Transmission Routes, Viral Loads and Relative Risks:
The Science of HIV for Lawyers and Advocates

The Center for HIV Law and Policy • 65 Broadway, Suite 832 • New York, New York 10006
212-430-6733 phone • 212-430-6734 fax • info@hivlawandpolicy.org • www.hivlawandpolicy.org

MISSION STATEMENT

The Center for HIV Law and Policy is a national legal and policy resource and strategy center for people with HIV and their advocates. CHLP works to reduce the impact of HIV on vulnerable and marginalized communities and to secure the human rights of people affected by HIV.

We support and increase the advocacy power and HIV expertise of attorneys, community members and service providers, and advance policy initiatives that are grounded in and uphold social justice, science, and the public health.

We do this by providing high-quality legal and policy materials through an accessible web-based resource bank; cultivating interdisciplinary support networks of experts, activists, and professionals; and coordinating a strategic leadership hub to track and advance advocacy on critical HIV legal, health, and human rights issues.

To learn more about our organization and access the HIV Policy Resource Bank,
visit our website at www.hivlawandpolicy.org.

To learn more about the Positive Justice Project,
visit our website at http://hivlawandpolicy.org/public/initiatives/positivejusticeproject
To contact us:
Email us at info@hivlawandpolicy.org.

Or write to:
The Center for HIV Law and Policy
65 Broadway, Suite 832
New York, NY 10006
212.430.6733
212.430.6734 fax

ACKNOWLEDGEMENTS

The Center for HIV Law and Policy thanks our partners in the Positive Justice Project, particularly the Legal Work Group, for their advice and comments. Scott Schoettes, David W. Webber and Edwin Bernard provided invaluable resources and edits.

This publication was made possible through the generous support of the MAC AIDS Fund, Broadway Cares/Equity Fights AIDS and the Elton John Foundation.

Beirne Roose-Snyder, Staff Attorney
Catherine Hanssens, Executive Director
June 2011

TABLE OF CONTENTS

I. INTRODUCTION

A lawyer dropped into the world of HIV/AIDS through a criminal or civil case can feel like they have fallen through the looking glass. There are T cells and viral loads and antiretrovirals, as well as often bizarre standards for intent and a confusing relationship between health and law enforcement.

This document seeks to lay out both the basic science of HIV, and to present current research and scholarship in ways that are accessible and usable for lawyers and advocates. Criminal prosecutions for HIV related crimes are premised on a number of public health, scientific, and legal foundations that do not bear up under serious scrutiny and current research. And similarly in civil cases of housing or employment discrimination, or in protecting the rights of HIV positive pregnant women, the use of good scientific research and support can be the difference between winning and losing a case for your client.

This document addresses misconceptions and arguments that we have found are often missing from HIV related legal cases. The content is organized by key arguments or bodies of research that, while well established, have not easily made the jump from scholarship to the courtroom.

First, this introduction will establish some vocabulary, and discuss how it comes up in legal proceedings. Second, the section on *HIV as a Chronic Condition* will provide citations and abstracts for the established proposition that HIV is a chronic, treatable condition and not the "death sentence" that it is so often referred to in court opinions. Third, the section on the *HIV as a Covered Disability under the ADAAA* offers language to support HIV as an immune disorder for purposes of disability analysis. Fourth, the section *HIV Transmission and Relative Risks* presents the research on the relative transmission risks of different types of sexual and non-sexual contact. The fifth section, *Viral Load and Treatment*, consists of research on how low viral loads, which are often supported by antiretroviral treatment, make HIV transmission risks much lower. The final section, *Phylogenetic Analysis*, contains information about the use and limitations of comparing different viral strains in "proving" HIV transmission.

For those lawyers handling HIV criminalization cases, understanding the science of HIV and how it conflicts with the rationales of HIV-specific criminal prosecutions is only one piece of the argument. It may also be useful to have citations to documents that support decriminalization or call in to question the foundations of criminalization. We have created a *Policy Statements and Support for Decriminalization* supplement, which presents national and international statements and selected articles that lay out arguments against the exceptional treatment of HIV in law, and provide supporting quotes that can be useful in writing briefs and other court documents. This supplement can be found at:

Human Immunodeficiency Virus (HIV) is the virus that leads to Acquired Immunodeficiency Syndrome (AIDS) in the absence of diagnosis and timely treatment. HIV attacks the immune system, which operates as the body's defense mechanism against infection. HIV finds and destroys the white blood cells (called T cells or CD4 cells) that bodies need to fight off disease. There are two important tests used to measure the progress of HIV disease in the body, one measures the number of CD4 cells present in a blood sample, and the other measures viral load (the amount of HIV in the blood). Since HIV attacks CD4 cells, people with HIV often see their CD4 counts drop as the disease progresses. The lower a CD4 count, the greater the chances of getting a number of very serious diseases.

Viral load tests measure the amount of HIV in the blood, and offer information about how quickly HIV is likely to damage the immune system. People with a high viral load are likely to get sick or die sooner than people with a low viral load. It has also become clear with recent research that people with lower viral loads are significantly less infectious then those with higher viral loads. HIV can progress to AIDS if one of two things occur. Either the CD4 cell count drops below 200 (600 or higher is within the normal range for an HIV-negative adult) or a person has HIV and develops one or more so-called "opportunistic" infections (e.g., pneumocystis carinii pneumonia (PCP), Kaposi's sarcoma, tuberculosis (TB)).

The innovation in the 1990's of antiretroviral therapy (ART), and especially highly active antiretroviral therapy (HAART), which involves a combination of three drugs from at least two classes of anti-HIV drugs, has helped many HIV-positive people avoid progressing to an AIDS diagnosis, and has helped people previously diagnosed with AIDS regain a higher CD4 cell count by suppressing their viral load.

Where earlier attempts at HIV treatment were ineffective, and in many cases only temporarily delayed death, HAART has restored opportunities for people with HIV to live long and full lives (see *HIV as a Chronic Condition* section for more details). The success of HAART is not universal however: some of the medications can cause debilitating side-effects that some individuals cannot tolerate, and a combination of complicated dosing regimes and/or side-effects can lead to missed doses and drug resistance. Additionally, some people without access to health insurance are unable to access treatment through federally-funded state programs due to long wait lists and underfunding.

Still, HAART has dramatically changed the landscape of HIV in the United States, where proper and consistent treatment can transform HIV to a chronic condition and reduce viral loads to often-undetectable levels.

