b/71576.

Annex 1. Operational flow charts

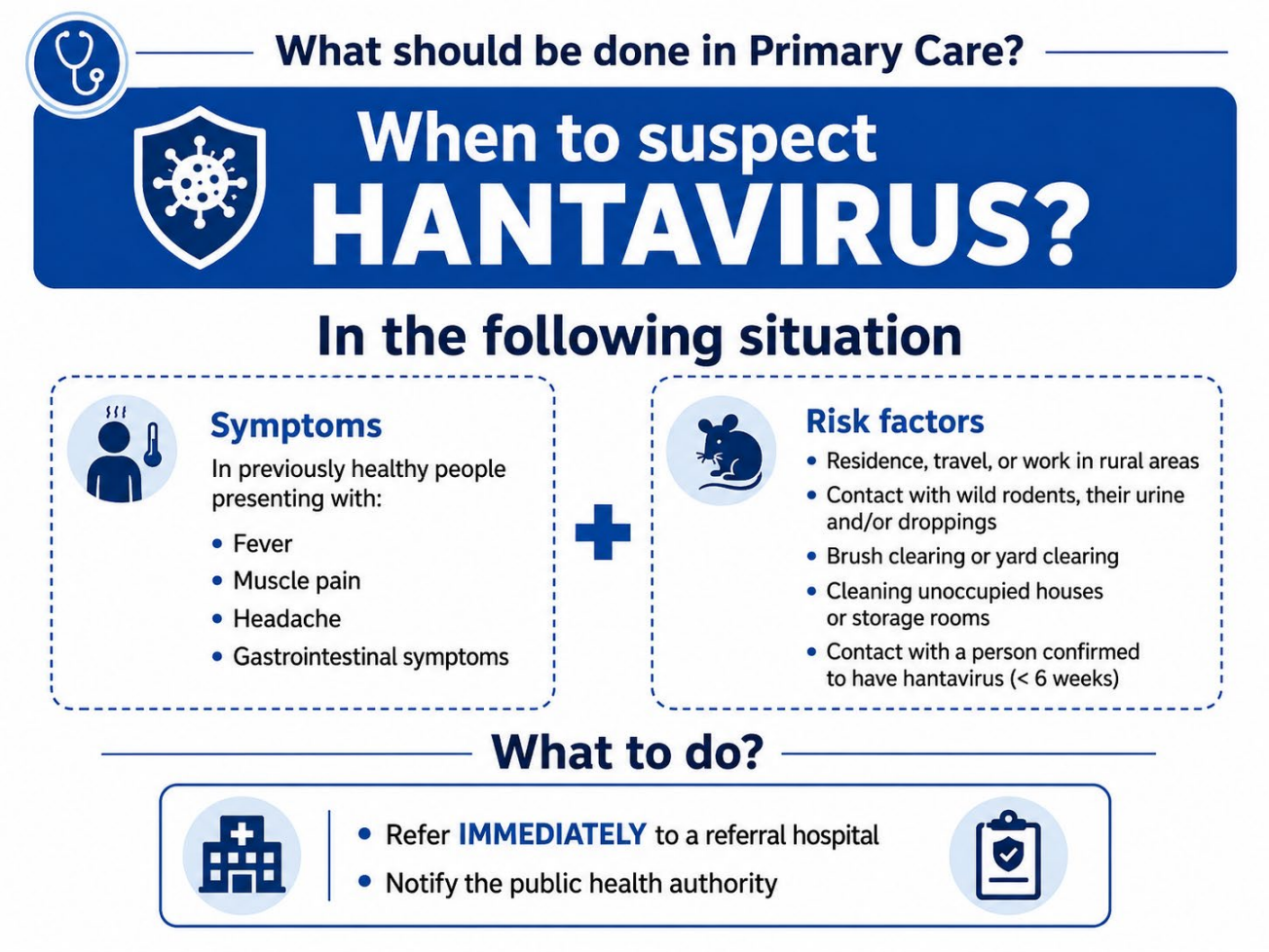


Figure A1.1. When to suspect hantavirus in primary care and immediate actions

Source: Adapted from Ministry of Health, Chile. Guía clínica para el diagnóstico, tratamiento, prevención y control del síndrome cardiopulmonar por hantavirus. Santiago: Ministerio de Salud; 2013. Available from: https://diprece.minsal.cl/wrdprss_minsal/wp-content/uploads/2015/02/Gu%C3%ADa-HANTA-completa.pdf

