www.refaad.com

Veterinary Medicine and Public Health Journal (VMPH)

Journal Homepage: https://www.refaad.com/Journal/Index/7

E-ISSN 2707-7195 | P-ISSN 2707-7187

Vol. 6, No. 2, 2025, pp. 49 - 57

Crimean-Congo Hemorrhagic Fever: An Overview with a Focus on the Epidemiological Situation in Iraq

Ali Adel Dawood[1*]

[1] Department of Anatomy, College of Medicine, University of Mosul, Mosul, Iraq.

[*] Corresponding Author: Ali Dawood (aad@uomosul.edu.iq)

Review Article

https://doi.org/10.31559/VMPH2025.6.2.2

Received: 5 May 2025

Revised: 24 May 2025

Accepted: 1 Jun 2025

How to cite this article: Dawood, A. A., (2025). Crimean-Congo Hemorrhagic Fever: An Overview with a Focus on the Epidemiological Situation in Iraq. *Veterinary Medicine and Public Health Journal*, 6(2), 49-57. https://doi.org/10.31559/VMPH2025.6.2.2

Abstract:

Crimean-Congo Hemorrhagic Fever (CCHF) is an acute zoonotic viral sickness which originates from Crimean-Congo Hemorrhagic Fever Virus CCHFV and spreads through Hyalomma ticks and infected blood and fluids from affected persons. This potent virus currently exists naturally throughout Africa the Balkans and the Middle East together with some Asian countries and Iraq sees its cases rise because of ecological reasons as well as unrestricted commercial livestock trade. CCHF manifests clinically in two ways from commonplace influenza symptoms to dangerous bleeding complications leading to a high death toll of 40% mortality. Host cell entry and replication take place during its life cycle because ticks connect animals and humans for pathogen transmission. Lab tests using Real- Time Polymerase Chain Reaction RT-PCR and Enzyme Linked Immunosorbent Assay ELISA detect CCHF, and supportive healthcare serves patients including fluid replacement with symptom care. Scientists continue working on vaccine development for the disease since no approved version exists at present. Seasonal spikes in Iraq exist that match the activity patterns of ticks during specific times of the year. Prevention strategies mainly include controlling tick populations and managing livestock management and protecting healthcare workers and actively educating the public. The study emphasizes the need to expedite work on surveillance technologies and vaccines and diagnostic systems to reduce the impact of the disease. The long-term control of CCHF requires integrating One Health programs that unite human health with animal health and environmental health. Controlling CCHF requires a medical and epidemiological approach together with strengthened community support to stop the disease from spreading during ongoing outbreaks.

Keywords: *CCHFV; disease; epidemiology; virus; Zoonotic.*

1 Introduction

The infecting agent in Crimean-Congo Hemorrhagic Fever (CCHF) episodes is CCHFV virus which belongs to Bunyaviridae family of the Nairovirus genus. People contract CCHF virus when they get bitten by specific Hyalomma ticks or when they interact with infected blood or body fluids from animals or humans. People face a substantial medical risk from CCHF since it exists naturally in Africa and the Balkans and Middle East and Asia but results in 40% fatal outcomes during severe disease progression (Al-Abri et al., 2017).

CCHF causes such a wide range of illness expressions that patients can experience minor flu-like signs or potentially deteriorate to critical hemorrhagic conditions. Following the spread of the infection patients begin to show petechiae accompanied by ecchymosis and internal bleeding until they reach multi-organ failure during critical stages of the disease. The span between infection exposure and disease manifestation depends on transmission method because symptoms emerge in 1–3 days when ticks bite humans yet blood or tissue contact cause symptoms after 5–13 days (WHO, 2024).

The disease passes between humans and animals as it represents a zoonotic condition. Cattle sheep and goats maintain the virus through their bodies however they stay free from disease symptoms. The transmission cycle of this virus happens between tick populations through animal host creation that enables its survival in endemic areas. Human-to-human transmission of CCHF virus becomes possible through direct contact involving infected blood as well as secretions and contaminated medical equipment (Butt et al, 2021; Spengler & Estrada-Peña, 2018).

The seasonal pattern of CCHF transmission follows the activity pattern of ticks reaching its highest levels in summer months. The disease has become more prevalent in Iraq as repeated outbreaks occurred within agricultural and livestock-related communities. The growing number of patients requires better disease monitoring and prevention efforts supported by vector management strategies together with public education initiatives (WHO, 2024; Leblebicioglu et al., 2024).