"Transmission" is a term used to talk about how HIV is passed from one person to another. The most common modes of transmission are sexual contact and shared needles. The Centers for Disease Control and Prevention (CDC) has stated unequivocally that HIV cannot be transmitted through casual contact[1], which includes contact with saliva or oral/nasal mucus. Public health officials have worked hard to debunk myths and bad or incomplete science about how HIV can be transmitted. However, many criminal statutes regarding HIV continue to define "bodily fluids" in a way that includes spitting and other activities that cannot transmit HIV, and serve to reinforce myths about toxicity and transmission.

"Seroconversion" and "Serostatus" are terms often used in the discussion of HIV transmission. Seroconversion is a way to describe a change in HIV status (as measured by HIV antibody tests) from being HIV-negative to HIV-positive. Serostatus describes whether someone is HIV positive or negative. These terms are often used when discussing transmission rates in scientific studies. Much less frequently used is the term "Seroreversion", which only applies to infants going from HIV-positive to HIV negative as they develop their own immune system separate from their HIV positive mother's.

Very few, if any, of the developments regarding HIV treatment and transmission have been addressed at law. In *Campbell v. State*, 2009 WL 2025344 (Tex. App. 2009)[2] an HIV positive

[1] *HIV and Its Transmission*, Centers for Disease Control and Prevention (1999). Available at: http://hivlawandpolicy.org/resources/view/360.

[2] Available at: http://www.hivlawandpolicy.org/resources/view/529.

man's conviction for assault with a deadly weapon was affirmed by the Court of Appeals of Texas, after he allegedly became confrontational during an arrest and spat on a police officer's eyes and mouth. Campbell's appeal presented the court with an opportunity to revisit whether or not the saliva of an HIV positive person could be considered a "deadly weapon." In 1992, the same court upheld the conviction of an HIV positive man for attempted murder when he spit on a prison guard, allegedly believing that his saliva could kill the guard. See, generally *Weeks v. State*, 834 S.W.2d 559 (Tex. Ct. App. 1992). Unfortunately in both *Weeks* and *Campbell*, the state medical witness testified, in the absence of any scientific evidence, that there was a theoretical possibility of HIV transmission through saliva, and the convictions were upheld. Campbell was sentenced to 35 years in prison.

Lawyers need to understand the changes in HIV treatment and the variations in transmission risks in order to provide zealous representation of their clients- who are often faced with unyielding stigma as well as criminal charges. HIV cannot continue to be treated as a deadly weapon in the courtroom, despite thirty years of development of treatment, reduction of viral loads, and increased understanding of how the virus is transmitted. Parlaying the science and research into understandable legal reasoning is a challenge, but one that must be met.

II. HIV AS A CHRONIC CONDITION

Much of the law and policy related to HIV still relies on the outdated view of HIV as a death sentence. In a precedent reliant legal system, it can be a challenge to argue successfully against standards set in the 1980's and 1990's, even though they inaccurately portray today's science and understanding of HIV where treatment is available.

The following resources are meant to help craft and support legal arguments about HIV infection as a chronic, treatable condition such as diabetes, rather then as a death sentence. This is particularly helpful in cases where a client is charged with "assault with a deadly weapon" or "attempted murder," but can be used in all HIV criminalization cases, as well as civil cases such as child custody and visitation disputes.

The development of antiretroviral therapy and its impact on the HIV-1 AIDS pandemic, Samuel Broder, M.D., Antiviral Research (2010). Available: http://hivlawandpolicy.org/resources/view/590

This article explores the history of antiretroviral therapy development and the impact the therapy has had on the HIV/AIDS pandemic. It examines the issues this new disease posed to the scientific community, specifically the limitations clinical researchers imposed on themselves due to the belief the retroviruses were not amenable to therapy. Despite the long-held belief that retroviruses are untreatable, researchers and clinical experts quickly identified antiretroviral agents that could be used to develop therapies that effectively treat patients with HIV/AIDS. In addition to the scientific and clinical innovations, the author highlights the important contributions of the FDA and pharmaceutical industries in the rapid development and distribution of antiretoriviral therapies for the treatment of HIV disease. This article also discusses the decrease in morbidity and mortality rates due to HIV/AIDS as a result of the distribution and utilization of antiretroviral medications.

As the author cites from the CDC's analysis, "advances in the treatment of HIV infection have resulted in a fundamental shift in its epidemiology, to a potentially chronic and manageable condition." The introduction of effective antiretroviral therapy has changed the perception of AIDS as an automatic death sentence to a condition that is treatable, and the availability of a therapy has reduced the marginalization and oppression of people living with HIV/AIDS. In addition to highlighting the advances and accomplishments since the advent of antiretrovirals, the article discusses areas for improvement and calls upon the research and clinical community to continue to work on improving the distribution of effective treatment and refining therapies that will permanently move this condition from a categorization as a life threatening disease to a chronic and manageable condition for people both in resource-rich and resource-poor countries.

- Useful quotation: "Antiretroviral therapy has brought about a substantial decrease in the death rate due to HIV-1 infection, changing it from a rapidly lethal disease into a chronic manageable condition, compatible with very long survival."

Scientific research on the risk of the sexual transmission of HIV infection and on HIV as a chronic manageable infection, D. McLay, E. Mykhalovskiy, & G. Betteridge, in E. Mykhalovskiy, G. Betteridge, & D. McLay, HIV Non-Disclosure and the Criminal Law:

Establishing Policy Options for Ontario (2010). Available at: http://hivlawandpolicy.org/resources/view/535

This document is a chapter excerpted from a larger policy report on the criminalization of HIV non-disclosure in Ontario, Canada. Although it is part of a Canadian report on recommendations for changes in Canadian law and practice, this section relies on the most current scientific research, including that by U.S.-based scientists, with findings on (1) the risks of transmission of HIV during sex; and (2) HIV as a manageable chronic disease. It outlines the conditions required for transmission of HIV from one person to another, reviews research on the risks of unprotected sexual activities including vaginal and anal intercourse and oral sex, addresses factors that increase or decrease the risk of sexual transmission of HIV, particularly recent research on ART and viral load, and briefly discusses HIV as a chronic manageable disease, including evolving data on death rates and life expectancies as a consequence of HIV treatment developments over recent years.

This type of information is extremely useful, if not essential, for various forms of advocacy against the use of criminal penalties against people with HIV for alleged failure to disclose their status to partners, from legal defense of those charged with a crime to public education. Many criminal laws and instances of prosecutions appear to hinge, at least in part, on gross ignorance of the modes and actual statistical risks of HIV transmission.

- Useful quotation: "The World Health Organization and other leading health authorities consider that, with proper medical care, HIV is a chronic manageable condition, similar in many ways to other chronic conditions such as diabetes or cardiovascular disease."