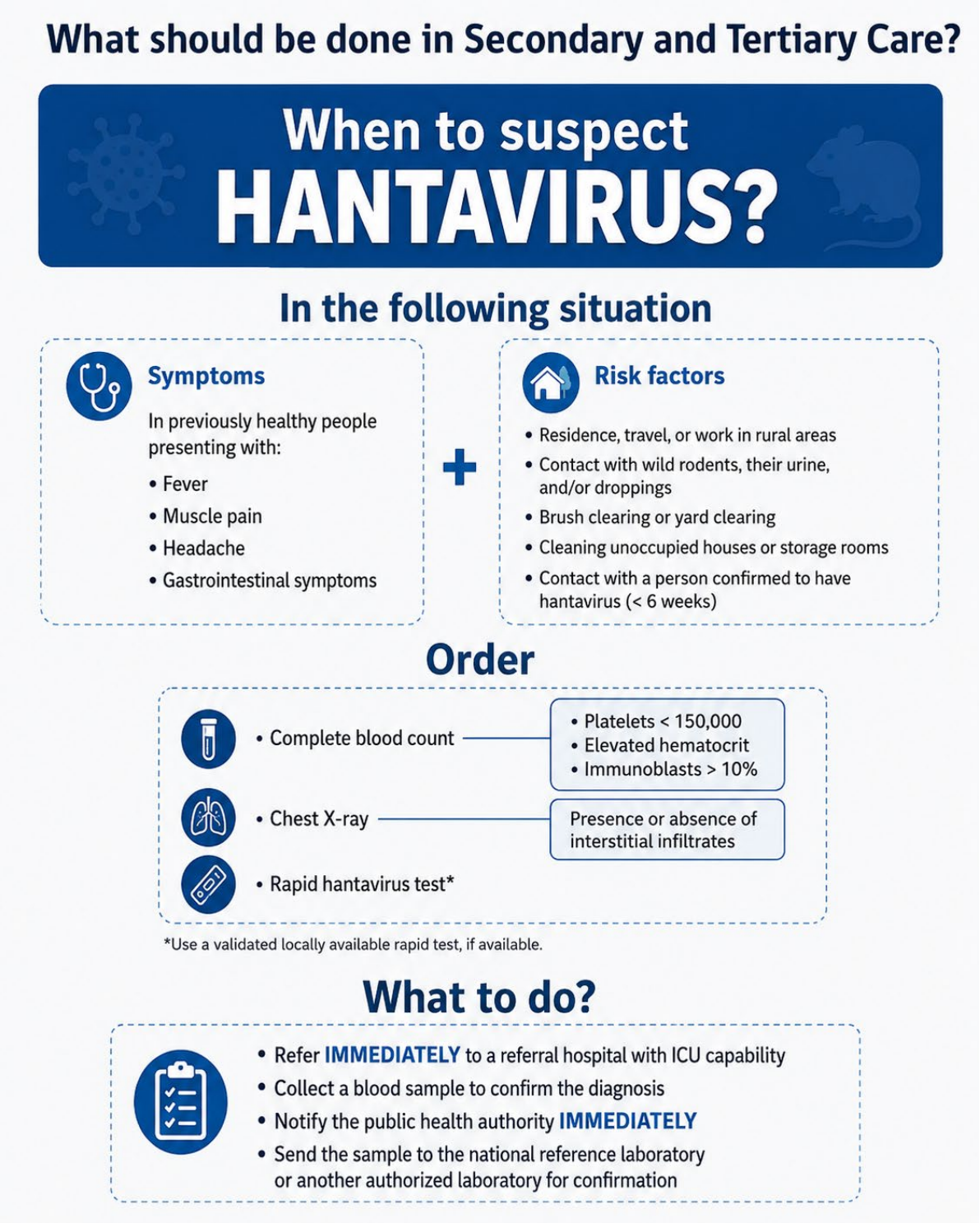


Figure A1.2. When to suspect hantavirus in secondary and tertiary care, recommended initial tests, and immediate actions

Source: Adapted from Ministry of Health, Chile. Guía clínica para el diagnóstico, tratamiento, prevención y control del síndrome cardiopulmonar por hantavirus. Santiago: Ministerio de Salud; 2013. Available from: https://diprece.minsal.cl/wrdprss_minsal/wp-content/uploads/2015/02/Gu%C3%ADa-HANTA-completa.pdf

