

ORIGIN OF HIV INFECTION

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Abstract

This scientific article discusses the current knowledge around the origin of Human Immunodeficiency Virus (HIV) infection. The paper explores the natural history of the virus before it became a global pandemic, its emergence in human populations, and its transmission routes from animal hosts to humans. Special attention is given to socio-economic, ecological, and historical factors contributing to the crossing of the species barrier and the spread of HIV infection. The article concludes with an assessment of modern-day understandings, ongoing research, and future perspectives.

Keywords: HIV, origin, zoonosis, primates, emergence, social factors, virus transmission, Africa, SIV, pandemic.

Introduction

The origin of Human Immunodeficiency Virus infection remains one of the most significant scientific topics in the history of medicine and virology. To understand HIV's emergence in human societies, it is important to examine the broader ecological, biological, and sociological contexts in which the virus evolved, spread, and eventually caused a devastating pandemic. HIV is a retrovirus that targets the human immune system, ultimately leading to acquired immunodeficiency syndrome if left untreated. However, the story of HIV is deeply intertwined with the evolutionary history of other primates and their own retroviruses.

The roots of HIV infection go back centuries before the actual identification of the virus in humans. In the rainforests of central and West Africa, various species of primates harbor naturally occurring lentiviruses, collectively termed Simian Immunodeficiency Viruses (SIV). Wild chimpanzees, sooty mangabeys, and gorillas have all been identified as natural hosts for SIV, and these animals generally do not show signs of illness from these infections. This is in contrast to HIV infection in humans, which, without treatment, ultimately leads to immunodeficiency and life-threatening opportunistic infections.

The process by which a virus crosses from animals to humans is known as zoonosis. In the case of HIV, extensive molecular research has traced the two main types—HIV-1 and HIV-2—to SIV from chimpanzees and sooty mangabeys, respectively. HIV-1, responsible for the majority of global infections, can be genetically linked to SIVcpz found in chimpanzees, particularly the subspecies *Pan troglodytes troglodytes*. HIV-2, less prevalent and mostly confined to West Africa, is closely related to SIVsm, the virus found in sooty mangabeys [1].





Transmission of SIV into human populations likely occurred through direct contact with blood or other body fluids during hunting and butchering of wild primates, a practice known as bushmeat hunting. The risk of zoonotic transmission is heightened in situations where humans frequently come into close contact with wild animal populations, particularly when handling bodily fluids. Economic necessity, nutritional needs, and cultural traditions have all contributed to the prevalence of bushmeat consumption in many African societies. In this context, humans may have unknowingly facilitated the leap of SIV into human populations, where it adapted, mutated, and became capable of sustained human-to-human transmission. It is important to note that the initial animal-to-human transmission of SIV did not automatically result in widespread epidemic outbreaks. The earliest instances of simian-to-human transmission likely produced only isolated cases, with the virus unable to spread efficiently among humans due to limited population density, mobility, and social interaction patterns. Over time, however, social and demographic changes in central and West Africa laid the groundwork for HIV to flourish. Urbanization, growth of commercial centers, increased longitudinal travel along new transport routes, and changing sexual behaviors all created new opportunities for human-to-human transmission.

The expansion of colonial infrastructure, establishment of health clinics using unsterile needles, and shifts in social norms—combined with poverty, conflict, and migration—further contributed to the amplification of the virus. Retrospective studies of human blood samples stored from the early twentieth century have identified HIV infection in individuals from Central Africa decades before the virus was officially recognized in the early nineteen eighties. These findings indicate that HIV was present and slowly spreading within localized African communities for a prolonged period before gaining the epidemiological conditions necessary for global dissemination.

The discovery of HIV in the early nineteen eighties, first among populations of men who have sex with men in the United States, ultimately led to the identification of cases in diverse groups worldwide. Nevertheless, molecular analyses demonstrate that the virus had been silently spreading within and outside Africa long before its clinical detection. By the time HIV became widely recognized by the medical community, significant transmission chains had already established themselves in numerous populations through sexual transmission, mother-to-child transmission, and the sharing of contaminated injecting equipment [2].

HIV's history as a cross-species infection highlights the intricate interplay between biology, environment, and human behavior. Its crossing to humans was not a sudden event, but rather the result of multiple transmission episodes and subsequent viral adaptation. Genetic sequencing has shown that HIV-1 group M, which represents the majority of global HIV infections, derives from a single or limited number of introductions from SIV infected chimpanzees to humans, followed by rapid adaptation and efficient transmission from person to person. Other groups of HIV-1 and HIV-2 represent separate spillover events, which were less successful in establishing ongoing epidemics in human populations.

The identification of the origins of HIV infection has relied on advances in molecular virology, epidemiology, and phylogenetics. Scientists have employed genetic sequencing to trace the evolutionary relationships between SIVs in non-human primates and HIV strains in humans. These studies support a scenario in which ongoing interactions between humans and primates in Africa provided repeated opportunities for zoonotic transmission. Among the various SIV strains, only a few





were capable of adapting to efficient human-to-human spread, thereby setting the stage for the current pandemic [3].

The complex history of HIV's origin underscores the profound influence of social, economic, and ecological transformations in the modern era. Movements of people, goods, and cultural practices across regional and national borders facilitated the spread of the virus to new populations. Wars, economic downturns, and population displacement further exacerbated vulnerable conditions, making certain groups particularly susceptible to infection. In addition, the lack of early awareness, limited diagnostic technologies, and insufficient public health infrastructures allowed the virus to circulate undetected for years. By the time HIV was identified as the causative agent of AIDS, it had already diversified into multiple subtypes and established a global presence. Today, understanding the origins of HIV is crucial not only for historical insight, but also for informing contemporary pandemic preparedness and the prevention of future zoonotic disease emergence [4].

Research on the origins of HIV continues to evolve with new discoveries in viral genomics, host-pathogen interactions, and changes in both human society and the environment. While the main animal hosts and transmission routes are now well established, scientists continue to investigate the possibility of additional cross-species events and the circumstances that enable such pathogens to adapt and thrive in new hosts. Understanding these complex interactions will be essential for preventing similar pandemics in the future. Recent studies have also highlighted the importance of social equity, improved surveillance, and ethical considerations in the context of preventing new spillover events. Local communities where human and animal interactions are frequent need to be involved in public health strategies, and their social realities taken into account in order to design effective interventions. Lessons learned from HIV's emergence and spread provide critical blueprints for managing emerging infectious diseases in a rapidly changing global landscape.

Conclusion:

The origin of HIV infection is the result of a long and multifaceted process involving interactions between humans and non-human primate hosts, shaped by historical, ecological, and social factors. While advances in modern science have clarified the routes and mechanisms by which SIV crossed into human populations and evolved into HIV, ongoing vigilance and research remain essential. The global impact of HIV/AIDS illustrates the necessity of monitoring zoonotic risks, understanding biological evolution, and addressing underlying social vulnerabilities. As our knowledge increases, so too does our responsibility to apply these lessons for the prevention and control of emerging epidemics.

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