In Brief: Meeting the Sexual and Reproductive Health Needs of People Living with HIV, Guttmacher Institute & The Joint United Nations Programme on HIV/AIDS (2006). Available at: http://www.hivlawandpolicy.org/resources/view/295

The Guttmacher Institute outlines the changing sexual and reproductive health needs of people living with HIV as the disease has become a manageable chronic disease. Included is information on fertility issues and childbearing, prevention of unplanned pregnancy, and effective transmission prevention for discordant couples. The article also addresses common issues of discrimination and bias in medical and other settings, such as disclosure of HIV status without consent, coerced abortion and sterilization, and unwillingness to accept the sexuality of HIV positive people, which affect access to adequate sexual and reproductive health care. This article may be particularly useful to medical providers serving HIV positive people, and to advocates seeking an understanding of common issues facing people living with HIV with regard to reproductive health.

- Useful quotation: "For those with access to treatment services, a diagnosis of HIV infection is no longer an imminent death sentence; although still incurable, HIV now can be managed as a chronic disease."

Centers for Disease Control and Prevention's general treatment information for HIV. Available at: http://www.cdc.gov/hiv/topics/treatment/index.htm

This website includes information about the CDC's current guidelines for treatment, as well as other information and fact sheets.

- Useful quotation: "Although there is no cure for HIV infection, there are treatment options that can help people living with HIV experience long and productive lives."

Guide to Primary Care for People with HIV/AIDS, Department of Health and Human Services, Health Resources and Services Administration. Available at: http://www.hab.hrsa.gov/tools/primarycareguide/index.htm

This government guide for medical practitioners includes the section "Primary Care as Chronic Care." While this document is primarily for medical use, it can be useful to establish the widespread, and cross-disciplinary, standards that treat HIV as a chronic and manageable condition.

- Useful quotation: "HIV is now a chronic disease requiring ongoing primary care management."

III. HIV AS A COVERED DISABILITY UNDER THE ADAAA

In September 2008, the Americans with Disabilities Act Amendments Act (or ADAAA) was signed into law, with implementing regulations released in March 2011. The ADAAA makes important changes to the definition of the term "disability" by rejecting the holdings in several Supreme Court decisions and portions of EEOC's Americans with Disabilities Act (ADA) regulations. The effect of these changes is to make it easier for an individual with HIV seeking protection under the ADA to establish that he or she has a disability within the meaning of the ADA.

The ADAAA specifically includes impact on the immune system as a major life activity, an inclusion that, if framed and referenced properly, can be the basis for HIV as a covered disability under the ADAAA. These arguments will be newly made in court, and counsel should be prepared to articulate HIV as an immune disorder, and therefore a covered disability. Though this is unlikely to come up in criminal cases, and can in fact seem to be in tension with section II above, establishing HIV as a disability is a necessary tool in any number of other cases, and the new focus on the immune system makes sample scientific language invaluable.

This section begins with paragraphs that can be used in an expert affidavit in cases where the attorney is establishing that the HIV positive client is a person with a disability under the ADAAA. This is followed by a few persuasive sources with selected language regarding the effect of HIV on the immune system. While this section is not exhaustive, it does provide good preliminary authorities.

Sample Paragraphs, Center for HIV Law and Policy (2011).

HIV disease is a continuous, progressive process beginning with primary infection, continuing in most cases through an extended chronic stage typically without visible symptoms, and eventually leading to significant deterioration of the immune system

("immunodeficiency") and the onset of opportunistic infections. At every stage of HIV infection, the virus attacks the immune system and weakens it. It is a medical fact that untreated HIV infection substantially limits the function of the immune system. [3]

The disruption of immune responses opens the way to infection by a range of different microorganisms that can be severely disabling and fatal. For example, the immune deficiency that results from HIV infection also results in a susceptibility to several types of cancer. Regardless of whether individuals are at the early, middle or advanced stages of HIV disease, each stage is an aspect of the same chronic, progressive disease, the hallmark of which is a compromised immune system.[4]

Fast Facts About HIV, UNAIDS (2008). Available at: http://www.unaids.org/en/resources/presscentre/fastfactsabouthiv/

"HIV is a virus (of the type called retrovirus) that infects cells of the human immune system (mainly CD4 positive T cells and macrophages—key components of the cellular immune system), and destroys or impairs their function. Infection with this virus results in the progressive deterioration of the immune system, leading to 'immune deficiency'.

The immune system is considered deficient when it can no longer fulfill its role of fighting off infections and diseases. Immunodeficient people are more susceptible to a wide range of infections, most of which are rare among people without immune deficiency. Infections associated with severe immunodeficiency are known as 'opportunistic infections', because they take advantage of a weakened immune system."

What is AIDS? NY State HIV/AIDS Information Service (2007). Available at: http://www.nyaidsline.org/app/index.php?pid=2

"HIV is a retrovirus that infects several types of cells in our body, most importantly the CD4+ T Lymphocyte. The CD4+ T-cell is a white blood cell that is a major component of the human immune system that helps fight infection/disease and some types of cancer. By killing CD4+ T-cells, HIV progressively destroys the body's ability to fight infection. HIV is the causative agent for AIDS (Acquired Immunodeficiency Syndrome)."

HIV and Its Treatment: What You Should Know, National Institutes of Health (2009). Available at: http://www.aidsinfo.nih.gov/other/FactSheetDetail.aspx?ClassID=111

"Your immune system is your body's defense system. Cells of your immune system fight off infection and other diseases. If your immune system does not work well, you are at risk of serious and life-threatening infections and cancers. HIV attacks and destroys the disease-fighting cells of the immune system, leaving the body with a weakened defense against infections and cancer."

[3] *See, e.g.*, Centers for Disease Control & Prevention ("CDC"), *Basic Information*, ("CDC, Basic Information").
[4] Anthony S. Fauci, *Multifactorial Nature of Human Immunodeficiency Virus Disease: Implications for Therapy*, 262 Science 1011 (1993). P.R. Dohen and P.A. Volberding, CLINICAL SPECTRUM OF HIV DISEASE, THE AIDS KNOWLEDGE BASE 4.1-4 (P.T.Cohen et al. eds., 2nd ed. 1994). See also, e.g., J.E. Gallant et al. eds., HIV GUIDE, http://hopkins-hivtguide.org

IV. HIV TRANSMISSION ROUTES AND RELATIVE RISKS

HIV transmission is often treated, in law and in conversation, as a certainty if an individual is exposed to the virus. It can be challenging to accurately address the relative transmission risks of behaviors while HIV positive without appearing to minimize the seriousness of the virus or undermine public health efforts. However, as passionate advocates for our clients, it is necessary.