There exists no CCHF vaccine available for approval at present so healthcare management relies primarily on support-based care including fluid replacement and symptomatic treatment with blood transfusions. Military medical personnel are actively pursuing the development of CCHF vaccines through preclinical testing stages yet face obstacles for achieving widespread immunization (WHO, 2024; Perven and Khan, 2022). CCHF incidence growth in Iraq and endemic areas demands robust improvements to diagnosis systems along with better infection control practices and vaccine development work to reduce disease effects. Public health authorities need to implement a campaign that teaches the public about tick prevention and livestock management and medical safety protocols for lowering transmission rates. The control of CCHF and prevention of upcoming outbreaks depend on continuous research development because epidemiological surveillance together with medical intervention and community engagement must be incorporated into an integrated approach (Muzammil et al., 2024; Microbe Notes, 2024).

2 CCHFV Structure

The spherical CCHFV virus exists as a membrane-bound virus structure that measures about 90 to 120 nm in diameter and contains surface projections which enable viral attachment to host cells. The viral genome contains three separate single-stranded RNA segments with negative sense and an arrangement of L M and S (Mishra et al., 2020).

Large (L) segment: Encodes the RNA-dependent RNA polymerase, essential for viral replication. Viral entry and immune evasion result from the Medium (M) segment which produces glycoproteins (Gn and Gc). The Successomal Instrain (SI) encodes the nucleocapsid protein through its small (S) segment while this protein supports both RNA packaging and replication processes (Carter, et al., 2012).

Glycoproteins Gn and Gc play essential roles in host cell recognition because they exist within the viral envelope that derives from the host cell membrane. A stable complex between nucleocapsid proteins and viral RNA is needed for replication according to Figure (1) (Carter et al., 2012, Mishra et al., 2020).

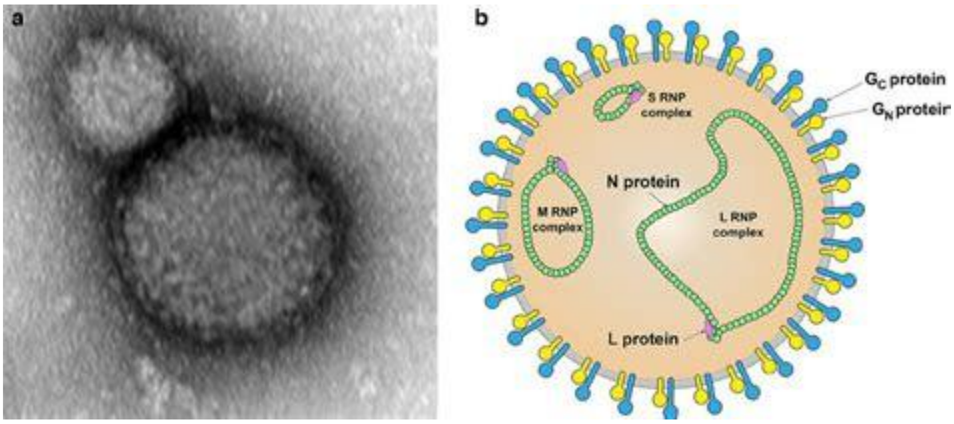

Figure 1: A: Transmission electron micrograph of a CCHFV. **B:** Structure of the CCHFV. https://microbenotes.com/crimean-congo-hemorrhagic-fever-virus/ (Aryal, 2021).

3 Life Cycle of CCHFV

Crimean-Congo Hemorrhagic Fever Virus (CCHFV) requires multiple complex stages in its life cycle to duplicate itself and persist between hosts and transmit between different hosts. Over the life cycle CCHFV establishes host cell binding then enters the host cells followed by replication and assembly processes before releasing new viral particles to transmit across animals and humans (Chinikar, et al., 2024).

3.1 Attachment and Entry

The primary step of CCHFV life cycle starts with glycoproteins (Gn and Gc) from the virus attaching themselves to special host cell membrane receptors. The virus utilizes the cellular process of endocytosis to gain access after attachment with the cell surface allowing its transition through vesicles to the cytoplasm. After membrane fusion occurs between the viral envelope and endosomal membrane the nucleocapsid component gains access to the host cell interior (Keshtkar-Jahromi, et al., 2023).

3.2 Replication and Transcription

Inside the cytoplasm RNA-dependent RNA polymerase from the L segment of CCHFV begins the processes both of genome replication and transcription. The virus creates messenger RNA (mRNA) through its replication process which results in the formation of proteins needed for survival and replication. Both nucleocapsid proteins and glycoproteins play essential roles in host cellular infection since protein virions from the S segment accomplish genome packaging along with glycoproteins produced from the M segment facilitating viral attachment and protecting against immune responses (Keshtkar-Jahromi, et al., 2023).