Clinical and laboratory diagnosis figures

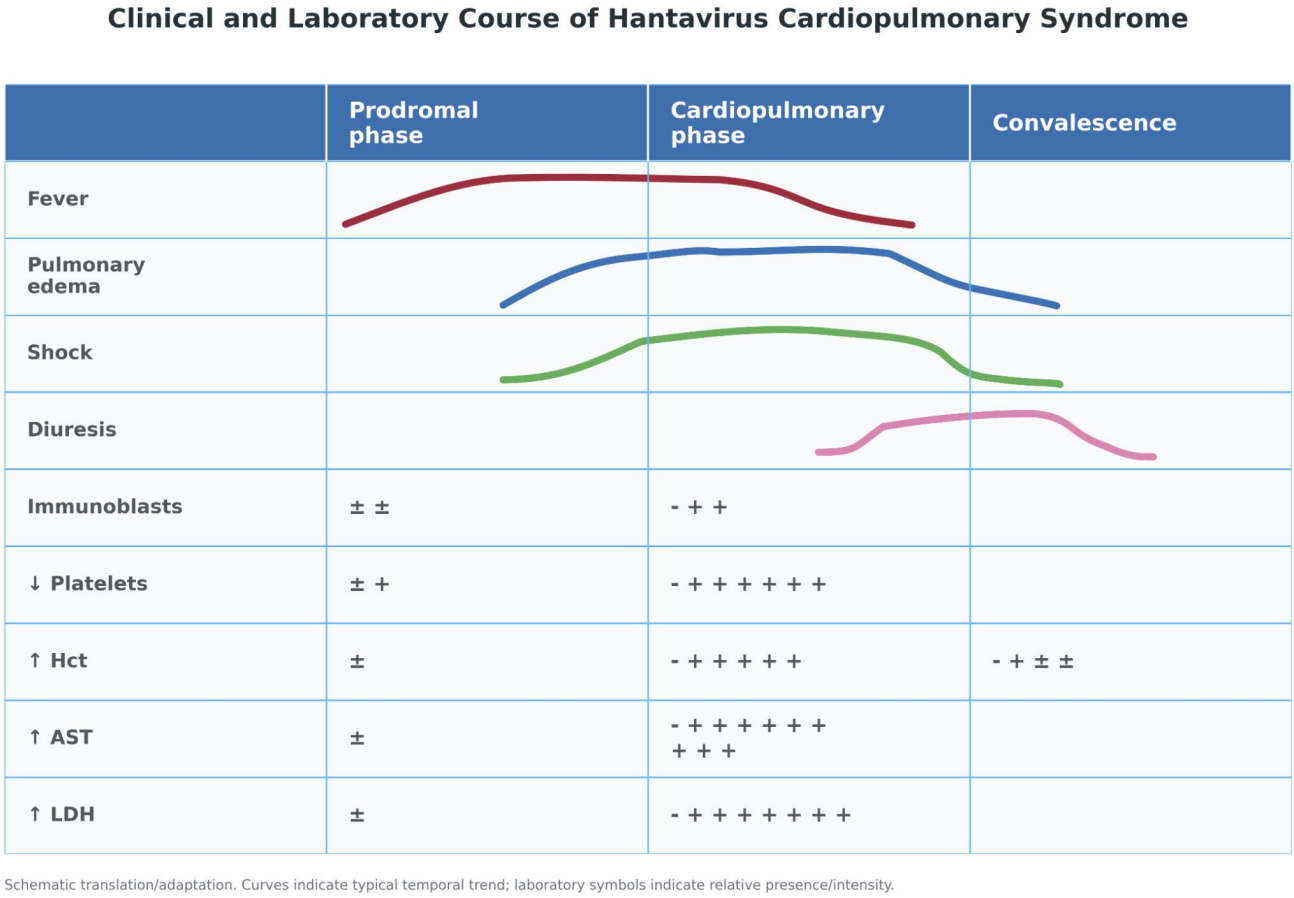


Figure A1.3. Clinical and laboratory course of hantavirus cardiopulmonary syndrome

Source: Adapted from Superintendencia de Riesgos del Trabajo. Hantavirosis o infección por hantavirus. Technical report. Buenos Aires: SRT; 2024. *(21)*