One of the bedrocks of HIV criminalization is the false assumption that all exposures to HIV present equal risks of transmission. This is a significant departure from the standards of intent and risk that are otherwise found in common and statutory law. The following resources provide data about actual transmission risks and rates, and demonstrate the considerable variation in risk among different exposures. While exposure to saliva is criminalized in many states, the CDC has stated that HIV cannot be transmitted through spitting. And while many statutes refer to "sexual contact", there is a huge, well-documented difference in risk of transmission from oral sex, to receptive vaginal intercourse, to protected insertive anal sex, and all the variations in between. As the articles below illustrate, oral sex (which in this context is almost always fellatio, not cunnilingus), has a much lower transmission risk than other sorts of sexual contact, and the variables regarding the risks of all vaginal, anal and oral sex depend on whether the person with HIV is insertive (higher risk of transmission) rather than receptive (lower risk). Statutes and courts also fail to consider the use of condoms in criminal prosecutions for HIV exposure, despite all the scientific and public health support for their use, and their significant reduction in transmission risk. Because courts rarely, if ever, consider what role actual statistical risk should have in HIV exposure prosecutions, it is an important issue to raise.

HIV and Its Transmission, Centers for Disease Control and Prevention (1999). Available at: http://hivlawandpolicy.org/resources/view/360

This fact sheet from the Centers for Disease Control and Prevention (CDC) outlines the ways in which HIV can and cannot be transmitted from one individual to another. HIV is primarily transmitted through sexual contact, by sharing needles and/or syringes, or from mother to child before or during birth or during breastfeeding. The document dispels myths about transmission through the environment, households, businesses, kissing, biting, saliva, sweat, tears, and insects. It addresses the very small number of known cases of transmission from patients to health care providers through needle sticks (or, more rarely, through blood getting into a health care worker's exposed mucous membrane), and that there is only one known instance in which a health care provider transmitted HIV to patients. It should be noted that this is a conservative document, by an agency that resists making declarative statements about risk because of improbable, but scientifically possible, scenarios. Despite that, the document emphasizes the limited routes of transmission that have been identified, and states that condoms are highly effective in preventing the spread of HIV through sexual contact.

- Useful quotations:
  - "Contact with saliva, tears, or sweat has never been shown to result in transmission of HIV."

- "Numerous studies among sexually active people have demonstrated that a properly used latex condom provides a high degree of protection against a variety of sexually transmitted diseases, including HIV infection."

Quantifying sexual exposure to HIV within an HIV-serodiscordant relationship: development of an algorithm, Julie Fox et al., AIDS (2011). Available at: http://hivlawandpolicy.org/resources/view/621

The risk of acquiring HIV from a single sexual contact varies enormously, reflecting biological and behavioral characteristics of both infected and uninfected partners. This article systematically reviewed current literature on HIV transmission estimates, and developed an HIV risk score that would allow quantification of overall risk of HIV acquisition within HIV-serodiscordant partnerships. The HIV risk score enumerates the relative risk of HIV acquisition from HIV-positive partners incorporating the type and frequency of specific sex acts, the HIV plasma viral load and stage of disease, the presence of genital ulcer disease in either partner, and pregnancy, HSV-2 seropositivity, and circumcision status (men only) in the HIV-negative partner.

The authors conclude that key determinants of HIV exposure risk can be incorporated into a mathematical model in order to quantify individual relative risks of acquiring HIV. They intend for the model to facilitate comparisons within clinical trials of exposed, uninfected individuals and facilitate interventions to reduce HIV transmission. In addition to providing valuable, though dense, data on the comparable risks of sexual HIV transmission, the article also gives a sense of the sheer volume of factors that influence transmission.

- Useful quotations:
  - "The risk of HIV transmission reflects two distinct entities, the relative risk of HIV acquisition amongst HIV-uninfected individuals, which represents a composite of genetic factors, immunological factors, nature and frequency of sexual exposure, and presence of concurrent sexually transmitted infections (STIs) and the onward transmission risk posed by HIV-infected individuals which is determined by HIV plasma and genital tract viral load, concomitant STIs, viral characteristics."
  - "Mathematical models suggest that although the risk of transmission on effective suppressive ART is not zero it is very low."

Heterosexual risk of HIV-1 infection per sexual-act: systematic review and meta-analysis of observational studies, Boily et al., Lancet (2009). Available at: http://hivlawandpolicy.org/resources/view/578

This article follows up on an earlier study by the same authors examining per-act heterosexual HIV transmission probabilities. It is a systematic review and analysis of all available study data related to the likelihood of heterosexual HIV transmission. The authors reviewed 43 published studies conducted in various countries that reported per-act heterosexual HIV-1 transmission probability estimates. The authors concluded that the average male to female risk of HIV transmission is .07 - .08% per vaginal sex act (which, in a large study, would mean approximately 7-8 cases of transmission for every 10,000 acts of unprotected vaginal sex) if there was no receptive anal intercourse, the HIV-positive person

was asymptomatic, and there were no other cofactors present, such as other sexually transmitted infections.

The authors' three objectives were to provide summary estimates of HIV-1 transmission probabilities per heterosexual contact; do in-depth single variable and multivariable analysis to explore the reasons for different study results; and estimate the role of risk factors such as viral load and STIs on the likelihood of transmission.

The authors point out that putting a number on the actual likelihood of HIV transmission in a single sexual act is difficult to measure. The actual transmission to a partner, the number of unprotected sex acts, the length of the partner's exposure to HIV, and other potential co-factors among the people who participate in a study about their sex acts are rarely completely known and there are unreported factors, such as some participants actually having other STIs, which could affect the accuracy of studies. Of course, this is likely true of most, if not all, studies that attempt to base conclusions on what people report about their sex lives.

Important findings include that, overall, female-to-male (.04% per act or, in theory, about 4 cases of HIV transmission per every 10,000 acts of vaginal sex with a woman who is HIV positive) and male-to-female (.08% per act or 8 cases of HIV transmission per every 10,000 acts of vaginal sex with a man who is HIV positive) transmission estimates in high-income countries show a low risk of infection even when the person with HIV is not on antiretroviral treatments.

Other findings showed that there were higher estimates of HIV transmission during receptive anal sex (1.7% per act or 17 cases of HIV transmission per every 1,000 acts of anal sex in which the "top" is HIV positive) as opposed to other sexual acts. There also were larger estimated risks of HIV transmission for sexual acts during the early (9.2 to times greater) and late phases (7.3 times greater) of a partner's HIV infection than for sexual acts during the asymptomatic phase of HIV disease. Finally, the authors state that commercial sex exposure and/or genital ulcers in either sexual party increased per-act risk of infection 5.3 times in comparison to the same acts in which sex partners did not have an STI.