3.3 Assembly and Maturation

The Golgi apparatus serves as a site for new viral components to gather after protein synthesis before modifying glycoproteins for improved viral infectivity. The virions develop as combinations between genome segments (L, M, and S) along with nucleocapsid proteins (Chinikar, et al., 2024).

3.4 Release and Transmission

The new virus produced by the host cell uses membrane budding to proceed outside while absorbing its lipid envelope from the host cell. Release of virus particles from infected cells results in their presence in extracellular areas to spread the infection either by cell-to-cell transmission or through transmission pathways using human contact or Hyalomma sulfuruga tick bites or animal fluid contamination (Keshtkar-Jahromi, et al., 2023).

3.5 Spread to a New Host

CCHFV transmission primarily happens when infected ticks transmit the virus to human and animal hosts. The virus exists in endemic regions through its maintenance in infected livestock populations that include cattle and sheep and goats. Healthcare staff face substantial danger from CCHF virus spread through blood infections or body fluid secretions and healthcare equipment that needs sterilization. After entering a new host, the virus starts its replication cycle which causes additional disease progression as well as continued transmission between hosts (Microbe Notes, 2024; Carter, et al., 2012).

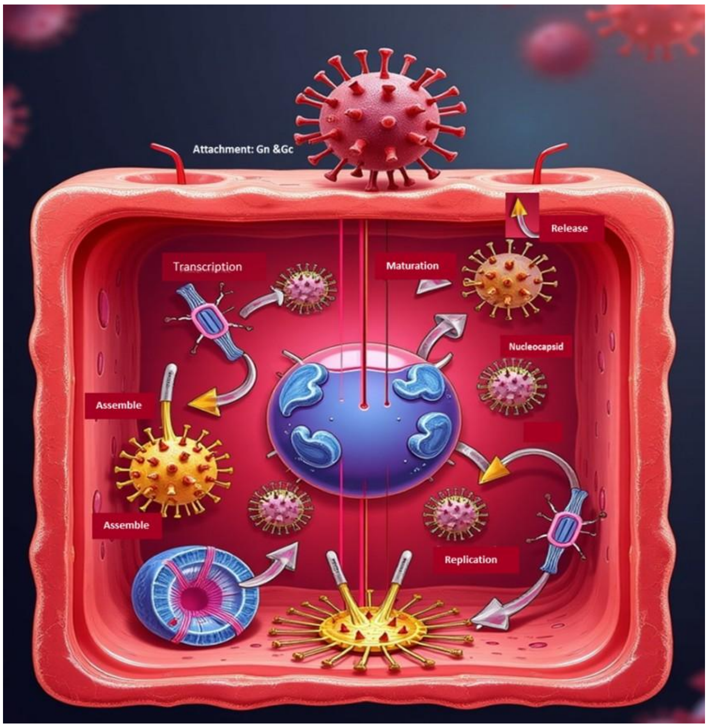

Figure 2: Life cycle of CCHFV.
(This figure was created by the author using AI programs).

4 CCHF Symptoms

CCHF displays features of a severe viral disease that starts with unfrequent sudden symptoms which immediately intensify. High fever alongside severe headache exists as the first sign of CCHF followed by muscle pain and dizziness as well as light sensitivity during this first period. Among the symptoms patients suffer are nausea and vomiting as well as abdominal pain and sore throat. When CCHF develops further it produces neurological symptoms together with mood changes and mental confusion and agitation then causes tiredness and depression while enlarging the liver. Based on transmission path the period before symptom onset ranges between 1 to 13 days according to (Spengler, et al., 2023; Frank, et al., 2024).

Case progression of CCHF virus can cause extensive bleeding which affects areas such as petechiae and ecchymosis and results in uncontrolled bleeding from infectious sites and internal abdominal organs. The combination of jaundice along with respiratory distress symptoms and multiple organ system failure leads to an extremely high mortality rate of 40%3 among patients. The disease poses a high risk to healthcare personnel and livestock handlers since CCHF spreads from person to person through blood along with secretions and medical devices (Celina et al., 2025).

When CCHFV infects animals naturally it normally fails to cause visible clinical symptoms. Cattle together with sheep and goats become infected when they encounter Hyalomma spp. infected ticks yet they usually show no signs of illness. Organisms infected with CCHFV sometimes experience brief fever periods yet fail to show serious signs of infection. During this week-long blood circulation phase the virus supports additional transmission if ticks bite these animals (Ksiazek, 2024).