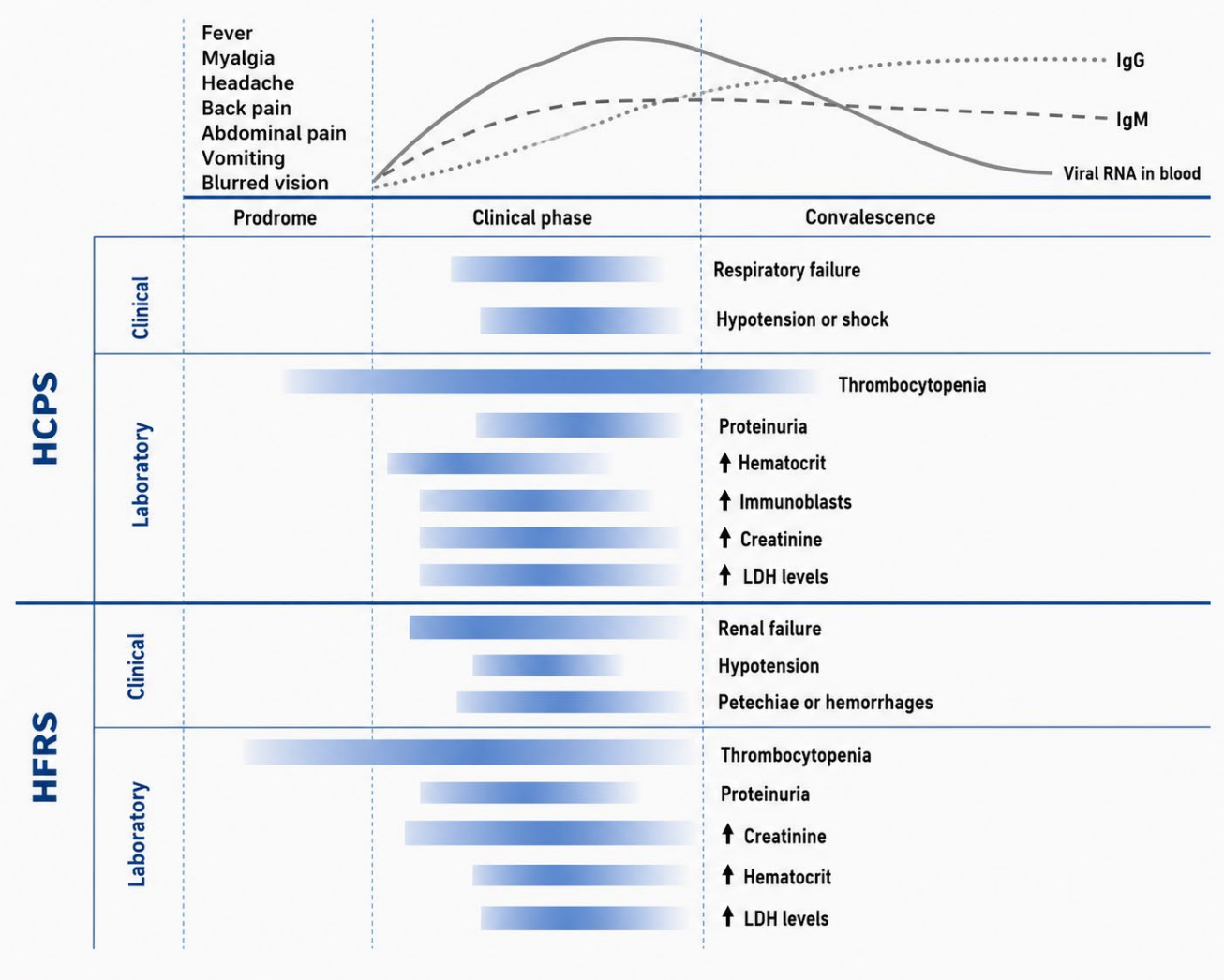


Figure A1.4. Clinical, laboratory, and serologic features supporting hantavirus diagnosis and differential syndromic assessment

Source: Adapted from Superintendencia de Riesgos del Trabajo. Hantavirosis o infección por hantavirus. 2024. Buenos Aires: Superintendencia de Riesgos del Trabajo; 2024. Available from: https://www.argentina.gob.ar/sites/default/files/hantavirosis_o_infeccion_por_hantavirus_2024.pdf.

Schematic of a virion bunyavirus

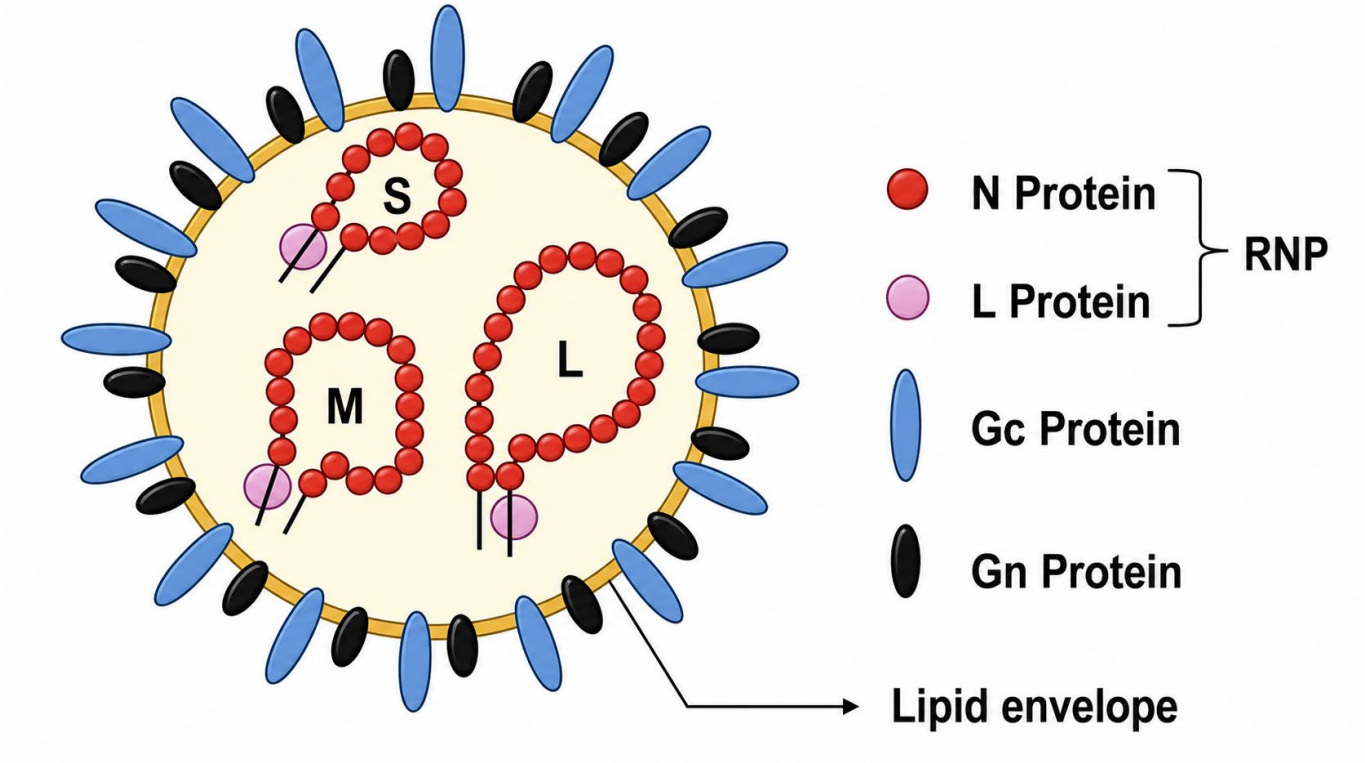


Figure A1.5. Hantaviruses are spherical viruses with a lipid coat, which are 80–110 nm in diameter. Its genome is RNA, linear and trisegmental. The three segments (L, M, and S) of the genome are encapsulated by the nucleocapsule protein to form ribonucleoprotein complexes and, together with the viral L protein (RNA polymerase dependent RNA Rdrp), are packaged within a lipid envelope derived from the modified host cell.