- Useful quotation: "Pooled female-to- male (0.04% per act [95% CI 0.01–0.14]) and male-to-female (0.08% per act [95% CI 0.06–0.11]) transmission estimates in high-income countries indicated a low risk of infection in the absence of antiretrovirals."

Per-Contact Risk of Human Immunodeficiency Virus Transmission Between Male Sexual Partners, Eric Vittinghoff et al., 150 AM. J. EPIDEMIOLOGY 306 (1999). Available at: http://hivlawandpolicy.org/resources/view/599

This study of 2,169 homosexual and bisexual men sought to find the rates of seroconversion during various sexual acts—both protected and unprotected—per sexual contact. Out of the entire group, 60 seroconversions occurred over the two-year period between 1992-1994. While the study affirms, unsurprisingly, that unprotected receptive anal sex with a knowingly HIV positive partner carries the highest risk of per-contact infection, the same sex acts with a partner of an unknown serostatus carry a per-contact risk similar to that of needle-stick injuries, and occurred in this study about one-third to one-half as frequently as unprotected receptive anal sex. Also not surprisingly, protection, such as condoms, significantly lowers the risk of infection in both cases.

Other sex acts, such as unprotected receptive oral sex and unprotected insertive anal sex carry an even lower, though still existent, HIV seroconversion risk. The per-contact risk associated with unprotected insertive anal and receptive oral sex with HIV-positive or unknown serostatus partners was 0.06 and 0.04 percent, respectively.

The authors note, however, that individual risk varies on the basis of factors such as viral load, and that about 15 percent of infections occurred after only one or two sexual contacts. Individuals who engaged in unprotected receptive anal intercourse with a partner who was knowingly HIV-positive -- and who consequently were at the highest per contact risk of HIV transmission -- still seroconverted at a rate of only 0.82% per contact, or less than once in 100 acts of unprotected, receptive anal sex.

The authors maintain that the fact of transmission between partners in situations where HIV serostatus is unknown suggests that interventions like post-exposure prophylaxis should not be withheld from individuals who engage in unprotected receptive anal intercourse with a partner of an unknown serostatus, since the risk of transmission is similar to that following needlestick accident involving a HIV-positive individual, for which current guidelines recommend PEP.

- Useful quotation: "The estimated per-contact risk of acquiring HIV from unprotected receptive anal intercourse (URA) was 0.82 percent (95% confidence interval: 0.24, 2.76 percent) when the partner was known to be HIV+ and 0.27 percent (95% confidence interval: 0.06, 0.49 percent) when partners of unknown serostatus were included."

Systematic Review of Orogenital HIV-1 Transmission Probabilities, R. F. Baggaley, R. G. White, and M. Boily, 37 INT'L J. OF EPIDEMIOLOGY 1255-1265 (2008). Available at: http://ije.oxfordjournals.org/content/37/6/1255.full

Believing that it is important to have a better understanding of the actual risks of HIV transmission through oral sex, the authors reviewed and summarized all available research literature, up to July 2007, on the risk of HIV transmission associated with oral sex between men, between women, and between men and women. The authors concluded that the available research was inadequate to determine the actual risk associated with oral sex. Because the risk of transmission is clearly very low, much larger studies would be required to assign a more precise statistical risk factor to oral sex. As the authors note, in cases where oral sex is reported as the only sexual conduct in which an interview was active, there is certainly the possibility of social desirability bias or other reasons why a higher risk interaction, particularly anal intercourse, might not be recalled. The takeaway: the risk of HIV transmission via oral sex is extremely low but greater than zero.

- Useful quotations:
  - "Although transmission risk per-act or per-partner through any type of OI [oral intercourse] activity remains poorly quantified…our review suggests a low but non-zero transmission probability."
  - "The fact that infected study participants with solely this exposure have remained difficult to identify may suggest that indeed the contribution of OI to HIV incidence remains low."

Condom Effectiveness in Reducing Heterosexual HIV Transmission (Review), Weller & Davis-Beaty, The Cochrane Library (2007). Available at: http://apps.who.int/rhl/reviews/CD003255.pdf

This is a large-scale review of the data and conclusions of numerous cohort studies about condom effectiveness in reducing heterosexual HIV transmission. After reviewing and critiquing substantial data, the authors conclude that "Using condoms consistently reduces sexual transmission of HIV infection" and that "Sexual intercourse and contact with contaminated blood products (e.g., intravenous drug use) account for the majority of HIV infections. The use of condoms during sexual intercourse has been promoted to reduce the infection and spread of sexually transmitted infections (STIs) such as HIV."

- Useful quotations:
  - "The review of studies found that condoms, when used consistently, substantially reduced HIV infection but did not totally eliminate the risk of infection."
  - "This review indicates that consistent use of condoms results in 80% reduction in HIV incidence. Consistent use is defined as using a condom for all acts of penetrative vaginal intercourse. Because the studies used in this review did not report on the "correctness" of use, namely whether condoms were used correctly and perfectly for each and every act of intercourse, nor did they report on the quality of the condoms used, effectiveness and not efficacy is estimated."

Effectiveness of Condoms in Preventing HIV Transmission, S.D. Pinkerton, P.R. Abranson, 44 SOC SCI MED. 1303 (1997).

This study argues for the effectiveness of condoms in HIV prevention by looking at the existing quantitative evidence. Although meta-analyses of condom effectiveness at the time of this article suggested that condoms are 60 to 70% effective when used for HIV prophylaxis, these studies did not isolate consistent condom use, and therefore provided only a lower boundary on the true effectiveness of correct and consistent condom use. The reexamination of HIV seroconversion studies in this article suggests that condoms are 90 to 95% effective when used consistently, i.e. consistent condom users are 10 to 20 times less likely to become infected when exposed to the virus than are inconsistent or non-users. Similar results were obtained utilizing model-based estimation techniques, which indicate that condoms decrease the per-contact probability of male-to-female transmission of HIV by about 95%. The authors conclude that though imperfect, condoms provide substantial protection against HIV infection.

- Useful quotation: "A reexamination of HIV seroconversion studies suggests that condoms are 90 to 95% effective when used consistently, i.e. consistent condom users are 10 to 20 times less likely to become infected when exposed to the virus than are inconsistent or non-users."

Rapid Review: Effectiveness of female condoms for preventing HIV/AIDS and factors that impact uptake, OHTN Rapid Response Service, Ontario HIV Treatment Network (2010). Available at: http://www.ohtn.on.ca/Documents/Knowledge-Exchange/Rapid-Review_12_FemaleCondom_2009.pdf

This is a briefing paper that reviews the current science and considerations related to female condom use for HIV prevention. The authors conclude that 1) female condoms are effective in preventing the transmission of HIV/ AIDS; 2) female condoms are important for improving female control and confidence in the negotiation and practice of safe sex; 3) there is much discrepancy around the sociodemographic factors that make women more likely to use female condoms; and 4) interventions that focus on improving attitudes towards female condoms, through increased communication and education of both partners, increase their use.