The absence of indicators in infected animals is essential for CCHF epidemiology because these animals provide the virus with its host base. The identification of CCHFV antibodies in livestock provides proof of previous virus exposure for finding areas where the disease naturally occurs. Simple blood tests known as serological testing serve to check viral spread among animals in order to create better disease prevention methods (Muzammil, et al., 2024).

5 Epidemiology of CCHF

The CCHF virus exists throughout Africa as well as Balkans and Middle East and Asia regions. The virus uses the Hyalomma spp. tick population both as carriers and reservoirs to achieve transmission. The disease spreads naturally in areas that contain large livestock populations therefore human infections develop through animal touching or tick-borne transmissions. Notes from epidemiological research have confirmed that CCHF virus outbreaks align with seasonal changes because tick activity rises in the spring-summer months which creates optimal epidemic conditions (Butt et al, 2021). Research indicates that the mortality rate for existing CCHF infections reaches 11.7% but previous infection exposure leads to decreased death numbers. Lower-income nations experience higher death rates from the disease because their healthcare systems are underdeveloped in three specific regional areas of World Health Organization (WHO) including African, South-East Asia, and Eastern Mediterranean regions (Ksiazek, 2024).

5.1 Routes of Transmission

The transmission of CCHF occurs mainly through Hyalomma spp. ticks that act both as pathogens and virus carriers between hosts. The viral infection process begins when an infected tick delivers a bite to humans or animals after which the virus enters their bloodstream. Cattle together with sheep and goats function as intermediate hosts because they carry the virus but remain asymptomatic. Human exposure to the infection occurs from direct physical contact between humans and blood or tissues belonging to infected animals especially during the time of slaughter or livestock management activities. During its stay in infected animal bloodstreams the virus keeps spreading for seven days until a different tick initiates another transmission loop (Chinikar et al., 2024). Transmission of the virus between humans occurs when individuals come into contact with infected blood secrets or bodily fluids making healthcare workers along with close contacts at high risk. Medical equipment sterilization failure together with repeated needle usage and medical supply contamination have led to infections transmission in healthcare settings. The transmission risk reaches maximum levels in healthcare facilities as well as slaughterhouses and agricultural sites because many personnel regularly handle infected fluids. The prevention of CCHF spread depends on three الكتاب protective actions including personal protective equipment (PPE) usage and tick control strategies along with proper livestock handling (Kodama, et al., 2022; Keshtkar-Jahromi, et al., 2023).

CCHF transmission occurs through wildlife animal species because immature ticks living inside hares and hedgehogs and rodents allow viral spread. The majority of bird species hold resistance against CCHF viral infection which produces no viremia yet spread ticks through transportation to adjacent regions. The animal migration, together with livestock transportation, acts as a factor in CCHF outbreak dynamics because ticks containing the virus can be transferred to different areas. The research of animal-virus relations serves to develop complete monitoring systems and control methods particularly in areas with high livestock farming and tick infestation activity (Spengler, et al., 2023).

5.2 Diagnostic Methods and Laboratory Testing

Medical professionals use serological and molecular testing methodologies to determine the presence of Crimean-Congo Hemorrhagic Fever virus in infected patients or livestock during diagnosis. RT-PCR technology serves as the most dependable approach to detect CCHFV RNA during the early phases of viral infection. Healthcare providers use enzyme-linked immunosorbent assay (ELISA) for detecting IgM and IgG antibodies because these tests show current and previous CCHF exposure. Outbreak management in Iraq faces diagnostic obstacles because reference laboratories provide rapid testing but collection samples pose challenges as well as biosafety issues and restricted rural healthcare access (Mertens, et al., 2021).

5.3 Treatment and Vaccine Development for CCHF

The medical approach for managing CCHF centers on supportive care because the infection has no specific antiviral treatment available at present. Symptomatic patients need to receive fluids through IV administration along with electrolyte treatment along with transfusions when hemorrhaging occurs severely. Some expert teams use Ribavirin as an antiviral drug but studies produce conflicting data about its treatment effectiveness. Medical reports demonstrate that early ribavirin administration might decrease mortality rates but show unsuccessful results when used in serious patient conditions. A patient with multi-organ failure requires immediate attention from intensive care services that monitor organ functions and provide mechanical ventilatory support (Bernard et al., 2022).