Source: Elliott R, Schmaljohn C. Bunyaviridae. [place unknown]: Basicmedical Key: 2016 [cite 20 May 2026]. Available from: https://basicmedicalkey.com/bunyaviridae/.

Normal vs. infected endothelial function

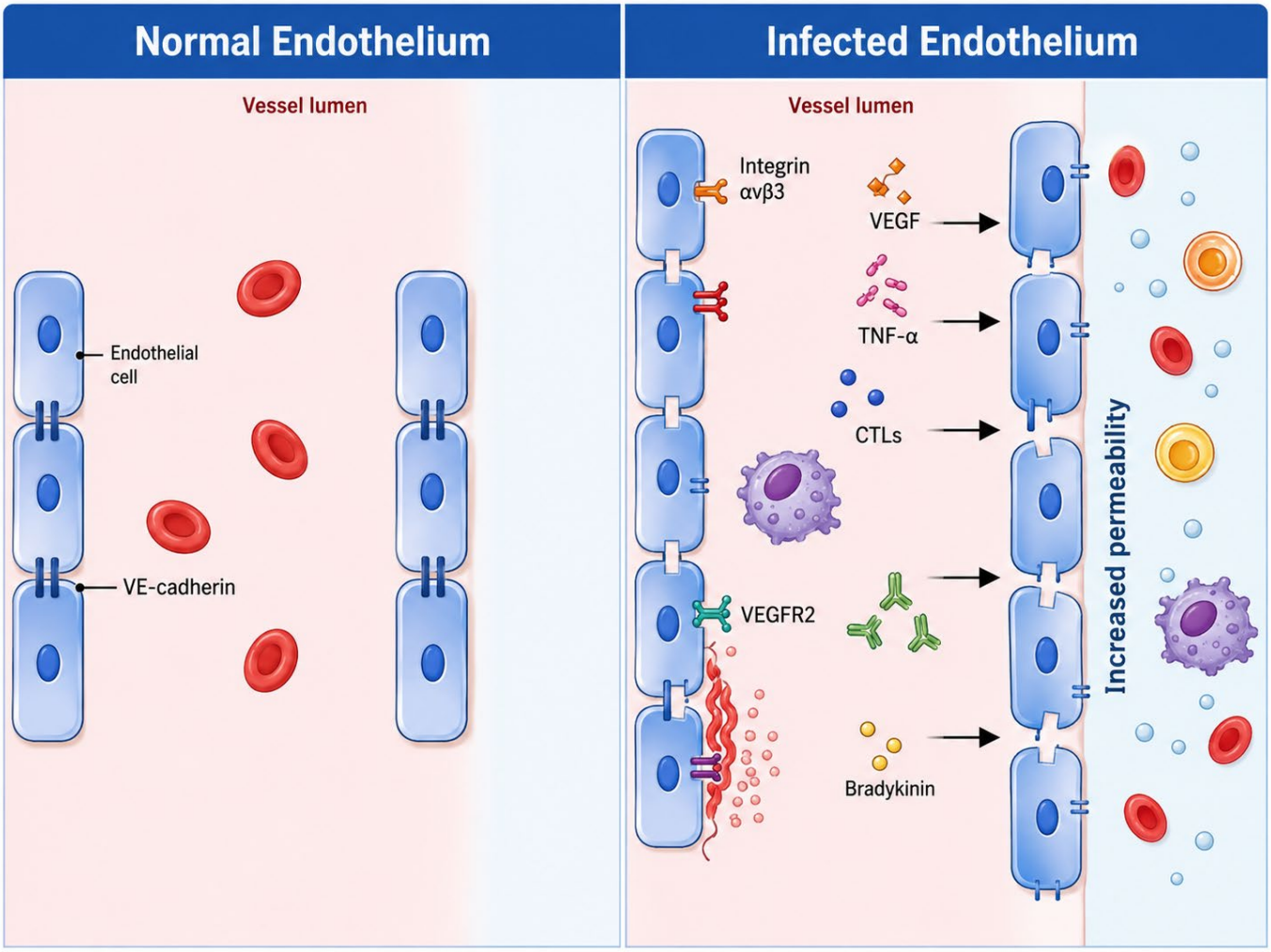


Figure A1.6. Normal vs. infected endothelial function

Source: Adapted from Moreno Sandoval HN, Rangel Guerrero SI, Thompson Bonilla R, Merino García JL, Lara Lozano M, Piña Leyva C, et al. Síndrome pulmonar por hantavirus, una amenaza latente en México. 2014. Available from: https://www.medigraphic.com/cgi-bin/new/resumen.cgi?IDARTICULO=48568

Annex 2. Airborne precautions, standard precautions, and key elements at a glance for the prevention and control of infections

Source: World Health Organization – Eastern Mediterranean Region. Airborne precautions. Cairo: WHO; 2023. Available from: https://www.emro.who.int/images/stories/media/hygiene-day-2023/IPC_poster_Airborne_EN.pdf.

Standard precautions for the prevention and control of infections

Aide-memoire

Background

Standard precautions aim to protect both health workers and patients by reducing the risk of transmission of microorganisms from both recognized and unrecognized sources.

They are the minimum standard of infection prevention and control (IPC) practices that should be used by **all** health-care workers, during the care of **all** patients, at **all** times, in **all** settings. When applied consistently, ***standard precautions*** can prevent the transmission of microorganisms between patients, health workers and the environment.