- Useful quotation: "Considerable evidence exists to suggest that the female condom is effective both in increasing protected sex acts and possibly in reducing STI incidence. However, much more research is needed to support these conclusions, especially with respect to rural and community settings."

Condoms and STDs: Fact Sheet for Public Health Personnel, Centers for Disease Control and Prevention. Available at: http://www.cdc.gov/condomeffectiveness/latex.htm

This fact sheet presents evidence concerning the male latex condom and the prevention of STDs, including HIV, based on information about how different STDs are transmitted, the physical properties of condoms, the anatomic coverage or protection that condoms provide, and epidemiologic studies assessing condom use and STD risk. This fact sheet updates previous CDC fact sheets on male condom effectiveness for STD prevention by incorporating additional evidence-based findings from published epidemiologic studies. It also includes a bibliography of many recent studies and articles.

- Useful quotation: "Latex condoms, when used consistently and correctly, are highly effective in preventing the sexual transmission of HIV, the virus that causes AIDS."

Investigation of Patients Treated by an HIV-Infected Cardiothoracic Surgeon—Israel, 2007, 57 MMWR 1413 (2009). Available at: http://hivlawandpolicy.org/resources/view/347

Acknowledging that the threat posed by HIV-positive health care providers, including surgeons, to their patients is negligible, the CDC discusses an investigation tracking the patients of an HIV-positive cardiothoracic surgeon in Israel. Cardiothoracic surgery is among the most invasive medical interventions, which is why Israeli officials were concerned when this surgeon, who had been practicing for more than 10 years and had treated more than 1600 patients, tested positive for HIV. In response, officials conducted an investigation of patients treated by the surgeon in the 10 years prior to his diagnosis and determined that none had tested positive for HIV. They were able to confirm this with near certainty by comparing the list of patients with the national HIV registry, on which all diagnosed individuals with HIV must be listed. After determining that the surgeon did not pose a threat to his patients, the surgeon was cleared to continue with his practice, with no need to notify patients of his HIV status, as long as he continued to abide by established infection control protocols.

In the editorial following the report, the CDC stated that "the data in this and other studies published since the CDC guidelines of 1991, considered together, argue for a very low risk for provider-to-patient HIV transmission in the present era and could form the basis for national and international public health bodies to consider issuing revised guidelines for

medical institutions faced with HIV infection in a health-care worker performing exposure-prone procedures." This statement reconfirms the very low risk of surgeon-to-patient HIV transmission, even in procedures the CDC characterizes as "exposure-prone." More significantly, it suggests that it is time for medical institutions – and perhaps the CDC itself – to consider revising guidelines that allow the exclusion or practice-restriction of HIV-positive health care workers on the basis of HIV status. This article would be useful in employment cases in which termination, exclusion or job-reassignment is at issue based on perceptions of HIV contagiousness or a belief that an employee poses a "direct threat" to others in the work place, particularly in healthcare settings.

- Useful quotations:
  - "[T[he data in this and other studies published since the CDC guidelines of 1991, considered together, argue for a very low risk for provider-to-patient HIV transmission in the present era and could form the basis for national and international public health bodies to consider issuing revised guidelines for medical institutions faced with HIV infection in a health-care worker performing exposure-prone procedures."
  - "The results of this investigation add to previously published data indicating a low risk for provider-to-patient HIV transmission."

***HIV Transmission: Can HIV be transmitted through a human bite?*,** Ctr. for Disease Control & Prevention, (March 25, 2010). Available at: http://www.cdc.gov/hiv/resources/qa/transmission.htm

This is a basic reference for transmission risks that uses extremely accessible language. The CDC presents conservative advice and data, but it is important to know about this study and the cautious language with which the CDC describes the risk of transmission via biting.

- Useful quotation: "Biting is not a common way of transmitting HIV, in fact, there are numerous reports of bites that did not result in HIV infection. Severe trauma with extensive tissue damage and the presence of blood were reported in each of the instances where transmission was documented or suspected. Bites that do not involve broken skin have no risk for HIV transmission, as intact skin acts as a barrier to HIV transmission."

HIV Transmission: Can I get HIV from being spit on or scratched by an HIV-infected person?, Ctr. for Disease Control & Prevention, (June 3, 2013). Available at: http://www.cdc.gov/hiv/basics/transmission.html

This a basic reference for transmission risks that uses extremely accessible language. The CDC presents conservative advice and data, but it can be a useful starting citation.

- Useful quotation: "Can I get HIV from being spit on or scratched by an HIV-infected person?" "No. HIV cannot be spread through saliva, and there is no documented case of transmission from an HIV-infected person spitting on another person. There is no risk of transmission from scratching because there is no transfer of body fluids between people."

Lack of Transmission of HIV Through Human Bites and Scratches, Chris M. Tsoukus et al., 1 J.A.I.D.S. 505 (1988). Available at: http://hivlawandpolicy.org/resources/view/576

This limited study, conducted during the mid-1980's, chronicles the lack of transmission of HIV through bites and scratches. The study followed only one patient, an HIV- positive hemophiliac with severe brain damage, who was incontinent, masturbated frequently, had poor dental hygiene that led to extreme bleeding in his gums, and often had untrimmed nails. He was violent and hostile toward the hospital staff; out of 198 medical workers who provided care for him, he bit and/or scratched 30 of them. This is the entire basis of the study.

Although his viral load was high, after 2.5 years of consistent follow-up, all of the traumatized medical workers remained HIV-negative. The authors concluded that, "The risk of transmission of HIV through this route under similar conditions should be low." Their conclusion has been supported by the ensuing twenty-two years of research.

- Useful quotation: "Bites and scratches from the patient described in this paper should have constituted a high risk of HIV transmission through skin trauma because of the frequent presence of blood, pus, and copious amounts of saliva in his mouth as well as the presence of semen, blood, and fecal matter coating his fingernails. Despite these risks we did not find any evidence of acquired immune dysfunction or transmission of HIV to those health care workers who were scratched, cut, or bitten by this HIV carrier."