The development of CCHF vaccines continues although healthcare providers do not have access to any approved vaccine for human treatment. The development of experimental CCHF vaccines has focused on four different strategies: inactivated virus vaccines alongside recombinant protein vaccines and DNA-based vaccines as well as mRNA vaccines. Current developments in mRNA vaccine technology resemble COVID-19 versions to show effective results in laboratory research. Researchers are investigating vector-based vaccines which use modified viruses to transport CCHFV antigens because these vaccines show promise for generating robust immune responses according to (Spengler, et al., 2023; Sarmadi, etr al., 2024).

The development of appropriate vaccine models to accurately screen human CCHF infection faces a major challenge due to insufficient animal model availability. The modeling of vaccine testing becomes difficult through the differences observed in immune response between non-human primates and rodents. The genetic characteristics of CCHFV differ among geographical regions leading to problems in developing a vaccine solution that works for all areas. Various candidates progress through clinical trials to develop effective immunization methods which scientists believe could become available in the next few years (Al-Abdely et al., 2025) The main protective methods for Countless Tick-Borne Haemorrhagic Fever (CCHF) include controlling ticks and implementing protective clothing for agricultural workers and strengthened infection control measures in healthcare facilities. The prevention of transmissible diseases relies on practicing early detection methods along with the quick isolation of possible patients as well as stronger surveillance techniques in affected areas. Building global research networks along with funding vaccine platform developments constitutes critical elements for CCHF control and public health damage reduction (Mishra, et al., 2012).

5.4 Immunological Response and Host Defense Mechanisms

During CCHFV infection the body activates innate and adaptive immune responses and severe disease progression relates to the release of cytokines. Those patients who display severe CCHFV infection develop high concentrations of inflammatory cytokines which cause vascular leakages and hemorrhages followed by multi-organ failure. Studies show CCHFV manages to interrupt antiviral interferon signaling thus enabling the virus to continue replicating. Interactions between viral pathogens and human host tissues constitute a fundamental basis for creating specific antiviral medications which support improved patient health outcomes (Messina et al., 2015).

5.5 Mathematical Modeling and Epidemiological Simulations

Advanced modeling of CCHF outbreaks in Iraq demands the combination of epidemiological research with data on livestock transport and tick population trends and environmental climate changes. Computer modeling techniques provide estimations for disease transmission risk levels as well as areas at high risk and infection probability levels which guide policymakers to predict when outbreaks will surge and spread across different regions. Real-time outbreak prediction has improved through Bayesian models and machine learning algorithms which enable proactive disease control interventions. The combination of GIS mapping technology with surveillance data enables more effective detection of CCHF distribution which supports vector control programs (Alhilfi, et al., 2023; Mahrous, et al., 2020).

6 Prevention Strategies for CCHF

6.1 Tick Control and Vector Management

The primary role of Hyalomma spp. ticks as CCHF vectors requires an effective method to control their population for the purpose of disease prevention. Livestock receive chemical-based treatments from acaricides because these products prevent tick infestations. The exploration of natural tick predators for biological control represents a method to manage tick populations in endemic zones. The identification of high-risk tick areas through normal surveillance operations enables strategic prevention plans in these zones (Mishra, et al., 2012).

6.2 Personal Protective Measures

All workers in agricultural and slaughterhouse and healthcare sectors need to wear protective dressing with gloves and masks and cover their arms when dealing with bloodborne infections or tick exposures. Proper prevention measures include keeping animal tissues away from direct contact during slaughtering activities while all surfaces and tools need proper disinfection. Healthcare workers need to maintain absolute adherence to infection control standards while performing hand hygiene along with medical equipment sterilization and separate management of suspected cases (Mahrous, et al., 2020).

6.3 Livestock Monitoring and Safe Handling Practices

The detection of viral spread in animal populations becomes possible through both routine veterinary examinations of livestock and their serological screening. Standardized practices for livestock slaughter together with controlled biosecurity protocols in livestock markets work to minimize human contact with the virus. Training programs for farmers and animal handlers should include complete tick removal methods and correct procedures for wasting infections which include animal waste (Sharififard et al., 2020; Hatem, 2017).

7 CCHF in Iraq: Endemicity and Epidemiological Trends

7.1 Historical Emergence and Spread of CCHF in Iraq

The medical community documented the first outbreak of CCHF in Iraq during 1979 and researchers linked the cases to sporadic human incidents from handling livestock and exposure to ticks. The disease successfully became an endemic public health challenge after decades and it particularly affected rural areas where people worked in agriculture and animal handling. The hot desert environment of Iraq sustains Hyalomma tick populations which spread CCHFV between livestock populations (Estrada-Pena and Vatanserver, 2018). The number of CCHF infections has increased continuously since the early 2000s while outbreaks occur with greater frequency. Recent epidemiological evidence reveals an increased CCHF case incidence between 2021 and 2025 while environmental changes, uncontrolled slaughter practices and rising tick populations also correspond to this phenomenon. Iraq's viral transmission escalation has been enabled by three main factors including urban development together with environmental temperature changes and natural wildlife population movements across Iraq's territories (Kodama, et al., 2023).

