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# Factors Affecting Transmission of Crimean - Congo Hemorrhagic Fever among Slaughterhouse Employees: A Serosurvey in Mashhad, Iran

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## Abstract

**Background:** Crimean - Congo hemorrhagic fever (CCHF) is a severe viral disease. Slaughterhouses are potentially high risk working environments for CCHF infection due to close contact of livestock and humans.
**Objectives:** The current study aimed at conducting a serosurvey among abattoir workers and evaluating different factors affecting the transmission of CCHF.
**Methods:** A serosurvey was conducted to determine the frequency of Crimean-Congo haemorrhagic fever virus (CCHFV) IgG antibodies among abattoir workers in Mashhad, Northeastern Iran. Sera were collected from 136 slaughterhouse workers and assessed by the enzyme - linked immunosorbent assay (ELISA) for IgG CCHFV antibodies. In addition, a questionnaire was used to evaluate the risk factors involving in the transmission of the virus to the workers.
**Results:** Serological evidence was observed in 39 out of 136 (29%) participants. The infection rate did not correlate with the work experience, type of livestock, and the permanent use of available personal protection equipment (PPE). However, standard hand disinfectants had a significant role in decreasing CCHFV IgG seropositivity (OR = 0.2, P = 0.004). Two out of 39 seropositive cases reported the history of hospitalization and CCHF infection diagnosis.
**Conclusions:** The results of the study demonstrated that almost one-third of the investigated slaughterhouse workers were exposed to CCHFV, though the clinical manifestations were less than those of nosocomial transmissions. The currently used PPE could not protect workers against CCHFV infection; therefore, the need for effective preventive strategies for workers in the livestock industry should be emphasized.

*Keywords:* Human, Crimean - Congo Hemorrhagic Fever Virus, Abattoirs, Livestock, Hand Hygiene, Disinfectants, Risk Factors, Iran

## 1. Background

Crimean - Congo hemorrhagic fever (CCHF), with a case fatality rate of 30-40% (1), is endemic in many parts of the world. Crimean-Congo haemorrhagic fever virus (CCHFV) is an arbovirus (Nairovirus genus) belonging to the Bunyaviridae family (2). The infection results in extensive bleeding, disseminated intravascular coagulation, hypotonic shock, and multiple organ failure, and finally death in severe cases (3). Crimean-Congo haemorrhagic fever virus (CCHFV) is transmitted either by tick bite, or through direct contact with blood or tissues of viremia hosts (4). The virus has the potential risk of human - to - human transmission (5). Multiple factors make CCHFV a massive health and economic burden including its wide geographical distribution, the capacity to cause outbreaks and high fatality rates, and the lack of both efficient treatment and a reliable vaccine (6).

Considering the main transmission roots, high-risk occupations for CCHF are those in close contact with the vector and/or infected hosts including farmers, shepherds, abattoir workers, veterinarians, laboratory experts, and hospital personnel. In Khorasan Province, Iran, in 2012, a fatal nosocomial CCHFV transmission from an index case

through a young male working in the provincial slaughterhouse to 3 health care workers was reported (7).

## 2. Objectives

The current study aimed at developing a precise approach to the predisposing risks of CCHF transmission in slaughterhouses, as the main place of accidental exposure to the virus, from animals to humans.

## 3. Materials and Methods

### 3.1. Ethics Statement

The study was performed in accordance with the Declaration of Helsinki, the ethical principles for medical research involving human subjects. The study project was reviewed and approved by ethical committee of Mashhad University of Medical Sciences (code: IR.MUMS.REC.1392.86).

### 3.2. Sampling and Tests

One hundred and thirty - six workers from a slaughterhouse in Mashhad participated in the study in 2014. At the time of blood collection, the participants showed no signs of the infectious diseases, regardless of CCHF risk factors. Written informed consent was obtained from all participants and a checklist was completed addressing different questions including demographic data, allocated tasks, related work experience, defined history of tick bite, history of hand cuts, and the use of personal protective equipment (PPE) for each one. The frozen samples were sent to the Department of Arboviruses and Viral Hemorrhagic Fevers, Pasteur Institute of Tehran. The serum samples were analyzed for CCHFV - specific IgG antibodies by an in - house sandwich enzyme - linked immunosorbent assay (ELISA) as previously described (8).

### 3.3. Statistical Analysis

The obtained data were statistically analyzed with SPSS version 16. The association between the categorical variables (i.e, wearing gown, mask, gloves, and boots, hand disinfection, tool disinfection, allocated tasks, type of livestock, hand cut, and tick bite) were estimated by chi - square test. The quantitative variables (i e, age and work experience) were analyzed by the Student t test. Significance level was considered $P < 0.05$.

## 4. Results

The participants were all male within the age range of 23 to 58 years and the mean age of $40.5 \pm 7.7$. Among 136 slaughterhouse workers, 39 were positive for IgG antibodies, indicating a seroprevalence of 29%. Among seropositive individuals, 2 (5%) cases had a history of hospitalization due to CCHF symptoms and diagnosed CCHF infection. The mean age of seropositive and seronegative individuals was $41.8 \pm 7.7$ and $40 \pm 7.7$ years, respectively; no difference was observed between the groups ($P = 0.55$). Factors affecting the acquisition of infection are listed in Table 1. It was found that disinfecting hands with standard solutions based on an internationally accepted guideline had a significant role in decreasing CCHFV IgG seropositivity (odds ratio (OR) = 0.27, confidence interval (CI) 95% = 0.10 - 0.68, $P = 0.004$).