Key elements of *standard precautions* include:

- risk assessment
- hand hygiene
- respiratory hygiene and cough etiquette
- patient placement
- personal protective equipment
- aseptic technique
- safe injections and sharps injury prevention
- environmental cleaning
- handling of laundry and linen
- waste management
- decontamination and reprocessing of reusable patient care items and equipment.

For additional information, refer to WHO's *Minimum requirements for infection prevention and control programmes (1)*.

Important advice for implementation

Health policy

- Promote a safety climate.
- Develop policies which facilitate the implementation of IPC practice.
- Provide resources for IPC programmes and implementation of *standard precautions*.

Risk assessment

- Train health workers on early recognition and assessment of risk of exposure to blood and body fluids – including secretions/excretions, splashes and/or sprays and contaminated surfaces.
- Train health workers on actions to reduce the risk of exposure to infectious agents.
- Perform a risk assessment within health care facilities related to the population they serve, level of care they provide (including common procedures) and available control measures and implement prevention measures and training based on this assessment.

Hand hygiene

- Provide alcohol-based handrub at the point of care.
- Provide handwashing facilities with clean running water and products (including soap and single-use paper or cloth towels).

Personal protective equipment (PPE)

- Train health workers on the rationale for and correct use of PPE, based on risk assessment.
- Provide adequate supplies of high-quality PPE that are continuously accessible at the point of care.

Respiratory hygiene and cough etiquette

- Post visual alerts at the entrance to health care facilities instructing people with respiratory symptoms to practise respiratory hygiene/cough etiquette.
- Place hand hygiene supplies, tissues, masks and no-touch waste bins in waiting areas.

Environment and environmental cleaning

- Provide a clean and hygienic environment, including water, sanitation and hygiene infrastructure and adequate ventilation (natural or mechanical).
- Provide efficient environmental cleaning and disinfectant products.
- Train cleaning staff on the principles and practices of environmental cleaning, including how to prepare and use cleaning and disinfection products.

Injection safety

- Follow safe injection practices according to policy that reflects the 7 steps for safe injections.
- Provide a policy and measures for the surveillance, prevention and management of sharps injuries.

Waste management

- Ensure that the health care facility follows a policy for minimizing, segregating, collecting, transporting, storing, treating and disposing of waste.

Decontamination and reprocessing of reusable medical equipment/devices

- Make a dedicated space available for performing decontamination and reprocessing of reusable medical devices.

World Health Organization

Source: World Health Organization. Standard precautions for the prevention and control of infections: aide-memoire. Geneva: WHO; 2022. Available from: https://www.who.int/publications/i/item/WHO-UHL-IHS-IPC-2022.1.

Key elements at a glance

Risk assessment

Health workers should:

- assess the risk of exposure to blood and body fluids, secretions/excretions, splashes and/or sprays or contaminated surfaces before any health care activity *(2)*, and make this a routine;
- select the appropriate actions to reduce the risk of exposure to infectious agents *(3)*;
- ask themselves prior to any patient interaction:
  - Do I need protection for what I am about to do because there is a risk of exposure to blood and body fluids, secretions, excretions, splashes and/or sprays *(3,6)*?
  - Do I need protection for what I am about to do because the patient has symptoms of undiagnosed infection (e.g. fever, cough, diarrhoea)?
  - Do I need protection for what I am about to do because the patient has symptoms of an undiagnosed infection (e.g. fever, cough, diarrhoea), requiring Transmission-based Precautions?
  - Do I need protection for what I am about to do because the patient has a known infection, requiring ***transmission-based precautions***?

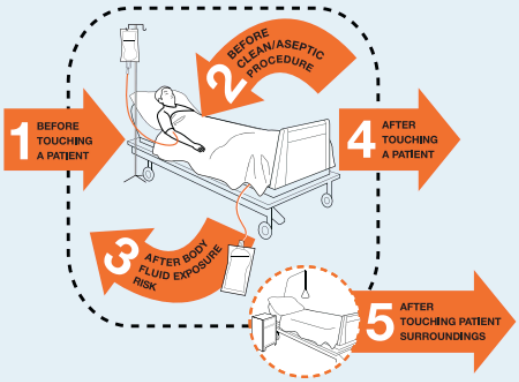
Hand hygiene

Health workers should perform hand hygiene the right way and at the right time, as described below. It is also important to take care of the hands by regularly using a protective hand cream or lotion, at least daily.

Summary technique

- If available, perform handrubbing with an alcohol-based handrub product as the preferred method for hand hygiene in health care, if hands are not visibly soiled *(2,4,5)*. Apply enough alcohol-based handrub product to cover **all areas** of the hands; rub hands until dry (20–30 seconds).
- Perform handwashing with soap and water if hands are visibly soiled. Wet hands and apply soap; rub all surfaces (40–60 seconds); rinse hands and dry thoroughly with a single-use towel; use the towel to turn off the faucet/tap *(2,4,5)*.

Summary indications (5 Moments for hand hygiene)



Source: WHO *(4)*.

Respiratory hygiene and cough etiquette

- Health workers should apply source-control measures to individuals with respiratory symptoms *(6)*, including:
  - asking patients to wear a mask or use a tissue to cover their cough;
  - placing acute respiratory symptomatic patients at least 1 metre (3 feet) away from others in common waiting areas.