7.2 Epidemiological Trends and Case Distribution

Between 2021 and 2023 the appeared medical authorities confirmed 986 CCHF cases which caused 16.8 percent of those infected to die. Regions of Iraq's southern territories witnessed most CCHF infections because tick-infested areas and major livestock trading centers are located in those regions. The disease displays predictable seasonal occurrence because tick populations become more active during spring and summer when human-livestock contacts increase (Spengler et al., 2023; Mertens et al., 2021). Competency-based hemorrhagic fever has shown signs of evolving toward urban centers because of unregulated slaughtering procedures combined with infected animal commercial deals. Members of the healthcare industry along with butchers and farmers experience the highest risk for CCHF transmission because they can get infected from handling blood and secretions from other individuals. Surveillance records demonstrate that most CCHF patients are male individuals (58.9%) who are typically 36 years old.

Table 1: CCHF cases in Iraq from 2021 to 2025: (CDCD, 2025) ref

Year	Confirmed Cases	Deaths	Case Fatality Rate (CFR)	Most Affected Governorates
2021	33	13	39%	Thiqar, Baghdad, Basrah
2022	212	27	13%	Thiqar, Missan, Muthanna
2023	986	166	16.80%	Southern Iraq, Baghdad
2024	Data pending	-	-	Ongoing surveillance
2025	Data pending	-	-	Ongoing surveillance

7.3 Public Health Response and Control Measures

The Iraqi authorities have established tick control systems combined with livestock movement restrictions in addition to running public health awareness programs to reduce CCHF outbreaks. Public health institutions have improved their hospital infection control methods and their ability to detect CCHF cases rapidly along with their surveillance capabilities. The disease-control efforts face ongoing obstacles because of poor healthcare infrastructure together with an absence of a vaccination and the continuous impact of environmental factors. Long-term disease control requires One Health strategy development which connects human health with animal health along with environmental health practices according to (Fereidouni, et al., 2023; Ergonul, 2006).

7.4 Economic Impact and Healthcare Costs

The financial impact of CCHF in Iraq reaches beyond healthcare facilities costs because it also causes losses in agriculture and disrupts livestock trade and puts stress on healthcare systems throughout the nation. Outbreak restrictions on livestock movement coupled with slaughter bans create shortages in meat supply and destabilize local markets which negatively affects farmers together with vendors. Hospitalization treatment for critical CCHF patients creates a heavy financial burden for public health systems as health facilities must provide isolation procedures as well as personal protective equipment and blood products. Preventive measures combined with surveillance programs help avoid recurring outbreaks so communities do not face prolonged financial difficulties. This information is backed by references (Alavi-Naini et al., 2006; Atwan et al., 2023).

7.5 Public Awareness and Preventive Programs

Public awareness efforts focusing on ticks and livestock practices while teaching signs and signals of CCHF infections served as crucial protective steps against CCHF transmission. Health authorities' direct public attention toward three main measures including tick management systems and proper PPE protocols and regulated slaughterhouse processes for human safety. The implementation of veterinary monitoring systems enables early identification of viral spread in livestock by monitoring their populations. Despite collaboration between the Iraqi Ministry of Health and global health organizations for healthcare worker training the ministry continues facing challenges from rural healthcare access and misperceptions which hinder widespread compliance (Atwan, et al., 2023; Choubdar, et al., 2019).

8 Conclusions

The review demonstrates why scientific content needs proper organization to avoid duplication which preserves both understanding and precise delivery. CCHF exists as a persistent health threat in Iraq because epidemiological information shows seasonal patterns that elevate caseloads when temperatures rise. The virus transmission between animals and humans depends heavily on environmental elements which contribute to growing tick vector numbers. The situation requires improved preventive tactics including tick control strategies together with health education initiatives alongside vaccine and treatment research for controlling disease dissemination and enhancing public health outcomes.

References:

Al-Abdely, H., Mohsin, A. M., Aakef, I. R., et al. (2025). Surveillance and epidemiological patterns of Crimean-Congo hemorrhagic fever in the Middle East. *International Journal of Infectious Diseases, 120*, 45–53.