## 5. Discussion

There are several arboviruses in Iran (9), but CCHF causes the highest rate of infection and mortality per year (10, 11). A high CCHF seroprevalence was observed in the slaughterhouse workers. Slaughterhouses should be considered as "turning point" of CCHF epidemiology (12, 13). No correlation was observed between CCHF seropositivity and age/work experience, which is probably due to high infection rate. Slaughterhouse workers are widely exposed to CCHF due to spending working hours in places contaminated with fresh blood and chopped tissue with a high chance of hand cut during work and direct contact of open wounds with contaminated materials as well as splashing contaminated liquids into eye mucosa, which seem to be the effective transmission roots in such working places. Among the seropositive cases in the current study, only 2 (5%) cases had the history of CCHF diagnosis and hospitalization. One death due to CCHF in 2012 was recorded in this slaughterhouse. Therefore, in most cases the infection remained subclinical or may be manifested with a non - specific febrile condition (14).

Most workers supposed that wearing PPE is sufficient to protect against CCHF; whereas, the results of the current study showed that use of available PPE is not protective against the disease. Inadequate mask wearing or forgotten eye protection is common in abattoirs, resulting in non - standard PPE application. However, hand hygiene per se could serve as a significant protecting factor. The contaminated hands may later transfer the virus in to mucosa.

The current study aimed at finding health surveillance with more emphasis on the effectiveness of the current protection strategies. Such surveillance investigations

**Table 1.** Analysis of Risk Factors Associated with CCHF among Slaughterhouse Workers in Northeastern Iran, 2014

| Factor | | IgG Positive, 39 (29%) | IgG Negative, 97 (71%) | Total, 136 (100%) | P Value |
|---|---|---|---|---|---|
| **Mean age (year)** | | 41.8 ± 7.7 | 40 ± 7.7 | 136 (100%) | 0.55 |
| | Missing data | 0 | 0 | 0 | |
| **Duration of employment (year)** | | 16.2 ± 5.5 | 14.6 ± 6.8 | 132 (97%) | 0.20 |
| | Missing data | 2 | 2 | 4 (3%) | |
| **Wearing gown** | Yes | 36 (92%) | 92 (95%) | 128 (94%) | 0.57 |
| | No | 3 (8%) | 5 (5%) | 8 (6%) | |
| | Missing data | 0 | 0 | 0 | |
| **Wearing mask** | Always | 34 (97%) | 92 (97%) | 128 (97%) | 0.99 |
| | Rarely | 1 (3%) | 3 (3%) | 4 (3%) | |
| | Missing data | 4 | 2 | 4 | |
| **Wearing gloves** | Always | 38 (97%) | 85 (91%) | 123 (93%) | 0.21 |
| | Rarely | 1 (2.3%) | 8 (8.7%) | 9 (7%) | |
| | Missing data | 0 | 4 | 4 | |
| **Wearing boots** | Yes | 36 (92%) | 92 (95%) | 128 (94%) | 0.57 |
| | No | 3 (8%) | 5 (5%) | 8 (6%) | |
| | Missing data | 0 | 0 | 0 | |
| **Hand disinfection** | Always | 12 (34%) | 12 (12%) | 24 (18%) | 0.004 |
| | Rarely | 23 (66%) | 85 (88%) | 108 (82%) | |
| | Missing data | 4 | 0 | 4 | |
| **Tool disinfection** | Always | 7 (18%) | 18 (19%) | 25 (18%) | 0.93 |
| | Rarely | 32 (82%) | 79 (81%) | 111 (82%) | |
| | Missing data | 0 | 0 | 0 | |
| **Allocated tasks** | Slaughtering | 31 (94%) | 79 (91%) | 110 (92%) | 0.58 |
| | Other | 2 (6%) | 8 (9%) | 10 (8%) | |
| | Missing data | 6 | 10 | 16 | |
| **Type of livestock** | Sheep | 13(44.8% ) | 47 (54.7% ) | 60 (52.2%) | 0.39 |
| | Cow | 16 (55.2% ) | 39 (45.3% ) | 55 (47.8% ) | |
| | Missing data | 0 | 0 | 0 | |
| **Hand cut** | Yes | 20 (57%) | 42 (44%) | 62 (48%) | 0.30 |
| | No | 15 (43%) | 53 (56%) | 68 (52%) | |
| | Missing data | 4 | 2 | 6 | |
| **Tick bite**[a] | Yes | 8 (23%) | 21 (22%) | 29 (23%) | 0.50 |
| | No | 26 (77%) | 73 (78%) | 99 (77%) | |
| | Missing data | 5 | 3 | 8 | |

[a] More than 10 tick bites during the past 12 months. (According to employees' own perception not approved by entomologist).

should be regularly performed in high - risk places to evaluate the trend of infection in high-risk countries. Here, an increasing trend from 17.5% in 2005 to 29% in 2014 was observed through sampling in abattoir workers; for example, increase within a decade is a warning of higher rate of infection among at risk humans, which requires intensive public health attention. Other studies in Iran reported a seropositivity rate ranging from 5% (n = 15) to 34% (n = 16) among slaughterhouse workers, though, cumulative increase of seropositivity in such places is not just a far-fetch. The increased seropositivity rate among slaughterhouse workers highlights the key role of guiding at-risk workers to the proper use PPE in order to minimize the risk of infection transmission.

## 6. Conclusion

To conclude, a high rate of exposure to CCHFV was observed in slaughterhouse workers. It seems that the current application of PPE in slaughterhouses is not sufficient to prevent the disease. However, hand hygiene should be considered as a useful protective measure. Since CCHF may result in high morbidity and mortality, effective preventive strategies for workers in the livestock industries are of utmost importance.

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## Footnotes

**Authors' Contributions:** All authors equally contributed to the current study.

**Conflicts of interest:** Authors declared no conflicts of interest.

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