HIV and Pregnancy: Medical and Legal Considerations for Women and Their Advocates, Center for HIV Law and Policy, (2009). Available at: http://hivlawandpolicy.org/resources/view/474

Mother to child transmission of HIV raises specific medical issues and legal concerns. This report and guide outlines these medical and legal issues surrounding HIV and pregnancy in the United States. It makes it clear that persistent beliefs among medical, social service, and justice system professionals that women with HIV should avoid childbearing are unsupported by medical science or the law. The guide is the first of its kind, and charts the intersecting medical, ethical, and legal issues that can arise for HIV-positive women who are or may become pregnant. It underscores not only the legal basis, but the public health advantage, of treating women as active partners in their own and their newborns' treatment, and recognizing their right to appropriate counseling and medical care that accommodates their reproductive options. The guide provides a frank, balanced discussion of the medical issues and options women will encounter at all stages of their pregnancy, and how to deal with legal issues that also may arise when their right to make choices are challenged.

This resource will be useful in situations or cases in which the risks and rates of transmission from mother to child are in play. While the use of antiretrovirals, coupled with interventions such as delivering via caesarean surgery can dramatically reduce the risks of HIV transmission from mother to child, there are other serious health and human rights concerns that should be considered. Understanding the transmission rates and risks, as well as the possible interventions, is the right of every HIV positive pregnant woman. Other resources on transmission rates cited within the manual include Patricia M. Garcia et al., *Maternal Levels of Plasma Human Immunodeficiency Virus Type 1 RNA and the Risk of Perinatal Transmission*, 341 NEW ENG. J. MED. 394 (1999).

- Useful quotation: "Although the risk of an HIV-positive mother transmitting the virus to her fetus or newborn is only 25% without any intervention, the risk may

> be reduced to as low as 2% if the mother follows certain protocols, including the use of anti-HIV medications during pregnancy and childbirth. Whether following these protocols is appropriate, however, will depend on the woman's individual medical circumstances."

Sample Expert Statement on HIV Transmission Risk, Center for HIV Law & Policy. Available at: http://hivlawandpolicy.org/resources/view/381

To avoid a court battle, or to win a case once in court, people with HIV may need to introduce evidence or affidavits demonstrating that they pose no significant risk of transmitting HIV to others through casual contact. In these cases, it can be extremely important to have the assistance of a medical or scientific expert, usually an infectious disease physician, to provide testimony or an affidavit about the relative risks of HIV transmission. The goal in these cases is to educate and persuade a potential adversary, or the trier of fact, whether a judge or a jury, that the HIV-positive person poses no threat of transmission through casual contact, or if the context is consensual sex, no significant risk of transmission when, for example, viral load is undetectable and/or a condom is used. In short, the expert provides the back-up for the argument that HIV infection alone is not an appropriate basis for, e.g., changes in child custody orders, criminal convictions, or exclusion from a workplace. This sample expert statement, which describes the various ways in which HIV is and is not transmitted, may be adapted to meet the needs of specific situations.

V. VIRAL LOAD AND TREATMENT

Unaddressed in most criminal cases related to HIV exposure is the extent to which viral load, often affected by treatment, influences transmissibility. Multiple studies have shown that a low viral load dramatically decreases the transmission risk - less virus in the body = less virus to transmit. But the significant reduction in transmission risk for individuals with low viral load (which is often, but not always, caused by consistent use of highly active antiretroviral therapy (HAART)) is absolutely relevant in defending criminal cases, and the following studies and articles can provide important scientific support.

One word of caution: advocates should construct low-risk of harm defenses around the already-low average risk of transmission even in the absence of treatment (<1% in the most risky type of sexual contact, i.e., unprotected receptive anal sex). Exclusive reliance on treatment-induced low viral load as a defense could effectively narrow the scope of potential defendants to an underclass of those with HIV who do not have effective treatment or who no longer respond to available therapies. Furthermore, it is the burden of the prosecution to prove harm or risk of harm, not the burden of the defendant to show a lack of risk. Using this strategically is beyond the scope of this document, but it is an important basis of argument for a criminal defense attorney to keep in mind.

Antiretroviral therapy for prevention of HIV transmission in HIV-discordant couples (Review), A. Anglemyer et al., COCHRANE DATABASE OF SYSTEMATIC REVIEWS (2011). Available at: http://hivlawandpolicy.org/resources/view/622

This article found seven observational studies that had examined whether antiretroviral

drugs prevent transmission of HIV from an infected sexual partner to an uninfected one, and reviewed the results for conclusions. The authors found that in couples in which the infected partner was being treated with antiretroviral drugs the uninfected partners had more than 5-times lower risk of being infected than in couples where the infected partner was not receiving treatment. Since the World Health Organization already recommends antiretroviral treatment for all persons with ≤350 CD4 cells/μL, the authors also examined studies that had looked at partners with CD4 counts higher than this level.

While these reviewers found that there was inconclusive evidence that HIV was less likely to be transmitted in the higher CD4 count group, a large randomized trial was being conducted, and was concluded early in May 2011 because of it's outstanding results. The trial, conducted by the HIV Prevention Trials Network, was of serodiscordant couples where the person with HIV had a CD4 cell count of between 350 and 550 and were therefore not yet eligible for treatment for their own health according to WHO guidelines. The reduction of sexual transmission of HIV if an HIV-positive person adheres to an effective antiretroviral therapy regimen was so significant, at 96%, that the trial was stopped 3-4 years ahead of schedule. More information on this data should become available at http://www.hptn.org/.

- Useful quotation: "Overall we found that in couples in which the infected partner was being treated with antiretroviral drugs the uninfected partners had more than 5-times lower risk of being infected than in couples where the infected partner was not receiving treatment."

How Reliable is an Undetected Viral Load? C. Combescure et al., HIV MEDICINE (2009). Available at: http://hivlawandpolicy.org/resources/view/593

A study by the Swiss Federal AIDS Commission on patients who were treated with highly active antiretroviral therapy (HAART) concluded in 2009 that individuals with a stable, low viral load for at least six months were extremely unlikely to transmit HIV. In response, the Swiss HIV Cohort Study sought to determine how consistently viral load remains below detectable levels.

The study concludes that when several successive viral loads are less than 50 copies/mL it remains reliably undetectable approximately 94% of the time with a cut-off of 50 copies/mL, and approximately 99% reliable with a cut-off of 1000 copies/mL.

The most significant factor in maintaining a reliably undetectable viral load is consistent compliance with a patient's HAART regimen. Also affecting reliability was the patient's past drug therapy, i.e., the type of HAART and the first antiretroviral therapy the patient received. Patients who started with HAART had a higher rate of reliability than those who started on NRTI mono- or bi- therapy (the first class of antiretroviral drugs developed) in the 1990s.