Al-Abri, S. S., Abaidani, I. A., Fazlalipour, M., Mostafavi, E., Leblebicioglu, H., Pshenichnaya, N., Memish, Z. A., Hewson, R., Petersen, E., Mala, P., Nguyen, T. M. N., Malik, M. R., Formenty, P., & Jeffries, R. (2017). Current status of Crimean-Congo haemorrhagic fever in the World Health Organization Eastern Mediterranean Region: Issues, challenges, and future directions. *International Journal of Infectious Diseases, 58*, 82–89. [CrossRef]

Alavi-Naini, R., Moghtaderi, A., Koohpayeh, H. R., Sharifi-Mood, B., Naderi, M., Metanat, M., & Izadi, M. (2006). Crimean-Congo hemorrhagic fever in Southeast Iran. *Journal of Infection, 52*(5), 378–382. [CrossRef]

Alhilfi, R. A., Khaleel, H. A., Raheem, B. M., Mahdi, S. G., Tabche, C., & Rawaf, S. (2023). Large outbreak of Crimean-Congo haemorrhagic fever in Iraq, 2022. *IJID Regional, 6*, 76–79. [CrossRef]

Atwan, Z., Alhilfi, R., Mousa, A. K., Rawaf, S., Torre, J. D. L., Hashim, A. R., Sharquie, I. K., Khaleel, H., & Tabche, C. (2023). Alarming update on incidence of Crimean-Congo hemorrhagic fever in Iraq in 2023. *IJID Regional, 10*, 75–79. [CrossRef]

Bernard, C., Holzmuller, P., Bah, M. T., et al. (2022). Systematic review on Crimean–Congo hemorrhagic fever enzootic cycle and factors favoring virus transmission. *Frontiers in Veterinary Science, 9*, 932304. [CrossRef]

Butt, M. H., Ahmad, A., Misbah, S., Mallhi, T. H., & Khan, Y. H. (2021). Crimean-Congo hemorrhagic fever and Eid-Ul-Adha: A potential threat during the COVID-19 pandemic. *Journal of Medical Virology, 93*(2), 618–619. [CrossRef]

Carter, S. D., Surtees, R., Walter, C. T., et al. (2012). Structure, function, and evolution of the Crimean-Congo hemorrhagic fever virus nucleocapsid protein. *Journal of Virology, 86*(20). [CrossRef]

Celina, S. S., Italiya, J., Obonyom, A., et al. (2025). Crimean-Congo haemorrhagic fever virus in ticks, domestic, and wild animals. *Frontiers in Veterinary Science, 11*, 1513123. [CrossRef]

Chinikar, S., Goya, M. M., Shirzadi, M. R., et al. (2024). Crimean-Congo hemorrhagic fever in the Middle East: A comprehensive review. *PLoS Neglected Tropical Diseases, 18*(2), e0011245.

Choubdar, N., Oshaghi, M. A., Rafinejad, J., Pourmand, M. R., Maleki-Ravasan, N., & Salehi-Vaziri, M., et al. (2019). Effect of meteorological factors on *Hyalomma* species composition and their host preference, seasonal prevalence, and infection status with Crimean-Congo hemorrhagic fever in Iran. *Journal of Arthropod-Borne Diseases, 13*(3), 268–283. [CrossRef]

Communicable Disease Control Division (CDCD). (2025). *AIDS Control Division and Immunization Unit / Public Health Department / Nineveh Health Directorate.*

Ergönül, O. (2006). Crimean-Congo haemorrhagic fever. *Lancet Infectious Diseases, 6*(4), 203–214. [CrossRef]

Estrada-Peña, A., & Vatansever, Z. (2018). Gaps in the distribution of Crimean-Congo hemorrhagic fever virus-carrying ticks. *Vector-Borne and Zoonotic Diseases, 18*, 289–298.

Fereidouni, M., Apanaskevich, D. A., Pecor, D. B., Pshenichnaya, N. Y., Abuova, G. N., Tishkova, F. H., Bumburidi, Y., Zeng, X., Kuhn, J. H., & Keshtkar-Jahromi, M. (2023). Crimean-Congo hemorrhagic fever virus in Central, Eastern, and Southeastern Asia. *Virologica Sinica, 38*(2), 171–183. [CrossRef]

Frank, M. G., Weaver, G., & Raabe, V. (2024). Crimean-Congo hemorrhagic fever virus for clinicians—epidemiology, clinical manifestations, and prevention. *Emerging Infectious Diseases, 30*(5). [CrossRef]

Hatem, J. (2018). Relative occurrence of ticks from some wild mammals in south of Iraq during January to December 2017. *Iraqi Journal of Environmental Sciences, 12*, 325–332.

