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Factors that Influence the Severity of Ebola Virus Symptoms

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Few viruses have caused the level of fear and panic like Ebola virus has. Its appearance in news headlines, movies, TV shows, and books has kindled this fear.

The virus is believed to have first appeared in 2013, in the village of Meliandou in southeastern Guinea. The details are rather vague, but most researchers believe that the first patient was a two-year-old resident of the village (Farmer, 2020, pp. 5-6). In fact, some accounts trace the source of the illness back to a cave, where the child was known to frequently play with bats. Regardless of where the disease was caught, it quickly spread within the child's family. The two-year-old died in December of 2013 (Farmer, 2020, pp. 7-9).

Even though Ebola was discovered in 1976 (Roosecelis Brasil Martines, 2015), for years it remained a mystery for the scientific community. Ebola is a zoonosis, meaning it is "an animal infection transmissible to humans." (Quammen, 2012, p. 14) Because of this, the virus has two primary requirements. First, it needs a host—something that all viruses, zoonosis or not, require. Second, it needs a reservoir. For a naturally occurring virus to make the leap from the wild into humans, it needs a species that it can first live in. This organism would hold the virus without getting infected themselves (Quammen, 2012, p. 23). Contact between a viruses' reservoir and humans is what leads to zoonotic infection (Quammen, 2012, p. 24).

Even after knowing this about Ebola, a rather mysterious aspect of the virus still baffles scientists. How can a disease so virulent and deadly in humans leave other mammals, specifically the host, virtually untouched? It is this aspect of the virus that this paper will discuss. The key to understanding this phenomenon is to first look at Ebola's reservoir species. Scientists are still unsure as to what that reservoir species is. However, most research indicates that the most likely reservoir for Ebola virus are bats (Leroy, et al., 2005).

Bats have several characteristics that allow them to escape the worst of Ebola. It is important to note that with any viral disease, including Ebola, symptoms aren't caused by the virus itself. Instead, they are a result of the host's immune response (Irving, Ahn, Goh, Anderson, & Wang, 2021, p. 365). Scientists have debated on how bats aren't affected from filoviruses, the family of viruses Ebola belongs to. There are two main theories: 1) bats are resistant to infection from the first place; and 2) bats have a better tolerance once they are infected (Guito, 2020, p. 2).

Some evidence suggests that bats' immune systems have an advantage over a virus before it even infects them. One of the major contributors to this are heat shock proteins. Heat shock proteins are produced to help through periods of prolonged exposure to high temperatures, something that bats experience due to their amount of flight time (Chionh, et al., 2019). This is also believed to be the reason why bats are such good incubators for viral mutations, as heat-shock proteins "contribute to the rapid acceleration of viral evolution…" (Irving, Ahn, Goh, Anderson, & Wang, 2021, p. 366) More importantly, heat-shock proteins protect against what is known as a cytokine storm, an overactive immune response that is initiated by viruses such as Ebola (Chionh, et al., 2019). Cytokine storms play a major role in the severity of disease experienced by Ebola patients. Some studies have indicated that increased levels of cytokines have a positive correlation with death rates (Roosecelis Brasil Martines, 2015, p. 167). By dampening or preventing a cytokine storm altogether, bats are less likely to be affected by the virus, or be symptomatic at all (Chionh, et al., 2019).

Once bats are infected, they have mechanisms that prevent them from being affected by the virus. One of the most pivotal aspects of this resistance is what is called a STING-dependent type I IFN response. These are responsible for inflammation, and in bats, these are dampened

(Irving, Ahn, Goh, Anderson, & Wang, 2021). It is important to note that IFNs are known to impact vascular permeability. These molecules are most likely what leads to coagulation and hemorrhaging in Ebola patients (Irving, Ahn, Goh, Anderson, & Wang, 2021). Another molecule, called NLRP3, is also dampened in bats. It is responsible for eventually activating proptosis, cell death due to inflammation (Irving, Ahn, Goh, Anderson, & Wang, 2021). Therefore, inhibiting this molecule could also inhibit cell death and severity of symptoms.

Examining the mechanisms by which mammals, like bats, evade symptoms can help researchers develop therapeutics and vaccines against viruses that threaten humans. A more careful study of the reservoir and spillover host relationship could be advantageous for emerging viral threats. In fact, studying bats and their complex physiology could also help humans live longer, healthier lives. Bats have many features that allow them to live longer (Irving, Ahn, Goh, Anderson, & Wang, 2021, p. 363). In conclusion, spillover-reservoir host relationships are more important to study than ever, as they could be the key to understanding the severity of disease.

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