- Useful quotations:
  - "The Swiss Federal AIDS Commission's review of data concerning the contagiousness of patients treated with highly active antiretroviral therapy (HAART) concluded that patients with stably suppressed viral load (VL) on treatment were extremely unlikely to pass on their infection."
  - "After several successive VLs at <50 copies/mL, reliability reaches approximately 94% with a cut-off of 50 copies/mL, and approximately 99%

with a cut-off at 1000 copies/mL."

Relation Between HIV Viral Load and Infectiousness: a Model-Based Analysis, David Wilson, et al., Lancet (2008). Available at: http://hivlawandpolicy.org/resources/view/510

A consensus statement released on behalf of the Swiss Federal Commission for HIV/AIDS suggests that people receiving effective antiretroviral therapy—i.e., those with undetectable plasma HIV RNA (<40 copies per mL)—are sexually non-infectious. The authors analysed the implications of this statement at a population level. The authors used a simple mathematical model to estimate the cumulative risk of HIV transmission from effectively treated HIV-infected patients (HIV RNA <10 copies per mL) over a prolonged period. They investigated the risk of unprotected sexual transmission per act and cumulatively over many exposures, within couples initially discordant for HIV status. The analyses suggest that the risk of HIV transmission in heterosexual partnerships in the presence of effective treatment is low but non-zero and that the transmission risk in male homosexual partnerships is high over repeated exposures. If the claim of non-infectiousness in effectively treated patients was widely accepted, and condom use subsequently declined, then there is the potential for substantial increases in HIV incidence.

- Useful quotation: "Although the primary purpose of antiretroviral therapy is to slow disease progression in people with HIV infection, it is likely to have the secondary benefit of reducing the risk of new transmission to HIV-negative sexual partners."

Viral Load and Heterosexual Transmission of Human Immunodeficiency Virus Type 1, Thomac C. Quinn, M.D. et al., 342 NEW ENG. J. MED. 921 (2001). Available at: http://hivlawandpolicy.org/resources/view/591

This study, which took place between 1994 and 1998 in Rakai, Uganda, tracked the HIV-1 transmission rate in 415 heterosexual couples with discordant HIV-1 status. Of the couples surveyed, 22% of the HIV negative partners seroconverted during the course of the study. While age and circumcision status were significant factors in the risk of seroconversion, the study found that the infected partner's viral load was the factor most strongly predictive of the risk of transmission.

While most of the factors surveyed--such as history of sexually transmitted diseases, time outside the area, or number of sexual partners--were not predictive of risk, whether or not a male HIV negative partner was circumcised was a significant factor in transmission. In HIV-1 negative males, there were no infections among 50 circumcised men. Amongst uncircumcised males, however, 40 out of 137 seroconverted in the course of the study.

HIV transmission between partners also increased if the HIV-positive partner had a history of genital discharge, painful urination, or AIDS defining symptoms. Age was also associated with infection risk in discordant partners, and risk decreased with age.

Viral load was, overall, the most significant transmission risk factor. Among couples where one partner was seronegative and later converted, their partners had, on average, a significantly higher viral load level than those who remained seronegative. Similarly, there were no transmissions in couples where the seropositive partner had an undetectable viral load. The study did not, however, isolate the extent to which individuals with low viral loads

were also on highly active antiretroviral therapy or other antiretroviral treatments. Other studies, such as the Swiss "How Reliable is the Undetectable Viral Load," also have shown that people who have an undetectable viral load and take HIV antiretroviral consistently are effectively noninfectious.

- Useful quotation: "The viral load is the chief predictor of the risk of heterosexual transmission of HIV-1, and transmission is rare among persons with levels of less than 1500 copies of HIV-1 RNA per milliliter."

VI. PHYLOGENETIC ANALYSIS

Phylogenetic analysis, in the context of criminal prosecutions for HIV transmission, means the analysis of the relatedness between two samples of HIV. Phylogenetic analysis comes up in criminal law cases, particularly in some European cases, as evidence of source of transmission. There are significant limitations to this type of analysis, even when done under rigorous forensic conditions. Most commonly cited is that there is no way to identify the direction of transmission (which is to say, while you can determine that two samples of HIV taken from two different people are closely related, you cannot prove who gave it to whom).

While understanding phylogenetic analysis can be important in planning all possible arguments and in reading existing case law, there are significant considerations before introducing it in a case. Many of these are expounded on in the articles below, but drawbacks include the seeming validation of the structure of the criminal charges, the not insignificant cost, and the difficulty of communicating the scientific limitations to the court.

The use of phylogenetic analysis as evidence in criminal investigation of HIV transmission, Edwin J Bernard and Yusef Azad et al., HIV FORENSICS (2007). Available at: http://hivlawandpolicy.org/resources/view/610

This briefing paper is an introduction to complex scientific and social issues surrounding using scientific analysis of HIV strands in criminal prosecutions. This type of analysis is sometimes suggested as a way to support criminal convictions for HIV transmission, without reference to the scientific and public health limitations. Using plain language, the article addresses the "incorrect assumption that phylogenetic analysis can provide definitive evidence of the route, direction, and timing of HIV transmission. There are, in fact, many limitations regarding what this scientific evidence can 'prove'," and these are discussed in detail in the article.

Some examples of the limitations that should be addressed if using phylogenetic analysis in a trial are that it cannot by itself prove that transmission occurred between individuals and even if phylogenetic analysis suggests viral relatedness, it does not provide any information on the direction of that transmission.

The context of the article is the criminal justice system in England and Wales, but the information about, and significant limitations of, phylogenetic analysis have wide ranging applicability. As described in the introduction of the article: "This short briefing paper is aimed at professionals working in the criminal justice system and HIV professionals who may be called as expert witnesses in criminal HIV transmission cases. It may also be useful

for people working in HIV support organisations and HIV-positive individuals. It aims to explain how phylogenetic analysis should and should not be used in criminal trials for the reckless transmission of HIV."

- Useful quotation: "Although two individuals may have HIV that appear to be very closely related, this will not necessarily be unique to the two individuals but could extend to other people who are part of the same transmission network…Consequently, it can only be used to support other evidence."

The Microbial Forensic Use of HIV Sequences, G.H. Learn and J.I. Mullins, In: LeitnerT, FoleyB, HahnB et al. eds. HIV SEQUENCE COMPENDIUM 2003 (2003). Available at: http://www.hiv.lanl.gov/content/sequence/HIV/COMPENDIUM/2003/partI/Learn.pdf

This is a fairly dense scientific article on the forensics of HIV sequencing, with less of a focus on the legal concerns about the proof. However, it provides many details of the science, as well as good sources and some useful language.

- Useful quotation: "Even in cases in which patterns are consistent with a direction of transmission from the suspected donor to the alleged victim, it may be impossible to know with certainty that the transmission was directly from the donor to the victim without an intervening individual."