Hutin, Y. J., Grolla, A., Nakouné, E., et al. (2024). Advances in Crimean-Congo hemorrhagic fever virus epidemiology and prevention. *Lancet Infectious Diseases, 24*(6), 531–540. https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(24)00255-8/fulltext

IFRC Epidemic Control Toolkit. (2025). *Crimean-Congo haemorrhagic fever (CCHF).* https://epidemics.ifrc.org/manager/disease/crimean-congo-haemorrhagic-fever-cchf

Keshtkar-Jahromi, M., Kuhn, J. H., Naderi, H. R., et al. (2023). Epidemiology, clinical manifestations, and treatment of Crimean-Congo hemorrhagic fever virus infections. *Current Tropical Medicine Reports, 10*(3), 215–229.

Kodama, C., Alhilfi, R. A., Aakef, I., et al. (2025). Epidemiological analysis and potential factors affecting the 2022–23 Crimean-Congo hemorrhagic fever outbreak in Iraq. *European Journal of Public Health, 35*(Suppl 1), i6–i13. [CrossRef]

Ksiazek, T. G. (2024). Crimean-Congo hemorrhagic fever in animals. *MSD Veterinary Manual.* https://www.msdvetmanual.com/generalized-conditions/crimean-congo-haemorrhagic-fever/crimean-congo-haemorrhagic-fever-in-animals

Leblebicioglu, H., Hirsch, M. S., & Mitty, J. (2024). *Crimean-Congo hemorrhagic fever*. UpToDate. https://www.uptodate.com/contents/crimean-congo-haemorrhagic-fever

Mahrous, H., Redi, N., Nguyen, T. M. N., Al Awaidy, S., Mostafavi, E., & Samhouri, D. (2020). One Health operational framework for action for the Eastern Mediterranean Region, focusing on zoonotic diseases. *Eastern Mediterranean Health Journal, 26*(6), 720–725. [CrossRef]

Mertens, M., Schmidt-Chanasit, J., Garrison, A. R., et al. (2021). Worldwide epidemiology of Crimean-Congo hemorrhagic fever virus in humans, ticks, and other animal species: A systematic review and meta-analysis. *PLoS Neglected Tropical Diseases, 15*(4), e0009299.

Messina, J. P., Pigott, D. M., Golding, N., Duda, K. A., Brownstein, J. S., Weiss, D. J., Gibson, H., Robinson, T. P., Gilbert, M., Wint, G. R. W., Nuttall, P. A., Gething, P. W., Myers, M. F., George, D. B., & Hay, S. I. (2015). The global distribution of Crimean-Congo hemorrhagic fever. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 109*(8), 503–513. [CrossRef]

Microbe Notes. (2024). *Crimean-Congo hemorrhagic fever virus overview*. https://microbenotes.com/crimean-congo-haemorrhagic-fever-virus

Mishra, A. K., Moyer, C. L., Abelson, D. M., et al. (2020). Structure and characterization of Crimean-Congo hemorrhagic fever virus GP38. *Journal of Virology, 94*(8). [CrossRef]

Muzammil, K., Rayyani, S., Sahib, A. A., et al. (2024). Recent advances in Crimean-Congo hemorrhagic fever virus detection, treatment, and vaccination. *Biological Procedures Online, 26*(20). https://link.springer.com/article/10.1186/s12575-024-00244-3

Perveen, N., & Khan, G. (2022). Crimean-Congo hemorrhagic fever in the Arab world: A systematic review. *Frontiers in Veterinary Science, 9*, 938601. [CrossRef]

Sarmadi, S., Ghalyanchilangeroudi, A., & Najafi, H. (2024). Vaccine approaches and treatment aspects against Crimean-Congo hemorrhagic fever. *Virus Disease, 35*, 377–383. [CrossRef]

Sharififard, M., Moradi, A., & Mohammadi, M., et al. (2020). An overview of Crimean-Congo hemorrhagic fever in Iran. *Iranian Journal of Microbiology, 12*, 367–375.

Spengler, J. R., & Estrada-Peña, A. (2018). Host preferences support the prominent role of *Hyalomma* ticks in the ecology of Crimean-Congo hemorrhagic fever. *PLoS Neglected Tropical Diseases, 12*(2), e0006248. [CrossRef]

World Health Organization. (2024). *Crimean-Congo haemorrhagic fever*. https://www.who.int/news-room/fact-sheets/detail/crimean-congo-haemorrhagic-fever