Patient placement

- A single room should be used for a patient who poses a risk of transmission to others (for example, if they contaminate the environment or have symptoms of a transmissible infection).

Source: World Health Organization. Infection prevention and control. Geneva: WHO; 2026 [cited 20 May 2026]. Available from: https://www.who.int/teams/integrated-health-services/infection-prevention-control/core-components.

PPE

Health workers should:

- select PPE, based on risk assessment *(3,6,7)*;
- remove and discard PPE when leaving the patient's room and perform hand hygiene;
- discard and replace PPE if it becomes damaged, soiled or wet.

Gloves

Health workers should:

- wear gloves during activities that may involve exposure to blood and other body fluids, for contact precautions and in outbreak situations *(3,6)*;
- remove gloves after caring for a patient – the same pair of gloves should not be worn for the care of more than one patient *(8)*;
- change gloves between tasks and procedures if moving from a contaminated body site to another body site on the same patient;
- remember that wearing gloves is **not** a substitute for hand hygiene *(5,8)*;
- wear sterile gloves for aseptic procedures, such as surgery or catheter insertion;
- not reuse gloves after reprocessing or decontamination, as this is not recommended.

Gown

Health workers should:

- wear a gown to protect skin and prevent soiling of clothing during activities that are likely to generate splashes or sprays of blood, body fluids, secretions or excretions – note: if the gown is not fluid-resistant, and if splashing or spraying is anticipated, a waterproof apron should be worn over the gown *(3)*;
- remove the soiled gown as soon as possible and perform hand hygiene.

Medical masks

Health workers should:

- wear a medical mask (also known as a surgical or procedure mask) to protect mucous membranes of the nose and mouth against splashes or sprays of body fluids, respiratory secretions and chemicals *(3)*;
- wear a medical mask to protect the patient during aseptic procedures (e.g. during surgery or lumbar punctures).

Respirators

Health workers should:

- wear a respirator (e.g. N95, FFP2, etc.) for protection from inhalation of airborne particles (tiny particles that float in the air) and/or when performing aerosol-generating procedures[1] *(3)*;
- do a fit test before using a respirator for the first time, and perform a seal check every time a respirator is used *(3,6)*;
- replace the mask or respirator if it is damaged, soiled or wet, or if breathing becomes difficult.

Eye protection

Health workers should:

- wear either eye protection (eye visor, goggles) or a face shield to protect mucous membranes of the eyes during activities that are likely to generate splashes or sprays of blood, body fluids, secretions and excretions *(3,6)*;
- ensure that goggles fit over and around the eyes or personal prescription lenses;
- ensure that a face shield covers the forehead, extends below the chin, and wraps around the side of the face – note that face shields are more comfortable to wear with eyeglasses.

Aseptic technique

Health workers should:

- use sterile items and equipment for all aseptic procedures;
- use aseptic technique for insertion and maintenance of all invasive devices and aseptic/clean clinical procedures for surgical procedures, wound dressing and similar, to prevent infections.

1. Current WHO list of aerosol-generating procedures: tracheal intubation, non-invasive ventilation (e.g., BiLevel positive airway pressure, continuous positive airway pressure), tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, bronchoscopy, sputum induction by using nebulized hypertonic saline, dentistry and autopsy procedures.

Source: World Health Organization. Infection prevention and control. Geneva: WHO; 2026 [cited 20 May 2026]. Available from: https://www.who.int/teams/integrated-health-services/infection-prevention-control/core-components.

Safe injections and sharps injury prevention

Health workers should:

- prepare injections in a clean workspace, where there is low risk of contamination from blood, body fluid, splashes or sprays *(9-12)*;
- perform hand hygiene prior to preparing the medication and touching the patient;
- use a sterile, safety-engineered syringe;[2]
- use a sterile medication vial and diluent;
- always use a sterile syringe and needle to withdraw and reconstitute medications, and never leave a needle in the septum of a vial;
- avoid use of multi-dose vials or, if used, dedicate the vial for single-patient use;
- label the multi-dose vial with the date opened, and discard according to the manufacturer's instructions, when sterility is compromised or after 28 days *(12,13)*;
- clean the patient's skin with soap and water or disinfect with 60–70% alcohol prior to the procedure;
- provide a puncture-resistant sharps container for sharps disposal at the point of care;
- not re-cap, bend, break, manipulate or manually remove the needle from the syringe;
- discard the sharps container when it is three quarters full, seal it and store it in a secure area.

Environmental cleaning

Health workers should:

- clean **and** disinfect patient care areas at least once a day, paying particular attention to frequently touched surfaces *(14,15)*;
- deal with spills of blood and body fluid/substance as soon as possible, in accordance with local protocols.

Appropriate handling and transport of linen

Health workers should:

- handle soiled linen and waste carefully (with minimal manipulation or agitation) to prevent personal contamination and transfer to other patients *(5,14,15)*;
- remove heavily soiled material (e.g. faeces) from linen, while wearing appropriate PPE, before placing it in the laundry bag;
- store clean linen in a manner that protects it from environmental contaminants.

Waste management

Health workers should:

- treat waste contaminated with blood, body fluids, secretions and excretions as hazardous infectious waste, in accordance with local regulations *(16)*;
- treat human tissue and laboratory waste that is directly associated with specimen processing as hazardous infectious waste;
- minimize the amount of waste produced by the health-care facility.

Decontamination and reprocessing of reusable patient care items and equipment

Health workers should:

- handle equipment soiled with blood, body fluids, secretions and excretions in a manner that prevents skin and mucous membrane exposure, contamination of clothing and transfer of pathogens to other patients, or the environment *(17,18)*;
- clean and disinfect (or sterilize, depending on the type and use of patient care equipment) reusable equipment before use with another patients *(4,17,18)*;
- discard single-use devices after each use *(17,18)*;
- clean and disinfect or sterilize reusable equipment/devices according to the manufacturer's instructions, national or international standards, using efficient methods and based on intended use.

2. Safety-engineered devices include syringes with reuse prevention (RUP) features and syringes with sharps injury protection (SIP) features. WHO recommends RUP syringes for all injections. RUP syringes with SIP features are highly recommended wherever possible *(13)*.

Source: World Health Organization. Infection prevention and control. Geneva: WHO; 2026 [cited 20 May 2026]. Available from: https://www.who.int/teams/integrated-health-services/infection-prevention-control/core-components.

Annex 3. Clinical management considerations in special populations

This annex provides additional clinical considerations for specific populations that may require adapted management approaches.

1. Pediatric patients

This guidance applies to children and adolescents with suspected or confirmed hantavirus infection. However, clinical presentation in pediatric hantavirus cardiopulmonary syndrome may be more variable than in adults, and early symptoms may be nonspecific. Clinicians should therefore maintain a low threshold for observation, referral, and escalation of care when compatible epidemiological exposure is present.

Laboratory warning thresholds, including platelet count, hematocrit, white-cell count, acid-base status, lactate, and renal function, should be interpreted according to age-adjusted reference ranges. Clinical deterioration may occur rapidly, and the presence of respiratory distress, hypoxemia, tachycardia, hypotension, altered mental status, oliguria, progressive thrombocytopenia, hemoconcentration, leukocytosis, or metabolic acidosis should prompt urgent reassessment and consideration of transfer to a pediatric intensive care unit.

In children with severe respiratory failure, shock, or rapidly progressive cardiopulmonary compromise, early consultation with a pediatric intensivist is recommended. If extracorporeal membrane oxygenation (ECMO) is being considered, eligibility, timing, circuit specifications, cannulation strategy, and transfer should follow pediatric-specific protocols. Cases meeting potential ECMO referral criteria should be discussed immediately with a pediatric ECMO-capable center.

2. Pregnant patients

Hantavirus cardiopulmonary syndrome during pregnancy is a high-risk condition for both the pregnant patient and the fetus. Management should be coordinated by an interdisciplinary team including intensive care, obstetrics, infectious diseases, neonatology, anesthesia, and infection prevention and control teams.

Pregnant patients with suspected or confirmed hantavirus infection should be monitored closely for respiratory deterioration, shock, fetal compromise, and preterm labor. Fluid management should remain cautious and individualized, because the pathophysiology of severe disease is dominated by capillary leak, pulmonary edema, and cardiopulmonary compromise. Vasopressor selection and dosing, respiratory support, and decisions regarding transfer to a higher-complexity center should be coordinated with the obstetric and critical care teams.

Continuous fetal monitoring should be considered during the cardiopulmonary phase when gestational age and local resources make fetal intervention feasible. Decisions about timing and mode of delivery should be individualized and made jointly by the intensivist and obstetric team, taking into account gestational age, fetal well-being, maternal hemodynamic status, oxygenation, and the risks of clinical deterioration during transfer, anesthesia, or delivery.

3. Immunocompromised patients and patients with major comorbidities

Patients with relevant comorbidities, including chronic cardiopulmonary disease, chronic kidney disease, immunosuppression, malignancy, or other conditions that may reduce physiological reserve, should be

considered at higher risk of clinical deterioration. These patients may require earlier referral, closer monitoring, and lower thresholds for escalation of care, even when initial symptoms appear mild.

Infection prevention and control considerations should be applied in the same way as for other suspected or confirmed cases. In immunocompromised patients, alternative or concomitant infections should also be actively considered, particularly when clinical evolution or laboratory findings are atypical.

Annex 4. Healthcare checklist for management

Table A4.1. Healthcare checklist for management

No.	Checklist item	
1	Suspect early in febrile patients with gastrointestinal symptoms, myalgia, headache, thrombocytopenia, and rural or wildland exposure.	☐
2	Do not wait for serologic confirmation when clinical and epidemiological criteria are suggestive.	☐
3	Hospitalize or observe suspected cases because deterioration can be rapid.	☐
4	Refer early to intensive care unit (ICU) when tachycardia, tachypnea, hypotension, marked thrombocytopenia, hemoconcentration, acidosis, or elevated lactate is present.	☐
5	Avoid fluid overload. In the cardiopulmonary phase or respiratory failure, do not apply automatic large-volume resuscitation intended for undifferentiated sepsis.	☐
6	Use vasopressors early when shock is present and fluid tolerance is poor.	☐
7	Activate the extracorporeal membrane oxygenation (ECMO) network early in severe hypoxemia, refractory shock, or rapidly accelerating deterioration.	☐
8	Notify immediately and coordinate confirmatory diagnosis.	☐
9	Follow contacts for up to 6 weeks and provide postdischarge follow-up for at least 6 months.	☐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